

NOIRS 2003 ABSTRACTS

CONTENTS

DAY ONE —TUESDAY, OCTOBER 28, 2003

CONCURRENT SESSION: A

10:30am - 12:00pm

Session: A1.0—Title: Lack of Progress on Construction Fatalities: What are the Obstacles to Prevention?	12
A1.1 What Do BLS Data Tell Us About Current Construction Fatality Trends?	12
A1.2 Analysis of Fatal Events in the Construction Industry 1993-2000: What Do OSHA Data Show?	12
A1.3 New Developments in OSHA Fatality Inspection Data: Enhancing Information Available for Surveillance	12
A1.4 Moving Beyond Surveillance: Lessons Learned from NIOSH Construction Safety Projects	13
A1.5 Comparing U.S. and European Construction Performance: Promising Leads for Research and Policy?	13
Session: A2.0— Title: Cutting Edge Research: The NORA Intervention Evaluation Contest	13
A2.1 Evaluation of the Effect of the Vertical Fall Arrest Standard in Washington State on Union Carpenters	13
A2.2 A Randomized and Controlled Trial of Participative Ergonomics for Manual Tasks (<i>Perform</i>)	14
A2.3 The Use of Supervisory Practices as Leverage to Improve Safety Behavior: A Cross-Level Intervention Model	14
Session: A3.0—Title: Economic Issues in Injury Research	14
A3.1 Relationships Between Work-related Injury Costs and Individual Risk Factors	14
A3.2 Measuring the Economic Burden of Fatal Occupational Injuries	15
A3.3 Economic Cost Model: Transferring Innovative Technology to the States	15
A3.4 How Large is the Government's Underestimate of the Number of Non-Fatal Occupational Injuries?	16
Session: A4.0—Title: Injury Surveillance: Monitoring Workplace Health and Safety	16
A4.1 Fatal Occupational Injuries, 1980-1998: Two Decades of Surveillance	16
A4.2 A Descriptive Study of Logger Fatalities from 1992-2000	17
A4.3 A Comparative Study of Occupational Fatal Injury Rates in South Korea and the United States	17
A4.4 Reported Workplace Fatalities: How Complete is the Picture?	17
A4.5 Incompleteness of the BLS Surveillance System in Estimating Work Related Amputations	18

Session: A5.0—Title: Safety Programs I	18
A5.1 Harmonising Corporate Safety Programs Across the Pacific - Doing the Right Things Right	18
A5.2 Effectiveness and Benefit-Cost of Peer-Based Workplace Substance Abuse Prevention Coupled with Random Testing	18
A5.3 Assessing Safety Awareness and Knowledge Among West Virginia Loggers	19
A5.4 Modeling the Preventive Effectiveness of Pre-placement Screening for Carpal Tunnel Syndrome	19
A5.5 Occupational Electrical Hazard Characterization Using MSDS Format to Communicate Injury Parameters and Prevention	19

CONCURRENT SESSION: B
1:30pm - 3:00pm

Session: B1.0—Title: Priorities for Construction Injury Research: Developing a Construction Safety Research Agenda	20
B1.1 A NIOSH Perspective on Construction Research Priorities	20
B1.2 An OSHA Perspective on Construction Research Priorities	20
B1.3 Contractor Perspectives On Research Construction Priorities	20
B1.4 Extramural Research Perspectives on Construction Research Priorities	21

Session: B2.0—Title: Quantifying Injury Exposure: A Tool for Evaluating Interventions on Road Construction Sites	21
B2.1 Defining Hazard Areas Around Construction Equipment	21
B2.2 Development of Internal Traffic Control Plans	21
B2.3 Measuring Worker Exposure to Work Zone Equipment	22
B2.4 Tracking Worker and Equipment Positions With GPS Receivers	22

Session: B3.0—Title: Safety Programs II	23
B3.1 Process Model of Safety Training Programs	23
B3.2 Assessing The Feasibility of Evaluating the Washington State Apprenticeship and Training Program	23
B3.3 Assessing OSHA’s Projections About the Effects of Its New Safety Standards	24
B3.4 Small Business Owners’ Perceptions of Workplace Safety and Health Programs	24
B3.5 An Intervention to Improve Construction Worker Safety and Health Through Design: Implementation and Outcomes	24

Session: B4.0—Title: Safety Research Methods I	25
B4.1 Methodologic Issues in the Use of Workers’ Compensation Databases for the Study of Work Injuries with Days Away from Work	25
B4.2 Targeting Injury Prevention Using Relative Injury Severity Rate Ratios	25
B4.3 Cross-state Comparisons of Injury and Illness Incidence, Lost Work Days, and Specific Injuries	26
B4.4 Blurring the Distinctions Between Home and Work: Similarities and Differences in Causes	26
B4.5 Computerized Coding of Injury Narrative Data from the National Health Interview Survey	26

Session: B5.0—Title: Agricultural Safety I.....	27
B5.1 Cost-Effectiveness of a Dealer’s ROPS Retrofit Education Campaign	27
B5.2 Evaluating Time-Dependent Errors in Daily Injury Self-reports from Youth in a Longitudinal Study of Agricultural Hazards	27
B5.3 Using Composite Measurement Scales to Model Injury Risks Among Youth Exposed to Agricultural Hazards	27
B5.4 Managing Human Risk in Livestock Handling	28
B5.5 Investigation of Vehicle Jarring/Jolting on Self-Propelled Farming Equipment	28

CONCURRENT SESSION: C
3:30pm - 5:00pm

Session C1.0—Title: Childhood Agricultural Injury Prevention	28
C1.1 The NIOSH Childhood Agricultural Injury Prevention Initiative	28
C1.2 Surveillance of On-Farm Injuries to Youth in the United States	29
C1.3 Hmong Children as Farm Workers in Minnesota: Hazards, Tasks, and Safe Work Practices	29
C1.4 Lessons Learned from the Process and Outcome of a Summit on Childhood Agricultural Injury Prevention	29
C1.5 ChildAg Injury Prevention Center Achievements	30

Session: C2.0—Title: Fire Fighter Turnout Protective Clothing	30
C2.1 Overview of the NIST/USFA Fire Fighter Protective Clothing Research Program	30
C2.2 State-of-the-Art Research on Firefighter Protective Clothing: The Role of Instrumented Manikins	31
C2.3 Overview of the NIOSH/NPPL CBRN Protective Clothing Research Program	31
C2.4 NFPA - Codes and Standards for a Safer World	31

Session: C3.0—Title: Fall Injuries in Construction I	32
C3.1 Prevention of Construction Falls by Organizational Intervention	32
C3.2 Construction Related Non-Fatal Falls in California	32
C3.3 Estimated Costs of Injuries Caused by Falling Through Roof Openings, Surfaces, and Skylights	32
C3.4 Identifying and Controlling Fall Hazards in Routine and Non-Routine Tasks	33

Session: C4.0 69—Title: Injury Surveillance: Mining	33
C4.1 Reducing Injuries from the Fall of Rock in Underground Coal Mines	33
C4.2 An Ergonomics Program Intervention to Prevent Musculoskeletal Injuries Caused by Manual Tasks in Coal Mining: Feasibility Study	34
C4.3 An Analysis of Injuries and Fatalities Related to Tire Safety at U.S. Mining Operations	34
C4.4 A Systems Analysis of Mining Injury and Fatality	34
C4.5 Mine Accident Injury and Illness Exploration Tools	35

Session: C5.0—Title: Emergency/Disaster Response	35
C5.1 Public Safety vs. Personal Risk: Injury Compensation for Police Officers and Emergency Responders in the U.S.	35
C5.2 Protecting Emergency Workers During Major Disaster Response	35
C5.3 The Potential for Use of Biological Safety Personnel in a Bioterrorism Response Surge Capacity System	36
C5.4 Ability and Willingness of Healthcare Personnel to Report to Duty During Severe Disaster Response	36
C5.5 Work Related Injuries and Psychosomatic Problems Amongst Police Officers	36

DAY TWO—WEDNESDAY, OCTOBER 29, 2003

**CONCURRENT SESSION: D
8:30am - 10:00am**

Session: D1.0—Title: The Psycho-social Aspects of Worker Response in Hazardous Workplaces: From Mining, Construction and Agricultural to Terrorism and War (Part I)	37
D1.1 The Need for Situational Awareness Assessment in Hazardous Work Environments	37
D1.2 Information Exchange and Organizational Survival in Dynamic Settings	37
D1.3 Judgment and Decision-Making in Hazardous Work Environments: A Critical Skill	38
D1.4 Prevention and Mitigation of Traumatic Incident Stress After Exposure to Hazardous Conditions	38

Session: D2.0—Title: Preventing Occupational Injuries in Alaska through Surveillance and Collaboration	39
D2.1 “Human Error” as a Leading Cause of Occupant Mortality in Air Taxi and Commuter Crashes in Alaska 1990-1999	39
D2.2 Progress in Partnerships for Surveillance and Prevention of Occupational Aircraft Crashes in Alaska	39
D2.3 Making Alaska’s Fishing Industry Safer: Applied Epidemiology and Engineering	40
D2.4 Fatality Assessment and Control Evaluation in Alaska	40
D2.5 Surveys of Alaska’s Aviation Industry	40

Session: D3.0—Title: Motor Vehicle Safety	41
D3.1 Workplace Injuries in Unionized Trucking Companies	41
D3.2 The Cost to Society of Fatal Occupational Injury to Truck Drivers	41
D3.3 Use of Aggregate Data in Modeling Factors Associated with Truck Driver Injury and Illness and Linkage of Truck and Claims Data	41
D3.4 Truck Crash Experiences of For-Hire Motor Carriers in the United States: 2000-2001	42
D3.5 Driver Distraction/Inattention and Driver Fatigue as Risk Factors for a Fatal Commercial Vehicle Collision in Kentucky	42

Session: D4.0—Title: Workplace Violence I	43
D4.1 Occupational Violence: Environmental Risk Factors	43
D4.2 The NIOSH Workplace Violence Research and Prevention Initiative	43
D4.3 The Evaluation of State-Based Approaches to Workplace Violence Prevention	44
D4.4 Workplace Violence Prevention in the Mental Health Setting	44

Session: D5.0—Title: Special Populations: Injuries Among Youth and Hispanics	44
D5.1 Preventing Youth Worker Fatalities	44
D5.2 Anthropometric Differences Among Hispanic Occupational Groups	45
D5.3 Fatal Occupational Injuries Among Hispanic Construction Workers of Texas, 1997 to 1999 .	45
D5.4 Farm Youth Can Be Reliable Reporters of Their Daily Injury Experiences	45
D5.5 Teenage Construction Workers: Hazards, Experiences, and Work Organization	46

CONCURRENT SESSION: E
10:30am - 12:00pm

Session: E1.0—Title: The Psycho-social Aspects of Worker Response in Hazardous Workplaces: From Mining, Construction and Agriculture to Terrorism and War (Part II)	46
E1.1 Psychosocial Aspects of Employee Evacuation from High Rise Buildings Under Extreme Conditions	46
E1.2 Work in Dynamic and Hazardous Environments: Where does the Potential for Intelligent Performance Reside and How is it Acquired ?	47
E1.3 Issues in Training Emergency Responders: Is Preparation for Terrorism Different from Training for “Ordinary” Disasters?	47
E1.4 Lesson Learned from WTC, Pentagon and Anthrax Incidents: Training for Disasters, Managing Critical Incident, and Pre-Incident Stress	48

Session: E2.0—Title: Construction Injuries I	48
E2.1 Injuries and Illnesses from Wood Framing in Residential Construction, Washington State, 1993-1999	48
E2.2 Characteristics of Work Scheduling and Work-Related Injuries in Construction	48
E2.3 Ontario Construction Industry Fatalities - 1992 to 2002	49
E2.4 Injury and Payment Rates for Different Injury Mechanisms among Types of Construction Work	49

Session: E3.0—Title: Transportation Injuries	50
E3.1 Nonfatal Injuries Resulting from Transportation Incidents	50
E3.2 Pedestrian Injuries Caused by Powered Material Handling Vehicles at a U.S. Heavy Manufacturing Company from 1998 to 2002	50
E3.3 Ambulance Crash-Related Injuries Among EMS Workers	50
E3.4 Road Compactor Overturn Injury Risk Factors	51
E3.5 The Work Zone Analysis System: A Tool to Evaluate Worker Exposure Around Hazardous Equipment	51

Session: E4.0—Title: Health Care Workers/Sharps Injuries	52
E4.1 Cost-Effectiveness of Safer Sharp Medical Devices for Prevention of HIV and Hepatitis C Infection in Healthcare Workers	52
E4.2 Effectiveness of the Bloodborne Pathogens Standard in Reducing the Rate of Sharp Injuries in California Hospitals	52
E4.3 Risk Factors for Occupational Blood Exposure: Estimates from the National Study to Prevent Blood Exposure in Paramedics	53
Session: E5.0—Title: Safety Research Methods II	53
E5.1 Comparison of Fatality Rate Denominator Choices: Population Based Methods	53
E5.2 Using Injury Classification Systems with Safety Report Narratives to Inform Occupational Injury Interventions	54
E5.3 Grouping ICD9-CM Diagnoses in Workers' Compensation Administrative Databases to Create Design Variables in Generalized Linear Models for Incidence and Outcome	54
E5.4 The Effectiveness of OSHA Inspections in Manufacturing in Preventing Lost Workday Injuries: How it Varies with Characteristics of the Workplaces and the Inspections	54
E5.5 How Low Can They Go? Potential for Reduction in Injury Rates	55

CONCURRENT SESSION: F
1:30pm - 3:30pm

Session: F1.0—Title: Job Safety and Health Intervention Effectiveness: Doing the Right Things	55
F1.1 Intervention Effectiveness: Evaluation of Six Workplace Safety Programs to Determine their Contribution Injury Reduction	55
F1.2 Evaluation of a Best Practices Back Injury Prevention Program in Nursing Homes	56
F1.3 Evaluating the Effectiveness of a Logger Safety Training Program in Reducing Injuries to Loggers	56
F1.4 Effectiveness of Narrative Approaches to Occupational Injury Prevention Interventions	56
Session: F2.0—Title: Construction Injuries II	57
F2.1 Construction Injury: Patterns of Factors Contributing to Different Types of Injury Events	57
F2.2 Training Effects on Work-Related Injuries Among Construction Laborers	57
F2.3 Disabling Traumatic Injuries in Construction: Fractures and Their Antecedents	57
F2.4 Reducing Risk of Musculoskeletal Disorders Through The Use of Rebar Tying Machines ...	58
F2.5 Using Narrative Reports to Identify Factors Contributing to Construction Injury	58
Session: F3.0—Title: Fire Fighters	59
F3.1 A Profile of Thermal Imaging Camera Ownership in the United States Fire Service	59
F3.2 U.S. Firefighter Fatalities at Structure Fires	59
F3.3 Firefighter Fatalities 1998-2001: Overview with an Emphasis on Structure-Related Traumatic Fatalities	59
F3.4 Analysis of Mine Fires and Fire Injuries at U.S. Underground and Surface Mines 1991-2001	60

Session: F4.0—Title: Occupational Injuries: Social and Economic Issues	60
F4.1 Comparing Costs of Fatalities from Two Fatal Occupational Injury Surveillance Systems in the United States	60
F4.2 Challenges for Workplace Injury Prevention in a Changing Canadian Health Care Sector ...	60
F4.3 New Perspectives in Construction Health and Safety Research: Investigation of the Complex Relationships Between the Worker, the Work Environment, and the Socioeconomic Context	61
F4.4 What Kinds of Injuries Do OSHA Inspections Prevent?	61
F4.5 Depression, Women, and Occupational Injuries	61

CONCURRENT SESSION: G
1:30pm - 3:30pm

Session: G1.0—Title: Innovations for Improving Fire Fighter Safety in Structure Fires	62
G1.1 Review of NIOSH Fire Fighter Structure Fire Fatality Investigations	62
G1.2 Fire Fighter Visibility: Which Way is Out?	62

Session: G2.0—Title: Workplace Violence II	63
G2.1 Minnesota Nurses' Study: Impact of Violence Prevention Policies	63
G2.2 Workplace Homicide During Robbery: A Case-Control Study	63
G2.3 Implementation of a Workplace Robbery and Violence Prevention Program	64
G2.4 The Impact of a Comprehensive Violence Prevention Intervention on Training Parameters	64

Session: G3.0—Title: Injury Hazards I	65
G3.1 An Acute Fatality While Applying a Spray-On Truck Bed Liner	65
G3.2 Safety Hazards to Workers in Modular Home Installation	65
G3.3 Occupational Injury Events Leading to Hospitalization	65
G3.4 Development of a New Electrical Injury Protection System-Selection of RF Transmitter Mounting Location on the Human Body	66
G3.5 Welding-Related Ocular Injuries	66
G3.6 Workplace Injuries and Illness Trends in the Electric Energy Industry: Initial Results from a Comprehensive Occupational Health and Safety Surveillance System	67

Session: G4.0—Title: Agricultural Safety II	67
G4.1 Magnitude and Etiology of Agricultural Injuries Among Households with Children: Regional Rural Injury Study-II	67
G4.2 Task-Specific Injury Rates for Youth Exposed to Agricultural Hazards	67
G4.3 A Case-Control Study of Injuries among Central Ohio Farm Youth	68
G4.4 Summer Work and Injury among Youth on Family Farms	68
G4.5 Risk Factors for Farm Work-Related Injuries: A Nested Case Control Study in the Agricultural Health Study Cohort	68

POSTER SOCIAL

1:30pm - 3:30pm

P01	Injury Atlas II - Occupation Level View of Lost Time Injuries - Ontario Construction Trades - 1997-99	69
P02	Farm Work Practices and Farm Injuries among Women and Men in Colorado, 1992-1997	69
P03	Effects of Company Size on Non-Fatal Injury Rates in Construction	70
P04	California Fatality Assessment and Control Evaluation (FACE): Summary of Occupational Fatalities in Los Angeles County 1992-2001	70
P05	Haulage Truck Safety at Surface Mine Dump Sites	70
P06	Worker Age and Type of Injury in Ontario Construction	70
P07	An Evaluation of Scaffold Safety at Construction Sites	71
P08	Animals Involved in 20 Agricultural Fatalities	71
P09	Roadway Work Zone Traffic Speed Control Study	72
P10	Back Injuries among Nurses: Change the Nurse or Change the Task?	72
P11	Iowa FACE Program Agricultural Injury Fatalities	72
P12	Communicating Severity of Hazard with the Signal Word on a Safety Sign	73
P13	Costs and Morbidity in Work-related Motor Vehicle Crashes	73
P14	Web-based Safety Toolbox Database	74
P15	Agricultural Injury among Rural California High-School Students	74
P16	Work-Related Time-Activity Patterns among Youth Exposed to Agricultural Hazards	74
P17	A Case-Crossover Pilot Study of Slips, Trips, and Falls in Health Care Workers	75
P18	Ergonomic Walkthrough Evaluations of a Pre-Manufactured-Home-Fabrication Plant	75
P19	Heat-Related Fatalities in North Carolina	75
P20	A Communication Intervention for Technology Transfer of NIOSH Field Portable Analytical Methods	76
P21	Research Program to Develop Optimal NIOSH Alerts for Farmers	76
P22	Hazards Associated with Military Service: Fatal Motor Vehicle Crashes among Veterans of the Gulf War Era	77
P23	Extended Work Schedule and Risk of Occupational Injury	77
P24	Work-RISQS — A Web-Based Injury Research Tool	77
P25	The Use of BLS Annual Survey Data for Hypothesis-Generating Studies and the Issue of Datasets for Modeling	78

DAY THREE—THURSDAY, OCTOBER 30, 2003

**CONCURRENT SESSION: H
8:30am - 10:00am**

Session: H1.0—Title: Investigating the Non-Reporting of Occupational Injuries	78
H1.1 Determinants of Claim Filing Among Young Injured Workers	78
H1.2 Injury Reporting in the Railroad Industry: Cause for Suspicion	79
H1.3 Distributional Effects of Filing a Workers' Compensation Claim	79
Session: H2.0—Title: Injury Hazards II	79
H2.1 Incidence, Risk Factors and Costs of Carbon Monoxide Poisoning in West Virginia Workers	79
H2.2 Traumatic Injuries Among Embalmers	80
H2.3 Traumatic Injuries in a Cohort of North Carolina Commercial Fisherman	80
H2.4 Hazards and Suggested Control Methods for the Wood Pallet Manufacturing Industry	80
H2.5 Evaluation of a Training Exercise for Teaching Drillers about Noise and Hearing Protection	81
H2.6 Disabling Occupational Injuries In U.S. Restaurants	81
Session: H3.0—Title: Machinery and Coal Mining Injuries	81
H3.1 Determination of Safe Roof-Bolter Speeds Through Computer Simulation	81
H3.2 Developing an Innovative Multi-disciplinary Approach: Electric Arc-induced Injuries in the Mining Industry	82
H3.3 Caught-In Injury Protection System for Wood Chippers	82
H3.4 Amputations at a U.S. Heavy Manufacturing Company From 1998 - 2002	82
H3.5 Development of a Safety Intervention in Small Metal Working Shops	83
Session: H4.0—Title: Fall Injuries in Construction II	83
H4.1 Load Testing of Job-Built Guardrail Systems	83
H4.2 Use of Text Data from Injury Reports/Investigations to Understand Construction Falls	84
H4.3 Postural Adaptation at Elevated and Sloped Surfaces	84
H4.4 Fall Prevention vs. Fall Arrest in Ontario Construction	84
Session: H5.0—Title: Back Injury Prevention	85
H5.1 Use of Mechanical Lifts Reduced Injury Rates among Nursing Personnel	85
H5.2 The Use of Workers' Compensation and Medical Claims Data for Surveillance of Acute Back Injuries among Health Care Workers	85
H5.3 VISN-Wide Deployment of a Back Injury Prevention Program for Nurses: Safe Patient Handling & Movement	86
H5.4 Musculoskeletal Disorders among Dental Students	86

NOIRS 2003 ABSTRACTS

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DAY ONE: TUESDAY, OCTOBER 28, 2003

Session: A1.0

Title: Lack of Progress on Construction

Fatalities: What are the Obstacles to Prevention?

Moderator: Matt Gillen

A1.1

Title: What Do BLS Data Tell Us About Current Construction Fatality Trends?

Author: Richardson S

In this presentation, fatal work injury trends in private industry construction from 1992 through 2001 will be examined using surveillance data from the BLS Census of Fatal Occupational Injuries (CFOI) program. A total of 10,826 fatal work injuries were recorded in private industry construction over the ten-year study period. The number of construction fatalities recorded in 2001 (1,224 fatal work injuries) was the highest annual count for any individual year and represented a 33 percent increase over the 1992 total. Though the number of fatalities has increased, rates of fatal injury in construction have changed little on a year-to-year basis over that period. The overall fatality rate for the ten-year period for construction was 14.0/100,000, and no rate for any individual year between 1992 and 2001 deviated more than 8 percent in either direction from that overall rate. In terms of individual occupations, rates for the ten-year period were highest among structural metal workers (78.4/100,000), construction laborers (37.1/100,000), electrical power installers/repairers (28.5/100,000), and roofers (27.8/100,000). Fatality rates for structural metal workers were down 45 percent from 1992 to 2001, but rates for roofers were up over 39 percent. Rates for most other construction trades were either down slightly or largely unchanged. Falls accounted for about a third of all fatalities in construction over this period, and the number of fatal falls increased by nearly 60 percent from 1992 through 2001. About 16 percent of the fatal work injuries in construction involved Hispanic or Latino workers, and the number of fatally-injured Hispanic construction workers in 2001 represented a 168 percent increase over 1992 totals. This presentation will further profile construction fatalities by detailed industry and occupation, demographic characteristics, and by the type of event or exposure.

A1.2

Title: Analysis of Fatal Events in the Construction Industry 1993-2000: What Do OSHA Data Show?

Author: Schriver W

Annual analyses of OSHA-inspected fatal construction events reveal a consistent pattern in the rank of the proximal causes. Intra-year comparisons of the ranks of 29 causes during the 1991-2001 years show rank-order correlation coefficients ranging from .90 to .95.

This paper describes and ranks each of these 29 causal categories, developed from reviews of OSHA Form 170 narratives, to assist OSHA in the development of intervention strategies. The paper also speculates on reasons that may explain the stability in the rank of these causes and implications for intervention.

A1.3

Title: New Developments in OSHA Fatality Inspection Data: Enhancing Information Available for Surveillance

Author: Rinehart R

More construction workers are killed each year than workers in any other industry in the United States, and the current number is at record levels. Twenty-three percent of all occupational fatalities recorded in 2001 by the Bureau of Labor Statistics (BLS) were in construction, even though construction represented only eight percent of the workforce. The construction fatality rate, or risk of dying on the job, is more than three times the national average for general industry. The construction fatality rate has remained this high for at least ten years. Researchers working on construction issues should be cognizant of fatality data, its uses, and limitations. In the Department of Labor, both the BLS and the Occupational Safety and Health Administration (OSHA) collect fatality data. BLS collects data through its Census of Fatal Occupational Injuries program and OSHA through fatalities it investigates. The OSHA fatality data are a subset of the BLS data, but the two databases are not directly comparable and cannot be linked. This presentation describes how OSHA collects fatality data. It also discusses limitations with the current data, which do not adequately describe risk factors associated with fatal events, and what OSHA is doing to improve the situation.

A1.4

Title: *Moving Beyond Surveillance: Lessons Learned from NIOSH Construction Safety Projects*

Author: Fosbroke D

The concept that construction is dangerous work is not novel, nor is the fact that working at heights, around electricity, in trenches, and around heavy machinery has killed thousands of construction workers. Research increasingly focuses on improving conditions in the construction industry, yet recent surveillance data suggest little headway in preventing construction worker injuries.

Why this lack of progress? One reason is that the construction industry's injury issues are complex sets of different problems-- sometimes related and sometimes not. No single at-risk-group accounts for a significant proportion of the 1000 construction workers killed annually. To reduce the toll in construction, research must target specific safety hazards among specific at-risk groups, typically representing 10 to 40 deaths per year. Another reason is that construction research tends to be descriptive and parochial in nature. If research is to impact the level of construction fatalities, researchers need to move beyond "discovering" that roofers fall off of roofs and begin conducting research that covers the spectrum of the public health model-- not just injury hazard identification.

The NIOSH Division of Safety Research began the NORA Traumatic Injury Research Program with the expressed goal of selecting research projects that advance the science of injury prevention along the public health model continuum. Program results are pending, but much has been learned about focusing injury research to bring it closer to prevention. By developing knowledge about tasks, materials, and processes; by moving research into the workplace; and by working with construction industry partners, researchers can focus research so that results are relevant to real world conditions. Simultaneously, researchers learn about channels of distribution, change agents, and spin-off applications, thus, greatly enhancing ability to move positive results out of the laboratory (and peer-review article) and into use on the construction site.

A1.5

Title: *Comparing U.S. and European Construction Performance: Promising Leads for Research and Policy?*

Author: Platner J

Several European Union (EU) nations have reported construction fatal injury rates which are considerably lower than US fatality rates based on the Census of Fatal Occupational Injuries (CFOI). Differences in data collection mechanisms may not allow fatality data to be directly compared across national boundaries. However, EU practices and policies provide alter-

native approaches which deserve consideration as ideas for potential leads for new types of construction interventions. For example, EU practices differ from the US with respect to allocation of responsibility for safety and health on the job-site between owners, contractors, architects and designers. EU directives and the related national enabling legislation provide incentives for safety in design and pre-construction risk assessment which are quite different from the US. Policy alternatives that encourage safety considerations in design and engineering, and which require pre-construction assessment of hazards and development of controls, provide valuable contrasts to current US practice. There are also several examples from the US of similar incentives/requirements being built into public and private bid structures and specifications. These and other approaches will be described.

Session: A2.0

Title: *Cutting Edge Research: The NORA Intervention Evaluation Contest*

Moderators: James Collins, Ted Scharf

A2.1

Title: *Evaluation of the Effect of the Vertical Fall Arrest Standard in Washington State on Union Carpenters*

Authors: Lipscomb HJ, Li L, Dement JM

Washington State enacted and enforced a fall standard for the construction industry in 1991, preceding the Safety Standard for Fall Protection in the Construction Industry promulgated by U.S. Federal OSHA in 1994. We used administrative data to identify a cohort of 16,215 union carpenters, their hours worked by month, and workers' compensation claims for the ten year period 1989-1998. Using these data, we evaluated changes in the rate of falls among this cohort after the fall standard in Washington State in 1991, taking into account the temporal trends in their overall injury rates. Time window analyses allowed us to explore when the standard appeared to have the greatest effect. Since the standard also has regulations designed to decrease severity of falls, we compared measures of severity before and after the standard including costs and days lost from work.

There was a significant decrease in the rate of falls from height after the standard went into effect, even after adjusting for the overall decrease in work-related injuries among this cohort. The greatest decrease was seen 3-3.5 years after the standard went into effect. There was also a significant reduction in mean paid lost days per injury; and when adjusting for age and temporal trend for costs among non-fall injuries there was a significant reduction in mean costs per fall.

A significant reduction in the rate and severity of falls from elevations among a large cohort of high risk carpenters was demonstrated following promulgation of the Vertical Fall Ar-

rest Standard in their state. Most pronounced effects were seen several years after the standard went into effect. The methods take into account the overall decline in injury rates among the cohort over 10 years surrounding the standard, and demonstrate evaluation techniques that are useful in the absence of a control group.

A2.2

Title: A Randomized and Controlled Trial of Participative Ergonomics for Manual Tasks (PerforM)

Authors: Burgess-Limerick R, Egeskov R, Pollock C, Straker L

Between Oct – Dec 2000, 177 small to medium sized workplaces (30 – 100 employees) were audited by state government workplace health and safety inspectors. The workplaces were categorised as either food processing, construction related manufacturing and wholesaling, and nursing homes/accommodation for the aged. The information gathered covered management systems, legislative compliance, productivity, absenteeism, lost time injuries, organisational culture, safety activity and physical risk estimates. Workers compensation data was also obtained subsequently.

Following the audit, this group of workplaces was offered the opportunity to be involved in the evaluation of a participative ergonomics intervention program aimed at reducing manual tasks injury risk (PERforM). 48 workplaces volunteered and 31 were randomly assigned to an experimental group which received the intervention immediately (Mar-July 2001), with the remainder forming a control group who were again offered the intervention at the completion of the evaluation in 2002. Nine months following the intervention for the experimental group, all workplaces were audited again by government inspectors (April-July 2002).

The estimate of risk exposure to employees at a workplace reduced in the experimental group following intervention compared with no change or an increase in the control group. This suggests the participative ergonomics intervention was successful in reducing the risk of musculoskeletal disorders associated with manual tasks. Aspects of task repetition and duration and postural awkwardness appeared to be more influenced by the intervention than commonly perceived risk such as exertion force. The pattern of risk across body regions was similar. The number of formal advices provided by government inspectors was greater for the control group than the experimental group, matching the differences in physical risk estimates. The PERforM intervention also appeared to change the safety management systems, with an increase in the provision of information to employees on manual tasks and an improvement in health and safety structures.

A2.3

Title: The Use of Supervisory Practices as Leverage to Improve Safety Behavior: A Cross-Level Intervention Model

Authors: Zohar D, Luria G

The paper presents three intervention studies designed to modify supervisory monitoring and rewarding of subordinates' safety performance. Line supervisors received weekly feedback concerning the frequency of their safety-oriented interactions with subordinates, and used this to self-monitor progress towards designated improvement goals. Managers higher up in the organizational hierarchy received the same information, coupled with synchronous data concerning the frequency of workers' safety behaviors, and highlighting covariation of supervisory action and workers' behavior. In all the companies involved, supervisory safety-oriented interaction increased significantly, resulting in significant changes in safety behavior and safety climate scores. Continued improvement during the post-intervention period suggests that managerial policy concerning the role of line supervisors in behavioral safety has been modified. Applied and theoretical implications are discussed.

Session: A3.0

Title: Economic Issues in Injury Research

Moderator: Timothy Struttman

A3.1

Title: Relationships Between Work-related Injury Costs and Individual Risk Factors

Authors: Chen GX, Jenkins E L, Biddle EA

Traditional analyses of the impact of work-related injuries have focused on numbers and rates (per 100,000 employed) of injuries and, occasionally, tabulations of injury costs from workers compensation data. This study combines workers, compensation data with actual work hours data (from payroll records) and survey data. In order to develop an additional metric for analysis, work-related injury costs were calculated as number of dollars in workers compensation per 100 work-hours and modeled using a generalized linear model.

Gamma regression was used to explore the associations between work-related injury cost rates and individual employee risk factors, taking account of the exposure variable of work-hours for each employee. This study makes use of data from a large NIOSH study in which a prospective cohort of 9,377 material handling employees was observed for up to two years from 1996 to 1998. All types of work-related injuries were included. The injury costs include medical and indemnity payments.

The 9,377 workers contributed 22.2 million work-hours. There were 2,065 injury claims with a total of \$2.1 million in payments. For the study population the average work-related injury cost rate was \$9.48/100 work-hours. The risk factors that were found to be significantly associated with the cost rate were history of previous back injury, age group, job title, smoking, and back belt wearing.

Analysis of cost per hours of work adds another dimension to analysis of work-related injuries and in combination with survey data, allows assessment of individual characteristics and risk factors in relationship to work-related injuries. Targeting of research prevention strategies may be enhanced with these additional analyses.

A3.2

Title: Measuring the Economic Burden of Fatal Occupational Injuries

Author: Biddle EA

Occupational injuries claimed the lives of nearly 50,000 American workers from 1992-1999 as reported through the Census of Fatal Occupational Injuries (CFOI) surveillance system. Occupational fatality counts describe only a portion of the burden to the worker, industry, and society. Measuring the economic loss of fatalities adds a valuable dimension to targeting efforts as well as a tool for assessing cost savings of prevention efforts.

This research developed an interactive computer program that unlike earlier works derives the economic burden using a bottom-up-approach—summing the cost of each individual fatality based on the decedent's characteristics as reported by CFOI. The model, consistent with the human capital theory, provides national and state estimates for the economic burden of occupational injury fatalities for selected groups such as specific industries, occupation groups, and minority workers.

Over the study period, the total cost to society for occupational injury fatalities was \$33 billion, ranging from about \$5 billion in 1994 to nearly \$4 1/2 billion in 1999. The mean cost for this period was \$784,189 and the median was \$791,556. Mean costs ranged from \$761,724 in 1999 to \$806,892 in 1992. The highest total costs of fatal occupational injury were in the construction industry—\$7 billion, or about 20% of the overall burden both in costs and number of fatalities. The public administration industry had the highest mean cost of fatalities with just over \$1 million and the agriculture industry had the lowest mean cost with \$557,371. Similarly, the mean cost of fatalities by occupational group ranged from \$1.1 million in managerial and professional specialties to \$459,330 in farming, forestry, and fishing. Costs were also estimated by case and worker characteristics. Cost estimates provide additional information about how injuries affect society. They can improve injury preven-

tion and control program planning, policy analysis, evaluation, and advocacy.

A3.3

Title: Economic Cost Model: Transferring Innovative Technology to the States

Authors: Hartley D, Biddle E, Starkey S, Fabrega V, Richardson, S

During 1992-1999 nearly 50,000 occupational fatalities were reported through the Bureau of Labor Statistic's (BLS) Census of Fatal Occupational Injuries (CFOI) surveillance system. A cost model developed at the National Institute for Occupational Safety and Health estimated that the total societal burden for 1992-1999 was nearly \$40 billion. This estimate was based on nationwide medical expenses for fatal occupational injury and lost wages due to premature death.

Wages used in this model were BLS Current Population Survey national estimates of the median annual earnings by occupation. These wage estimates vary substantially by state; the highest being twice that of the lowest. Estimates from this cost model are driven, in large part, by wage data and therefore have similar variability. Cost estimates using national wages were compared to estimates generated from state wages to determine the effect on the estimates of overall societal burden of occupational injury.

During the period studied, there were 3,959 fatal occupational injuries in Texas. Truck drivers had the largest number of fatalities (587). Texas cost estimates were 10-11% lower than national estimates for the same occupation. For example, the Texas mean estimate for 47 year old white male truck drivers was \$739,000 compared to \$826,000, the national mean estimate for this same group. Estimates for 28 year old white male truck drivers in 1994 varied from \$849,000 to \$943,000.

This pilot shows substantial differences in cost estimates generated using state data versus estimates using national data. CFOI states can adopt this technology as a tool for use with frequencies and rates for targeting prevention of worker fatalities. Additionally, using state-specific wage data in the national model will improve the accuracy of societal cost estimates for fatal occupational injury.

A3.4

Title: *How Large is the Government's Underestimate of the Number of Non-Fatal Occupational Injuries?*

Authors: Leigh JP, Marcin JP, Miller TR

Debate surrounds the size of the underestimate of non-fatal injuries produced by the U.S. Bureau of Labor Statistics. In this study, we build models to estimate the undercount. The idea behind our method is to estimate the numbers of injuries among workers omitted by design from the Annual Survey and then sum them. We therefore create six categories: BLS Annual Survey, federal government, agriculture, state and local government, self-employed outside agriculture, and all other. The federal government provides its own estimate for its employees. The remaining four categories are estimated in models that assume numbers of non-fatal injuries can be predicted by numbers of persons employed in the categories as well as numbers of injury deaths. Evidence is presented that non-fatal and fatal injuries are proportional across industries. The models account for underreporting by employers and employees. Assumptions regarding deliberate underreporting rely on 13 estimates from the literature as well as our own analysis of BLS data. For example, we show that it is likely that small firms are especially prone to underreport. The Census of Fatal Occupational Injuries demonstrates that small firms are among the most hazardous. But the Annual Survey data suggests non-fatal injury rates are low within small firms.

We estimate that the Annual Survey misses from 0% to 70% of the injuries (from private firms, excluding the self-employed) it is designed to capture. When we include firms and governments it is not designed to capture, and consider reasonable assumptions regarding inaccurate underreporting, we estimate the BLS misses between 33% and 71% of all non-fatal injuries.

We conclude that the government significantly underestimates the number of non-fatal occupational injuries.

Session: A4.0

Title: *Injury Surveillance: Monitoring Workplace Health and Safety*

Moderator: Larry Jackson

A4.1

Title: *Fatal Occupational Injuries, 1980-1998: Two Decades of Surveillance*

Author: Marsh SM

Background: With almost 20 years of data, the National Institute for Occupational Safety and Health's National Traumatic Occupational Fatalities (NTOF) surveillance system contains the largest source of consistently collected fatal occupational injury data in the U.S.

Methods: NTOF includes death certificate information from the 50 states, New York City, and the District of Columbia. Certificates are collected yearly for victims 16 years of age or older who had a positive response to the "Injury at work?" item and an external cause of death. Rates per 100,000 workers were calculated by using the micro data files from the Bureau of Labor Statistics' Current Population Survey. A linear regression model was used to determine if rates decreased significantly by year from 1980 through 1998. To determine statistical significance, p-values for the test that the regression slope was not equal to 0 were evaluated at $p=0.05$.

Results: During this 19-year period, the average rate was 5.0 per 100,000 workers. The 48% decline in rates from 1980 to 1998 was significant (7.4 to 3.9, respectively; $p<0.0001$). While all age categories experienced significant declines in rates, the youngest workers (16-17 years old) experienced the largest decrease and the oldest workers (65 years and older) experienced the smallest decline. Causes of death with the largest decreases in rates were fires (75%) and water transport (67%). The decline in rates was significant for all causes except suicide and for all industries except retail trade, finance/insurance/real estate, and mining.

Conclusions: Although there have been statistically significant decreases in the number and rate of fatal occupational injuries since 1980, prevention efforts must continue to focus on older workers, causes of death such as motor vehicles, and those persons working in industries such as mining.

A4.2

Title: *A Descriptive Study of Logger Fatalities from 1992-2000*

Author: Scott DF

The overall goal of this retrospective descriptive study was to develop a profile of logger fatalities. Relationships between the cause of the fatality (dependent variable) and independent variables, including year, month, day, time of day, region, age, gender, race, employer size, and part of body which was injured and caused the death were examined.

The purpose of this study was to establish a new method to examine logger fatality data by combining two dependent variables (cause of fatality and the activity of the logger when killed) into one variable (CAUSE-ACTIVITY) and comparing that dependent variable to several selected independent variables.

The profile of the most common logger fatality, based on this 1992-2000 descriptive study, would be a white male tree cutter (feller) between the ages of 55 and 64 cutting trees between August and November. The victim would have an accident occurring between the hours of 9 a.m. and 2 p.m. on a Tuesday, Wednesday, or Thursday, working for an employer employing from 1 to 10 workers in Kentucky, West Virginia, Virginia, or Pennsylvania, and dying from a head injury.

Results from this study show that the four major problems in logging are: most fatalities occur in the south, treefallers cutting trees suffer a larger percentage of fatalities, a majority of fatalities are caused from head injuries, and small logging companies suffer a disproportionate amount of fatalities.

A4.3

Title: *A Comparative Study of Occupational Fatal Injury Rates in South Korea and the United States*

Authors: Ahn Y, Bailer AJ, Bena JF

Occupational fatal injury rates present a standardized measure of workplace risk that allows for comparison between subgroups of a population and across countries. Rates of fatal injuries from the Republic of Korea and the United States are compared. Mortality and employment information from Korea were obtained through the Korea Occupational Safety and Health Agency, and are from national workplace insurance company data files. Mortality data from the United States were provided by the Census of Fatal Occupational Injuries and employment estimates from the Current Population Survey were used.

Overall and sector-specific fatality rates for the years 1998 through 2001 are presented. These analyses can be used to identify areas where workers in the two countries face similar risks, and where these risks differ. Preliminary results indicate

that workers in Korea face a higher risk of fatal injuries than their American counterparts overall. In certain industries the rate of fatal injuries is at least three times as large for Koreans than for Americans. In particular, the Korean occupational fatality rate in manufacturing was over 13 per 100,000 workers per year, while the United States rate in this industry was less than 4 per 100,000 workers per year. Processes within industry sectors are described in an effort to explain differences in the rates that are observed. By comparing these differences in rates across countries, a better understanding of fatal injuries and their causes can be gained, and allow for more focused safety interventions.

A4.4

Title: *Reported Workplace Fatalities: How Complete is the Picture?*

Author: Alberg NM

It is well known that single source surveillance for workplace fatalities is inadequate. The provincial Workplace Safety and Health Division (WSH), Department of Labour in the province of Manitoba, Canada, has the responsibility for tracking fatalities in all workplaces. The system collects information on both workers and general public who die at, or as the result of, a workplace and its hazards. Although data is available for the past 20 years, the enhanced surveillance model has been in place for three years. This tracking is undertaken within the industry mosaic of companies which are under either Provincial or Federal Workplace Safety and Health Acts, within a framework of a Provincial Workers' Compensation Act which designates some sectors as mandatory coverage, while others are voluntary, and includes self-employed workers. There is active reporting to WSH from several agencies, supplemented by a daily review of both print and airwave media.

Given that the WCB's establish administrative criteria at the provincial level, using their number of reported fatal workplace events as the suggested national figure introduces a discrepancy in what is being counted. In Manitoba, the number of fatalities reported by the WCB is one third of the total number within the WSH tracking system. At the national level, where there is a separate tracking system for fatalities occurring on farms since 1990, the Canadian Agricultural Injury Surveillance Program (CAISP), the discrepancy between the two numbers is 4-5 fold, with many more deaths being reported by the multi-source CAISP system.

This presentation will present numbers from Manitoba's enhanced model of surveillance, demonstrating that earlier numbers have significantly underestimated the true burden of workplace fatalities. The current challenge is to determine the best combination of surveillance sources available to most jurisdictions, and best serves the needs of the health and safety community.

A4.5

Title: *Incompleteness of the BLS Surveillance System in Estimating Work-Related Amputations*

Authors: Rosenman KD, Stanbury MJ, Reilly MJ

The current national system for estimating occupational injuries and illness is an employer-based survey administered by the U.S. Department of Labor, Bureau of Labor Statistics (BLS). The incompleteness of this system has been recognized for chronic occupational illness such as silicosis. We used hospital/emergency room and workers' compensation data from Michigan to evaluate the BLS estimates for amputations. We will present the methodology we used to develop a more complete count of amputations.

We estimated that in 1997 there were 764 work-related amputations in Michigan, of which 562 were treated in a hospital and/or emergency room. For the same year, BLS estimated there were 440 amputations in Michigan, and there were 619 amputations reported to the Michigan workers' compensation program.

The BLS estimate was only 58% of our estimate. Workers' compensation reports represented 81% of our estimate. Reasons for the underestimate of amputations in the BLS system and implications of this underreporting on intervention strategies will be discussed.

Session: A5.0

Title: Safety Programs I

Moderator: Dee Higgins

A5.1

Title: *Harmonising Corporate Safety Programs Across the Pacific- Doing the Right Things Right*

Author: Coleman R

Large multinational corporations are at the forefront of efforts to manage traumatic occupational injury risks. Little work has been done considering cross-border issues in managing occupational risk. Boral Limited is used as a case study to argue for a more thoughtful approach than the one size fits all standard method of occupational health and safety management.

This presentation outlines the implementation issues, cultural differences and organisational psychology involved in harmonising safety programs in a large company operating over 500 sites, employing 15,000 people, conducting business in high-risk industries in the USA, Australia and Asia.

Risk profiles are presented for each major global region, examples of programs and results of interventions are discussed.

A5.2

Title: *Effectiveness and Benefit-Cost of Peer-Based Workplace Substance Abuse Prevention Coupled with Random Testing*

Authors: Miller TR, Zaloshnja E, Spicer RS

Objective: Substance abuse is a major cause of occupational injuries. Almost no studies have evaluated the impact of workplace substance abuse prevention programs on occupational injury, despite this being a major justification for these programs. This paper estimates the effectiveness and benefit-cost of a substance abuse prevention program from the perspective of a 26,000-employee, nationwide transportation company operating in 47 states. A peer-based substance abuse program was adopted by labor and management in early 1987 and implemented in regional waves from 1988 through 1990. In addition to changing workplace culture and attitudes toward substance use, the program was designed to educate, identify, intervene, and refer workers to appropriate support services to attain healthier, substance-free lifestyles without employer disciplinary action. The peer-based program was strengthened by federally-mandated random drug testing implemented in 1990 and enhanced before random alcohol testing was implemented in 1994.

Methods: With interrupted time-series analysis, we analyzed the association of monthly injury rates and costs for 1985-99 with phased program implementation, controlling for injury trend in the industry and for other corporate events that could influence safety. Injury costs were estimated with an industry-specific model and checked against corporate workers' compensation and liability insurance experience.

Results: The combination of the peer-based substance abuse program and testing was associated with an approximate one-third reduction in injury rate, avoiding an estimated \$48 million in employer costs. The benefit-cost ratio was estimated at 27:1. Per employee, the peer-based program cost the company \$35 and testing cost another \$35 in 1999. Those expenditures avoided an estimated \$1850 in employer injury costs per employee.

Conclusions: Peer-based prevention programs buttressed by random testing can be cost-effective injury prevention measures in workplaces where the culture enables substance abuse.

A5.3

Title: *Assessing Safety Awareness and Knowledge Among West Virginia Loggers*

Authors: Helmkamp JC, Lundstrom WJ, Ramprasad J

PURPOSE: Although logging plays a vital role in West Virginia's economy, it is one of its most hazardous industries. Logger certification and 3-year re-certification training required by the State Division of Forestry, addresses best management practices and first aid. However, information on safety has not traditionally been included. The purpose of this study was to provide loggers with innovative strategies to prevent injuries and assess changes in their awareness and knowledge of logging safety after training.

METHODS: A 45-minute safety module is now included in all training sessions. This module consists of an overview of safe logging practices and a video that emphasizes many of these same practices. A recently completed field guide with additional safety tips is also provided to each logger. To assess whether this training increased safety awareness, loggers were surveyed before and after completing this training.

RESULTS: From April through December 2002, 93% (803/868) of loggers attending 36 training sessions voluntarily participated. Half of the surveyed loggers had a copy of the OSHA logging standard. Forty-nine percent thought 'accidents' were part of the job and experienced 'close calls' during a typical work-week. Suggesting improved knowledge and awareness, a greater proportion of loggers answered survey questions incorrectly before training was conducted. For example, prior to training, 20% incorrectly indicated that most fatal logging incidents occur within ten feet of a felled tree's stump compared to 1% after training; 30% could not initially identify an overloaded log truck compared to 16% after training; and 32% could not identify the safest escape path compared to 17% after training. All $p < 0.001$.

CONCLUSIONS: Information on safe logging practices and injury control were introduced in required West Virginia logger training in 2002. Preliminary results of pre- and post-training surveys indicate significant improvements in loggers' knowledge and awareness of safety practices.

A5.4

Title: *Modeling the Preventive Effectiveness of Pre-Placement Screening for Carpal Tunnel Syndrome*

Author: Evanoff BA

Workers with abnormal median nerve conduction studies are at increased risk of developing carpal tunnel syndrome (CTS). Pre-placement medical screening with nerve studies is promoted as a strategy to reduce CTS in jobs requiring intensive hand

activity. Though recent court decisions have established that it is legal to exclude workers from jobs based on the results of nerve conduction testing, this practice remains controversial.

We modeled the preventive effectiveness of pre-placement screening for CTS, using values for key variables derived from existing literature. In our model, the 5 year cumulative incidence of CTS in a working population ranged from 3% to 15%, the prevalence of baseline abnormalities of median nerve conduction ranged from 2.5% to 20%, the RR of future CTS conferred by median nerve abnormalities at baseline ranged from 1.5 to 4, and the sensitivity and specificity of testing ranged from 90% to 98%. We tested 150 possible combinations of these variables to estimate the number of workers who would have to be screened in order to prevent one case of CTS (range = 30 - 2045, median = 162) and the number of prospective workers who would be rejected for employment in order to prevent one case of CTS (range = 5 - 245, median = 22). Screening was more effective when RR, prevalence of baseline abnormalities, and incidence of CTS were high. Using \$500 as the cost of post-offer screening, the costs per case of CTS prevented ranged from \$15,108 to \$1,022,727 (median = \$81,051). Using \$30,000 as the average total cost of a case of CTS, a policy of screening was cost-saving in only 24/150 models tested. We conclude that post-offer screening for CTS should not be recommended in the absence of data demonstrating its effectiveness in preventing disease.

A5.5

Title: *Occupational Electrical Hazard Characterization Using MSDS Format to Communicate Injury Parameters and Prevention*

Authors: Capelli-Schellpfeffer M, Golding A

Electricity holds a pervasive and seemingly safe presence in society. Yet annually US occupational electrical incidents persist as a significant cause of injury, fatality, and property loss. Adequate electrical hazard characterization remains a challenge to advancing mitigation based on regulations, design, engineering, procedures, task planning, and personal protection. Recent engineering and biomedical research correlates the potential for damage, injury, or death in an electrical incident as a function of the duration and magnitude of the incident's energy transfer. This report uses principles of electrochemical and electromechanical energy balance and release adopted from the chemical and toxicology literature to characterize and communicate electrical hazard parameters. The toxicity of electricity is described using terms familiar from material safety data sheet (MSDS) formats common to hazard materials (HAZMAT) notices, including, for electricity, the threshold limit, permissible exposure limit, short term exposure limit, lethal dose, flash point, and explosivity. Hazard control is similarly addressed, with special attention to skin, respiratory, and organ system effects. As a presentation "take-away" a confined space and

“MSDS” sheet for electricity is offered. Trainers, emergency responders, and task planners, including engineers, safety professionals, and employees working on or near energized conductors in industry, construction and utilities, are anticipated audiences. “Human Error” as a Leading Cause of Occupant Mortality in Air Taxi and Commuter Crashes in Alaska 1990-1999

Session: B1.0

Title: Priorities for Construction Injury Research: Developing a Construction Safety Research Agenda

Moderator: Michael McCann

B1.1

Title: A NIOSH Perspective on Construction Research Priorities

Author: Gillen M

Construction is one of four high hazard industry sectors identified by NIOSH. An Institute-wide "Construction Steering Committee" (CSC) facilitates coordination of NIOSH's construction program. The presentation will describe CSC priority-setting activities and resulting priorities. The CSC created a "Research Activity Matrix" (RAM) to inventory and rank major construction hazards and to array current research activities. The RAM uses the public health model as a framework to classify research along the research spectrum (surveillance, analytic research, intervention development and evaluation, and dissemination) The RAM can be used to classify construction research efforts, identify gaps in construction research, identify opportunities for advancing construction research to fill those gaps, and prioritize research activities in research areas most likely to advance potential for injury prevention. Establishing future research priorities requires additional assessment tools, and the use of qualitative input (e.g., the OSHA regulatory agenda, other policy activities, and an impact assessment on whether or not the research can make a difference) as well as quantitative input (e.g. incidence rates). Whereas past NIOSH injury research has tended to be descriptive in nature, recent projects have begun to develop specific interventions and to evaluate the impact of interventions on the on outcomes of injury, or exposure to injury. Cross-cutting priorities related to approach and sector topics will be described, along with perspectives on emerging priorities with a particular emphasis on traumatic injuries in construction.

B1.2

Title: An OSHA Perspective on Construction Research Priorities

Author: Rinehart R

The construction industry presents many challenges to the occupational safety and health researcher. One fundamental obstacle is that highly specialized construction contractors collaborate at worksites for relatively short periods of time through complicated contractual relationships to complete a diversity of custom projects in every region of the country. Some of these construction projects are very sophisticated with dozens of contractors and subcontractors present at any given time. While worksite and employer are typically one and the same in general industry, this one to one relationship is not true for construction. OSHA is not typically regarded as a research agency, but it does fund several projects unique to construction each year. It also provides detailed inspection data from its Integrated Management and Information System to a wide variety of external researchers and, most importantly, uses the results of research to make data-driven decisions on how best to target resources. This presentation will provide an overview of current construction research projects underway at OSHA. Emphasis will also focus on outstanding questions and gaps in our knowledge that could, if answered and filled, improve our ability to effect positive safety and health change throughout this industry.

B1.3

Title: Contractor Perspectives On Research Construction Priorities

Author: Rice W

Construction contractors face a variety of job specific incentives and constraints related to safety based on owner specifications, the design and engineering of the structure, bidding procedures, insurance and bonding requirements, scheduling and pace of work, site coordination of subcontractors, skills and knowledge of workers and management, organization of the work process, and auditing performance and quality. Effectively reducing or eliminating injuries on the job site requires the engagement of site owners, architects and engineers, insurers, contractors, subcontractors, unions and workers. Safety research must consider the interests of all of these stakeholders in order to maximize its impact. Research must move beyond just demonstrating it can work on one site, to a stage where we are moving new practices into the field across the industry, or improving our understanding of why they are not being adopted. Construction is a diverse industry that operates on narrow profit margins which can make changes in work processes and equipment risky. We know how to run jobs with millions of work hours without a lost work time injury when clients value that performance. Why are known best practices not adopted or

enforced uniformly across the industry on large and small sites? Researchers should engage contractors and workers as partners in practical assessments that consider economic impacts, organizational barriers to change, skills needed, and how a change in one process may impact other work processes. Just interesting research results are of little value to either contractors or workers. We want to see real change in the industry that lead to significant reductions in injuries and fatalities, and gives contractors with the best safety performance a competitive advantage.

B1.4

Title: Extramural Research Perspectives on Construction Research Priorities

Author: Gittleman J

Over the past decade overall injury rates in construction have fallen from 6.9/100 workers to 3.2/100 workers, a decline of more than 50%. However, within the construction sector there are still many high risk activities posing safety hazards and causing injury to workers. Research projects by CPWR and its consortium members have spanned a wide array of topics which have characterized traumatic injury, work-related musculoskeletal disorders, and on a more limited basis health effects such as lead, noise and exposure to silica. Safety projects have demonstrated the value of interventions focused on fall protection, lock-out tag-out procedures, scaffold safety practices and materials substitution (e.g. light weight block).

In the early 1990s, many of these projects started out as surveillance efforts to identify the magnitude of the problem. In the mid-nineties efforts shifted to interventions to identify solutions and in some cases best practices. From 2000 to the present implementation of risk reduction strategies via use of engineering controls, work practices, personal protective equipment, and training are being explored. Moving the research agenda forward will require continued intervention and evaluation along with greater emphasis on impact assessment and diffusion of information and technology throughout the industry to employers and employees.

Session: B2.0

Title: Quantifying Injury Exposure: A Tool for Evaluating Interventions on Road Construction Sites

Moderator: Stephanie Pratt

B2.1

Title: Defining Hazard Areas Around Construction Equipment

Author: Hause MG

Construction workers are at risk of fatal and serious nonfatal injuries when working on foot near construction vehicles (e.g., dump trucks) and equipment (e.g., graders, wheeled loaders, and excavators). Between 1992 and 1998, excluding collisions between vehicles and single-vehicle crashes, 818 construction workers were killed in incidents involving construction vehicles and equipment. Of these, 703 deaths were due to a worker on foot being struck by a vehicle (437 deaths), or being caught between, in or pinned by a vehicle (266 deaths). Evaluation of worker exposure to the hazard of being struck by construction vehicles and equipment requires an understanding of the blind areas surrounding the construction vehicles and equipment. A blind area is the area around a vehicle or piece of construction equipment that is not visible to the operators, either by direct line-of-sight or indirectly by use of internal and external mirrors. Forty-three blind area diagrams for construction equipment have been developed; 19 by our in house research staff, and 24 via an external vendor through a contract. The diagrams will be combined with information on operating speeds of the equipment and human reaction times to define hazardous areas around equipment on asphalt paving operations. Zones of varying probability of being struck by operating equipment will define these hazard areas. The blind area diagrams presented are an integral component of defining worker exposure to being struck by operating equipment learned from pre-intervention and post-intervention studies that are currently being conducted.

B2.2

Title: Development of Internal Traffic Control Plans

Authors: Graham JL, Williams CL, Burch R

A temporary traffic control plan (TCP) describes how a specific work zone is to be set up to ensure the safety of the motoring public traveling through the work zone; however, construction equipment and vehicles within the work space are not addressed by TCPs. In contrast to a TCP, an internal traffic control plan (ITCP) is a tool that project managers can use to coordinate the flow of construction vehicles, equipment, and workers operating in close proximity within the activity area, so that the safety of workers can be ensured. NIOSH is sponsoring research on

internal traffic control plans for asphalt paving operations on freeway segments. This research consists of observations of asphalt paving operations at two freeway sites in Arizona. Internal traffic control plans are being developed for these two operations and a development guide is being prepared that outlines procedures for preparing internal traffic control plans for asphalt paving operations. While this intervention is promising to reduce injuries to highway construction workers, the actual reduction in worker injuries is unknown.

B2.3

Title: Measuring Worker Exposure to Work Zone Equipment

Author: Hammer B

NIOSH is evaluating interventions to reduce the exposure of workers on foot to injury hazards around highway construction equipment. As part of this evaluation, visual observation methods were pilot tested on an asphalt paving operation.

For the pilot test, two visual observation methods were developed to provide overlapping surveillance of worker exposure to moving construction equipment. First, video cameras were positioned at strategic angles to the worker/equipment interface. Second, field observers were stationed on both sides of the operation in close proximity to the work. These observers, who had been briefed on the equipment hazard areas, followed the operation making notes of worker exposure to hazard areas.

By using the two methods, data were obtained for four different sub-operations: milling, laying geotextile fabric, paving base course asphalt, and paving finish course asphalt. These data were merged to determine the total number of exposures, the vehicle hazard area quadrant of each exposure, and the duration of the exposure.

To develop a functional system for collecting exposure data, the relative advantages and disadvantages of both methods were assessed. One disadvantage of the observers is that they miss events entirely if distracted or recording a prior event. Improvements to the data collection recording sheet may lessen distraction time, but will not eliminate it. The videotape is advantageous in that it can be used to capture missed events and/or verify those that were observed. Furthermore, exposure times are much more precisely recorded on the tapes. The disadvantage of taping is the inability for the viewer to accurately judge depth. However, this can be offset by simultaneously taping from many angles.

By making critical improvements to each of the methods and integrating them into a complete system, a valuable field collection tool for measuring worker exposure to equipment is being developed.

B2.4

Title: Tracking Worker and Equipment Positions With GPS Receivers

Author: Hendricks SA

To quantify worker exposure to hazardous areas around operating construction equipment, the National Institute for Occupational Safety and Health (NIOSH) conducted a pilot test using global positioning system (GPS) to simultaneously track the positions of several workers and pieces of construction equipment. Recent advances in GPS receivers make it possible to locate positions with unprecedented levels of accuracy with off-the-shelf technology, although some error in the position identified by GPS still exists. The pilot testing was done during a paving operation at the Pittsburgh Research Laboratory which included milling, geotextile placement, and paving of base and wearing courses. Continuous positions of workers and equipment were collected using four different GPS receiver models. Additional static and roving tests were also conducted. The accuracy of GPS position and movement estimates is a function of the capabilities and therefore, the cost of the receiver, as well as factors ranging from errors in estimating satellite orbits to interference from obstacles (e.g., buildings) near the receiver. During the pilot test, the least expensive receivers located horizontal positions with a 68% precision of 2.1 meters and a 95% precision of 4.4 meters, while the more expensive receivers located horizontal positions with a 68% precision of 0.7 meters and a 95% precision of 2.6 meters. The goal of this effort will be to estimate the probability that a worker is located within a predefined hazard area of a piece of equipment at a specific time so that overall exposure to the worker during the day can be estimated. Since strong correlation exists between the errors of GPS horizontal position estimates from two different receivers at the same point in time, errors in distance between two different GPS receivers will be less than the sum of the individual errors. Results from the pilot test indicate that the error in distance between two of the more expensive receivers has a 68% precision of 0.3 meters and a 95% precision of 1.7 meters. Results also indicate that the squared error distance can be reasonably estimated by a gamma distribution which will allow monte-carlo simulations to be conducted to estimate the probability that a worker is in the hazard area of the specified piece of equipment. Based on these results, the more expensive receivers will be used for equipment and laborers whose tasks require them to work near operating equipment while the least expensive receivers will be used for workers who are not expected to work near operating equipment (e.g. foremen, inspectors, etc.), but who may on occasion approach operating equipment.

Session: B3.0

Title: Safety Programs II

Moderator: Matt Bowyer

B3.1

Title: Process Model of Safety Training Programs

Author: Jensen RC

Many safety professionals spend a significant portion of their time developing and conducting training programs. It sometimes happens that individuals with extensive expertise in safety do not have a corresponding level of expertise in training methods. This paper was developed to provide a useful overview of safety-training programs using a process model. The method for developing the model was to coalesce a prior model by the author, recommendations by the Occupational Safety and Health Administration, and two investigations of effective training programs. One of these programs was a labor-based ergonomics-training program for employees of nursing homes. The other was a joint labor-management safety-training program for construction laborers.

The effort resulted in a graphic model depicting the decisions and processes involved in conducting a safety-training program. It begins with an initial decision on whether training is really needed. The point of including this decision in the model is to encourage consideration of possible engineering approaches that might present a more effective solution than training. If the decision is for training, the first three processes proceed in order: determine training needs, develop learning objectives, and develop training materials. A decision is then made to include, or not include, a pre-training assessment of trainee knowledge and/or skill. This is encouraged because it provides a baseline for evaluating the effectiveness of the training program. The fourth process is the pre-training assessment. The next two processes are to conduct the training and evaluate the program. Multiple evaluation methods are recommended. If the program will be conducted again, the training organization must decide if improvements will be made. If yes, making the improvements is the final step in the process. Otherwise, the program may proceed with a new group of trainees. The paper discusses each decision and process, giving examples from the two programs investigated.

B3.2

Title: Assessing The Feasibility of Evaluating the Washington State Apprenticeship and Training Program

Authors: Anderson KR, Biddle EA

Washington State has supported a registered apprenticeship program since 1941. This program combines classroom studies with on-the-job supervised training. In 1999, 1,044 apprentices received certifications in 92 occupations, ranging from watershed resource specialist to construction worker. These programs have been evaluated for their ability to create a skilled and diverse workforce, but not for their impact on worker safety and health.

This study assessed the ability to capture information necessary for a training effectiveness evaluation using safety, health, and economic outcome measures. Data on apprentices completing the training program from 1993 to 1999 were collected by the Washington State Department of Labor and Industries from three administrative databases (Apprenticeship and Training, Wage and Hour, and Workers' Compensation).

NIOSH received records from the Apprenticeship and Training (A&T) graduate database. Records for those graduates who secured employment in Washington were matched to records from the A&T database. Graduates who filed workers' compensation in Washington were matched to their record from the A&T database. Graduate records were obtained for 9,313 apprentices over the period requested and 8,726 (94%) had reported income in Washington. Of the graduates, 6,281 had workers' compensation records, with a total of 14,720 injuries and illnesses.

The ability to generate statistics and analyze matches from these records are critical components to determine if an additional study of the effectiveness of this program using health and economic outcome measures is feasible. Problems with this approach included attrition because graduates left the state, a lack of occupation identifiers to compare wage rates between groups, no method available to distinguish if a graduate worked in the trade related to his/her apprenticeship, and no clear method to identify a comparison group. These problems are sufficient in magnitude that an evaluation study could not be conducted. However, descriptive statistics concerning the apprentices can be presented.

B3.3

Title: *Assessing OSHA's Projections About the Effects of its New Safety Standards*

Authors: Mendeloff JM, Kyung SK

When the Occupational Safety and Health Administration (OSHA) sets new safety standards, it makes projections about what the effect of full compliance with the standard will be in terms of preventing fatal and non-fatal injuries. This research investigates whether actual injury trends bear out the projections. We look at 5 (out of a total of 6) safety standards adopted from 1990 to 1996. Because of the better data for fatalities, our study looks only at them.

The first step in our methodology was to identify an evaluation plan for each standard based upon the data contained in the Regulatory Impact Analysis for each standard. For example, we looked to see whether the predictions applied to certain injury types in certain industries. Then we turned to several sources of information to track the particular categories identified as being preventable by compliance with the standard. The sources included the BLS Census of Fatal Occupational Injuries, the NIOSH National Traumatic Occupational Fatality data base and OSHA's Fatality investigation reports.

In every case, we found that the actual level of fatalities was higher, often much higher, than had been projected. One reason for the differential was probably that non-compliance still existed. But he also found that the baseline number of fatalities was usually too high and that the "prevention factor" was often poorly justified and overoptimistic. The disparity was especially large for standards involving training, where OSHA assumed that trained workers would not be hurt.

A major reason for the disparities we found was that OSHA lacks good information about prevention factors. We discuss some options for remedying this deficit. Better data could help OSHA set priorities better and understand more clearly the potential and limits of its actions.

B3.4

Title: *Small Business Owners' Perceptions of Workplace Safety and Health Programs*

Authors: Palassis J, Haring Sweeney M, Schulte PA, Okun AH

More than half of the U.S. workforce is employed in small businesses comprised of 100 or fewer workers. Large companies usually have full-time occupational safety and health (OS&H) departments with professionals and trainers, but small companies cannot afford such expense. Workers in small companies are at greater risk of incurring work-related fatalities than in large companies. The U.S. Office of Management and Budget

has reported that having OS&H management programs in place can be an effective tool for reducing work-related injuries and illnesses and related financial costs.

NIOSH funded a study to investigate and characterize OS&H management programs and perceptions in small businesses (Dyjack D. and Redinger C., final report, 2002). To gain greater insight into this issue, focus groups and interviews were conducted with owners, managers, and key informants in representative geographical locations during 2001-2002. Preliminary results of these studies indicate that employers with less than 20 employees were generally unaware that written OS&H programs were required, even in states possessing a statute requiring such programs. Professional associations and vendors were viewed as important sources of OS&H information. Time, followed by a lack of perceived need, were reported to be the major barriers to implementing OS&H programs. A majority of business owners communicated a distrust towards OSHA, and dissatisfaction with perceived governmental interference in their businesses, and generally indicated they would not use OSHA consultation services even if they required assistance. The cost of workmen's compensation insurance was a major concern of the participants, and therefore holds promise for influencing small business owners to implement OS&H programs at their worksites. The study recommends that efforts to raise awareness and promote OS&H programs be anchored in specific professional small business associations and be tailored to meet the needs of specific businesses while addressing OS&H barriers and incentives.

B3.5

Title: *An Intervention to Improve Construction Worker Safety and Health Through Design: Implementation and Outcomes*

Authors: Hecker S, Barsotti A, Gambatese J, Gibbons, B, Weinstein, M

This paper describes the implementation and outcomes of a safety-in-design process called Life Cycle Safety (LCS), carried out on a large semiconductor factory construction project in Oregon. The goals of LCS were to 1) reduce safety and health risks to construction workers and facility operations and maintenance personnel through attention to design options in programming and design phases; 2) tap the experience and expertise of trade contractors and their personnel early in the design process; and 3) develop a database for tracking problems and solutions for use in future projects. Building on a strong history of continuous improvement and bringing forward lessons learned from earlier projects, the project owner established safety through all life cycles of the facility to be constructed as a key project goal. A multi-organizational, multi-disciplinary task force, including representatives of the owner, design firm, construction manager, and a safety consultant, developed and oversaw the LCS process. Specific elements included risk comparisons by disciplinary work groups of design options in programming

and LCS review of each design package during detailed design. Trade contractor involvement included focus groups with four trades during programming, trade contractor participation in LCS reviews, and exit interviews with trade contractors to collect data on their experience during the construction process itself. Several types of outcome data are presented including:

Quantitative and qualitative analysis of LCS review comments
Case examples of design decisions that successfully mitigated risks and others in which LCS reviews identified risks that were not mitigated through design. Analysis of pre- and post-project trade contractor interview comments.

Specific exposures and issues addressed by LCS and the paper include fall risks for multiple trades; musculoskeletal risks from material handling, cramped work areas, and poor access; and the relationship between design, sequencing, and scheduling in creation and mitigation of hazards.

Session: B4.0

Title: Safety Research Methods I

Moderator: Robert Koedam

B4.1

Title: *Methodologic Issues in the Use of Workers' Compensation Databases for the Study of Work Injuries with Days Away from Work*

Authors: Oleinick A, Zaidman B

Background: This review describes the sensitivity of administrative databases in workers' compensation for the ascertainment of days-away-from-work (DAFW) work injuries.

Methods: Review of the literature supplemented by data from governmental or organizational reports or data produced for this report.

Results: Employers currently appear to provide workers' compensation insurance coverage for 98.9% of wage and salary workers who fill approximately 90% of jobs in the United States. In industries, such as manufacturing, the fraction of covered jobs is higher than 90%.

The literature indicates that covariate effects differ by time from injury. Thus, unbiased covariate estimates can be obtained using analytic groups grouped by time from injury. We recommend that follow-up begin at 8+ DAFW because 7 DAFW currently represents the longest waiting period in states.

There is almost complete agreement between appropriately adjusted counts from the Bureau of Labor Statistics annual survey of DAFW injuries and counts of wage indemnification claims covering payments for temporary or permanent total dis-

ability in the Minnesota Workers' Compensation Division. BLS counts are adjusted for under-ascertainment and statutorily mandated minimum waiting periods for wage compensation eligibility. Minnesota Workers' Compensation Division counts are adjusted to remove 16% of workers who recorded no payments for DAFW or who, because of Minnesota's counting conventions governing wage compensation eligibility, were eligible with fewer than the 4+ DAFW used to adjust BLS data. With these adjustments, the BLS counts are within 5-10% of the indemnity counts.

Conclusion: Statewide workers' compensation administrative databases have high sensitivity for DAFW injury case ascertainment.

B4.2

Title: *Targeting Injury Prevention Using Relative Injury Severity Rate Ratios*

Authors: Kines PA, Mikkelsen KL

Introduction: Prioritizing injury prevention traditionally includes analyzing injury surveillance data for distributions of proportions and rates of injuries. This study examined the utility of supplementing these measures with relative injury severity rate ratios.

Method: Relative injury severity rate ratios were calculated using a national database of serious versus minor nonfatal occupational injuries, as well as an international database of fatal versus nonfatal injuries. The ratios give an indication of the relative risk and reporting of injuries.

Results: For male workers the highest relative injury severity rate ratios (serious versus minor) were in farming, construction, and for elevation falls. For elevation falls in construction the ratios increased with increasing age, decreased with increasing firm size, and were highest in the carpentry and painting trades. The ratios varied by construction trade for elevation falls involving ladders, scaffolds and roofs. Trend analyses of fatal versus nonfatal injuries from, e.g., the United States, Canada and the United Kingdom, show stable, increasing and decreasing trends (1995-1999), respectively.

Discussion: The advantage of relative injury severity rate ratios is that they are calculated for cases only and without exposure data. This allows for detailed analyses in areas where exposure data traditionally is not collected — for example, different types of work surfaces. In this case, this study found that the risk of a nonfatal ladder injury being serious varied by construction trade. International trend comparisons are possible in spite of different terminology and categorizations, as the focus is on relative rate ratios.

Conclusion: Relative injury severity rate ratios are a useful

supplementary risk measure to proportions and incidence rates in assessing risks for varying degrees of injury severity. In addition to injury prevention goals of reducing the number and incidence rates of injury incidents, a further goal could be a reduction in relative injury severity rate ratios.

B4.3

Title: *Cross-state Comparisons of Injury and Illness Incidence, Lost Work Days and Specific Injuries*

Author: Neuhauser FW

Evaluation of statutory and regulatory safety efforts using cross-jurisdictional comparisons have always been difficult and often unconvincing because the differences in industry mix and employer size distribution within industry dominate any intervention effect. Taking advantage of special access to the BLS microdata from the Survey of Occupational Injuries and Illnesses (SOII), the author is able to establish for the first time cross-state occupational injury and illness statistics with controls for employer size and industry. Industry mix and employer size within industry are reweighted and adjusted at up to the 4-digit SIC level. Cross-state comparisons are made for injury and illness rates, lost work day incidence, fatalities, and specific injury types and causes. The data will extend at least 1994-2001 and may be completed from 1987-2001 before October.

The presentation will include the methodology used to adjust the SOII data at the individual employer and incident level. The author will present results of an analysis using these data to measure the incentive effect of workers' compensation cost on workplace safety. The author will also instruct interested researchers in how to obtain and use these unique state-adjusted incidence data for conducting cross-jurisdictional analysis of specific regulatory and statutory safety measures.

B4.4

Title: *Blurring the Distinctions Between Home and Work: Similarities and Differences in Causes*

Authors: Smith GS, Wellman H, Warner M, Sorock GS, Courtney TK, Pransky G

Work injuries are usually regarded as different from other injuries. However, there is increasing realization that home and work injuries have similar etiologies and may involve similar prevention strategies. We examined the contribution of injuries at work to the total injury burden of working age adults (18-64 years) and compared the similarities and differences between on- and off-the-job injuries.

The National Health Interview Survey (NHIS) now collects more detailed information on injuries, including the work-relatedness of all medically attended injuries occurring in the previous three-month period to any member of the family. National

estimates of non-fatal work and off-the-job injuries for the U.S. were determined from 1997 to 1999.

Of the 19.4 million injuries annually to working age adults, 29% (5.5 million) occurred at work (38% among currently employed persons). The total injury rate was 11.7/100 population and the rate for injuries at work was 4.4 per 100 employed persons. Among males, 42% were injured at work compared to only 30% for females. The age group 18-24 years had the highest proportion of injuries at work (41% vs. 33% for ages 35-44). The leading causes of work injuries and all injuries had a relatively similar distribution in working aged persons except for motor vehicle injuries (3% at work vs. 15% overall) and overexertion injuries (27% vs. 18%): falls (21% vs. 26%), struck by/falling against (17% vs. 15%), cutting and piercing (12% vs. 9%), machinery (7% vs. 3%), and foreign body in eye (3% vs. 2%).

The separation between work and non-work injuries is becoming increasingly blurred, as these injuries often involve similar mechanisms. The costs of medical care and time off work are largely paid for by employers regardless of where injuries occur. We need to explore all the options at home and work to reduce the burden of injuries.

B4.5

Title: *Computerized Coding of Injury Narrative Data from the National Health Interview Survey*

Authors: Wellman HM, Lehto RM, Sorock GS, Smith GS

OBJECTIVE: To investigate the accuracy of a computerized coding program for classifying injury narratives into external-cause-of-injury (e-code) categories.

METHODS: This study used injury narratives and corresponding e-codes assigned by experts from the 1997 and 1998 United States National Health Interview Survey. A Fuzzy Bayesian model was used to assign injury descriptions to 13 e-code categories. Sensitivity, specificity and positive predictive value were measured by comparing the computer generated codes with e-code categories assigned by experts.

RESULTS: The computer program correctly classified 4695 (82.7%) of the 5677 injury narratives when multiple words were included as keywords in the model. The use of multiple word predictors compared with using single words alone improved both the sensitivity and specificity of the computer generated codes. The program is capable of identifying and filtering out cases that would benefit most from manual coding. For example, the program could be used to code the narrative if the maximum probability of a category given the keywords in the narrative was at least 0.9. If the maximum probability was lower than 0.9 (which will be the case for approximately 33% of the narratives) the case would be filtered out for manual review.

CONCLUSION: These results suggest that accident narratives can be e-coded by machine with reasonable accuracy especially by using a multiple word classification approach. The capacity to filter out certain cases for manual review improves the utility of this process. The ability to set threshold levels significantly reduces the amount of manual coding required without sacrificing accuracy and allows the user to focus on the difficult narratives. Public health programs, hospitals and other organizations with limited resources might benefit by implementing a machine learning approach to coding at least a portion of their narratives. Program output should always be tested by manual coders for accuracy.

Session: B5.0

Title: Agricultural Safety I

Moderator: James Harris

B5.1

Title: Cost-Effectiveness of a Dealer's ROPS Retrofit Education Campaign

Authors: Myers ML, Cole HP, Westneat SC

An educational program implemented by a farm equipment dealership in a Kentucky county was effective in influencing farmers to retrofit their tractors with rollover protective structures (ROPS) to protect tractor operators from injury in the event of an overturn. The dealership launched the program following the death of a customer in a tractor overturn, which could have been prevented if the tractor had been ROPS-equipped. This paper reports on the cost-effectiveness of this program in the county as compared to no program in a control county. With a three-year intervention period, 0.55 fatal and 0.78 non-fatal injuries were averted in the intervention county when compared to the control county and when viewed over 45-year time horizon. The savings per injury averted over this period was \$166,748 at a 4% discount rate, which is cost-effective when compared to other public health interventions.

B5.2

Title: Evaluating Time-Dependent Errors in Daily Injury Self-Reports From Youth in a Longitudinal Study of Agricultural Hazards

Authors: Wilkins JR III, Strickland M, Crawford JM, Koechlin KM, Shotts L, Elliott M, Bean TL

A longitudinal study of children and adolescents 8-18 years of age exposed to agricultural hazards was conducted to empirically develop multivariable risk prediction models of agriculture-related injury. Data on all unintentional injury events were obtained through a modified form of Participant Event Monitoring (PEM), where youth were expected to report their work (and non-work) injury experiences in a semi-structured daily

diary over a 13-week period. One aspect of data quality assessment concerned the validity of the youth self-reports of injuries, with a focus here on the question: Does participation fatigue cause the quality of the self-reported injury data to deteriorate over the follow-up period? Results of the analyses presented are based on the (daily) data reported by all Year-2 participants, who numbered 150 and returned 1,618 weeks (11,326 days) of data. These 150 youth reported 1,274 unintentional injuries (work and non-work events), producing 11,466 injury instrument item responses to be examined for time trends in the rate of occurrence of "Discernible" Recording Errors (9 injury instrument items per injury \times 1,274 injuries). Discernible recording errors (DREs) are emphasized because there will likely be recording (i.e., transcription) errors that are not detectable by visual inspection only. Each of the 11,466 responses was examined and coded to one of the following categories: no DRE, DRE present (item non-response), DRE present (item partial response), DRE present (illogical/nonsensical response), DRE present (other). Overall, 5.2% of the 11,466 responses contained some type of DRE. The weekly mean DRE rate declined slightly over time, indicating modest progressive improvement in data quality (for both girls and boys). Girls committed proportionately fewer DREs than boys, but like the time trends, these differences were not statistically significant. The effect of age, youth IQ, and introduction of an instructional videotape on the DRE rates will also be discussed.

B5.3

Title: Using Composite Measurement Scales to Model Injury Risks Among Youth Exposed to Agricultural Hazards

Authors: Koechlin KM, Wilkins JR III, Crawford JM, Shotts LF, Elliott M, Bean TL

The objective of this work is to develop user-friendly Composite Measurement Scales (CMS) that parents and other caregivers can use to assess the magnitude of injury risk among youth who perform agricultural tasks. CMS models will be based on data from the NIOSH-funded investigation entitled, "Empirical Derivation of Work Guidelines for Youth in Agriculture" (J.R. Wilkins III, PI). Youth ages 8 to 18 and a parent or guardian were recruited through 4-H clubs in Central Ohio over three years (1999-2001). Variables available for CMS modeling include (but are not limited to) farm chore history, risk perception of youth and "parent partners," handedness, demographics, place of residence (on a farm or not), vision problems, anthropometry, standing steadiness, neurobehavioral competence, hearing ability, intellectual attainment, and muscular strength. Also available for up to 13 weeks per youth are longitudinal data on the amount of time spent daily on each of 52 farm-related activities and multiple characteristics of all injuries experienced. Poisson regression modeling with variables readily knowable by a parent or guardian such as youth age, gender, height, weight, etc. is being used to develop each task-specific CMS. Regression coefficients from the fitted models are scaled

and rounded to integers for ease of use. For each variable in the model, an integer score is obtained based on the youth's characteristics, and a total score determined by summing the individual scores. The magnitude of the total score reflects that individual youth's injury risk for the specific task. Over the 3-year study period, 407 youth and their "parent partners" provided usable data (4,098 youth weeks, 2,788 injury events). Empirically-derived CMS models for at least five specific tasks will be presented along with conclusions and recommendations.

B5.4

Title: *Managing Human Risk in Livestock Handling*

Authors: Isaccs SG, Powers L, Lineberry GT, Scharf T, Wiehagen WJ

According to the 1997 Census of Agriculture, 66.7% of farms in the United States produce some form of livestock. Similarly, 63.4% of Kentucky farms have livestock. Considering that agriculture typically occupies one of the top three rankings of hazardous occupations, research opportunities exist for studies identifying causes of traumatic injuries on livestock farms. This project addresses the human risk and injury prevention in livestock handling practices.

Using the precepts of the Work Crew Performance Model (Wiehagen, Lineberry, et al, 1994), a critical-factor assessment tool from the mining and construction industries, this project attempted to identify and prioritize critical tasks in both routine and emergency livestock handling situations. Tasks were identified and ranked by farm-family focus groups on the basis of the seriousness of economic consequences resulting from the failure to perform the task correctly. Focus group results for both routine and emergency livestock handling situations will be presented.

Kentucky Cooperative Extension Agents for Agriculture completed a validation of the tasks identified by these farm families. County agents assisted in identifying and ranking the most critical tasks when handling livestock. The results of this validation process will also be presented.

A livestock handling safety checklist has been developed that will become part of multi-disciplinary extension education programming in Agricultural Economics, Agricultural Engineering, and Animal Science. The likelihood and economic consequences of injury events in livestock handling can be compared to the costs of practices, technologies, and facilities for safe handling to aid livestock producers in choosing less risky courses of action.

B5.5

Title: *Investigation of Vehicle Jarring/Jolting on Self-Propelled Farming Equipment*

Authors: Mayton AG, Ambrose DH, Jobes CC, Matty TJ

This presentation will update an ongoing, NORA-sponsored project in which NIOSH researchers are studying the injury risk associated with operator exposure to vehicle jarring/jolting on mobile farming equipment. Field and laboratory data collection are described and findings from the analysis of data are discussed. Field data were collected for tractor operators during baling, mowing, and tilling and a skid-steer loader operator during removal of a small tree. Preliminary results show the operator of the skid-steer loader is exposed to higher levels of vehicle jarring/jolting than the tractor operators for the said operations. Moreover, the results are highlighted for health and work history data collected from 50 farmers and farm equipment operators attending a major farm bureau convention and annual meeting. Further, researchers discuss a computer-based, seat suspension model that will enable researchers to determine how effective the seat suspension will attenuate jars and jolts. The model will also aid in the evaluation of engineering controls to lower the risk of worker injury. The results of this project could be used to significantly reduce operator lost-time injuries associated with vehicle jarring/jolting.

Session C1.0

Title: *Childhood Agricultural Injury Prevention*

Moderator: David Hard

C1.1

Title: *The NIOSH Childhood Agricultural Injury Prevention Initiative*

Author: Hard DL

The NIOSH Childhood Agricultural Injury Prevention Initiative builds upon previous NIOSH research and objectives, as well as the goals, recommendations and strategies in the 2002 report "Childhood Agricultural Injury Prevention: Progress Report and Updated National Action Plan from the 2001 Summit" and the earlier 1996 report "Children in Agriculture: Opportunities for Safety and Health—A National Action Plan (NAP)." These reports recommend leadership, surveillance, research, education, and public policy. The NAP plan specifically recommended that NIOSH serve as the lead federal agency in preventing childhood agricultural injury.

In implementing the Childhood Agricultural Injury Prevention Initiative, NIOSH has assumed a leadership role by identifying, funding and developing childhood agricultural injury prevention activities. Efforts by NIOSH and its extramural partners have resulted in substantial progress. Twenty-five research

grants specific to childhood agricultural safety and health research have been funded and completed. Early grants focused on surveillance, intervention strategies, evaluation of educational/training programs, and the evaluation of farm safety day camps. New grant proposals were called for in FY2003 for research to 1) develop and evaluate new or existing enhanced control technologies, 2) develop and evaluate incentives which encourage adults to protect youth, or 3) identify the economic and social consequences of youth working on farms. Additionally, a RFA was announced for renewal of the National Center for Childhood Agricultural Injury Prevention in FY 2003, which is an integral part of the overall initiative. A national surveillance plan for childhood agricultural injuries is being developed and implemented by NIOSH. A website featuring publications and summaries of the research conducted under this initiative has been implemented and updated for public access. Finally, receiving external input for the Initiative has been addressed by reinstating the Federal Task Force on Childhood Agricultural Injury Prevention and planning for another stakeholder input meeting in 2005.

C1.2

Title: Surveillance of On-Farm Injuries to Youth in the United States

Author: Myers JR

In 1997, the National Institute for Occupational Safety and Health (NIOSH) began a national initiative to prevent fatal and nonfatal injuries to youth on farms in the United States. A major component of this initiative is the development of a surveillance program for injuries to youth that occurred on farms. This surveillance program is an internal NIOSH activity, and has the goal of providing national and regional surveillance on injuries occurring to a variety of youth populations exposed to farm hazards. The populations at risk include: youth farm workers and the children of farm workers; children of farm operators; and, children visiting farming operations. Development of the surveillance program included the assessment of existing data sources for their utility in providing on-farm youth injury information, and the development of new data collection systems to cover populations not adequately addressed by existing data systems. Existing data systems that have been examined include the Bureau of Labor Statistics' Census of Occupational Fatal Injuries, the Consumer Product Safety Commission's National Electronic Injury Surveillance System, and the National Center for Health Statistics' Vital Statistics Mortality data system. New data collection efforts include periodic farm operator surveys conducted in cooperation with the National Agricultural Statistics Service, periodic youth farm worker surveys conducted in cooperation with the Department of Labor through the National Agricultural Workers Survey, and the annual collection of farm-related death certificates through the cooperation of State Vital Statistics Registrars. By combining information from all these data sources, NIOSH intends to create a

workable and cost effective approach to providing injury surveillance for the three broad youth populations at risk to farm hazards. Finally, this surveillance program will undergo an external review by experts in the area of agricultural safety and health surveillance to ensure the scientific soundness and appropriateness of this program.

C1.3

Title: Among Children as Farm Workers in Minnesota: Hazards, Tasks and Safe Work Practices

Authors: Shutske JM, Schermann M

The purpose of this NIOSH-funded research project has been to 1) examine the extent and nature of children's agricultural labor in farm families of Hmong origin in Minnesota; 2) investigate culture-specific health behavior patterns and culturally appropriate health promotion methods for farm families of Hmong origin; and 3) analyze the North American Guidelines for Children's Agricultural Tasks (NAGCAT) manual labor guidelines for applicability and appropriateness for use by Hmong farming families. Qualitative and quantitative research methods were used, including extensive literature review; review of secondary data; semi-structured interviews of parents, grandparents, and other care providers; focus groups; field observations of children and families performing work; and height and weight measurements of children. Text narratives, field notes, and photographs were analyzed using Atlas.ti software used to manage and organize qualitative data. Numerical data were analyzed with SPSS. Hmong farm children are engaged in different work tasks, roles, and responsibilities compared to mainstream North American farm children. Hmong children perform tasks in four temporal phases: preharvest, harvest, post-harvest, and at the market. The characteristics and intensity of tasks performed by children differ in each phase. Tasks differ by age and gender. Girls work longer hours and carry heavier loads than boys of the same age. Standard health and safety materials are not widely accepted by Minnesota Hmong farmers. Participants in this project helped develop culturally appropriate and relevant materials for Hmong farm parents and children. These materials and the development process will be presented and discussed.

C1.4

Title: Lessons Learned from the Process and Outcome of a Summit on Childhood Agricultural Injury Prevention

Authors: Lee BC, Marlenga BL, Gallagher SS, Hard DL, Phelan CH

Background: Following a five-year infusion of public and private dollars to implement a national action plan on childhood agricultural injury prevention (for which NIOSH serves as lead agency), a comprehensive progress review was warranted. The

planning and implementation of the 2001 Summit on Childhood Agricultural Injury Prevention involved: a) six months of information gathering; b) a 3-day Summit conference with 87 participants; c) synthesis of results; and d) publication and dissemination of its final report.

Purpose: There are no textbook formulas for conducting agenda-setting initiatives, thus, the Summit core team assessed lessons learned from the Summit's process and outcome in order to recommend strategies for future initiatives.

Methods: Five core team members (authors) conducted assessment activities including an objective review of the detailed Activities Timing & Tracking Chart (regularly updated throughout the planning and implementation phase) and written evaluation feedback of Summit participants (n=62). Subjective observations and perspectives of core team members were discussed via teleconference calls, then solidified through an in-person meeting convened four months following publication of the Summit report.

Results: Key lessons learned were: a) a tracking chart and weekly conference calls were extremely valuable for delegating multiple tasks among core team members from four different agencies; b) advance preparation of participants was inadequate, since most failed to review "required reading" prior to the Summit; c) scheduled "networking" time during the Summit conference yielded positive outcomes such as new collaborations among individuals representing organizations with philosophical and programmatic differences; and d) during the eight months following the Summit conference, feedback from 87 participants regarding draft recommendations diminished notably.

Conclusion: Elements for a successful future agenda-setting initiative include: substantial financial and human resources; a committed core leadership group; a systematic process that can be compressed into minimal time; and incentives for sustained participation among key stakeholders.

C1.5

Title: Child Ag Injury Prevention Center Achievements

Author: Lee BC

**Bridging the Gap between Research and Practice:
Value of the National Center for Childhood Agricultural Injury Prevention**

A National Center for Childhood Agricultural Injury Prevention was funded in 1997 as a component of NIOSH's childhood agricultural initiative. This Center has facilitated achievement of several objectives of the national action plan, Children and Agriculture: Opportunities for Safety and Health. Center staff has directed numerous interventions, research, and professional training initiatives, including: Planned and implemented the 2001

Summit on Childhood Agricultural Injury Prevention, then published and disseminated its results; convened a consensus group to propose and publish recommendations of the National Adolescent Farmworker Occupational Safety and Health Advisory Committee; established the Childhood Agricultural Safety Network, a liaison of national organizations representing youth, agriculture and safety; generated and support utilization of the North American Guidelines for Children's Agricultural Tasks (NAGCAT), now an international reference. Conducted research to evaluate NAGCAT impact; developed and published recommendations for Creating Safe Play Areas on Farms; hosted three professional 3-day training events: Rural Youth Safety Summer Seminar; provide frequent technical assistance and professional consultation across the U.S.; submit commentary to the media regarding positive and negative messages that inform the general public and/or impact social norms. The value of a Center that is geographically and organizationally apart from NIOSH is demonstrated through effective public-private partnerships that were forged to address issues spanning beyond basic and applied research. Without the Center's bridging capabilities, it would have been difficult to convene major consensus-development initiatives; especially those that establish work or play guidelines for children on farms; or initiatives that generate national strategies. The Center also serves as a valuable communication link between federal agencies, academic researchers, community leaders and the general farm public via a quarterly newsletter, Internet site, toll-free phone and regular interactions with the farm media.

Session: C2.0

Title: Fire Fighter Turnout Protective Clothing

Moderator: Timothy Merinar

C2.1

Title: Overview of the NIST/USFA Fire Fighter Protective Clothing Research Program

Author: Madrzykowski D

In June of 1996, the National Institute of Standards & Technology held a workshop on Firefighter Thermal Exposure to identify the research needs of the fire service and the protective clothing industry in this area. From the top priorities NIST began working to develop a better understanding of the thermal conditions that firefighters are exposed to and those, which most often result in, burn injuries. The US Fire Administration joined with NIST in supporting this research program. With the additional support NIST began developing an understanding of the mechanics of low flux heat transfer that results in firefighter burn injuries and developing methods to predict burn injuries based on a given thermal exposure. The impact of moisture and compression on the insulating capabilities of the protective clothing materials were measured and modeled. A study examining the impact of different types of thermal sensors on the

measurement of temperature and heat flux through protective clothing was conducted with the support of the National Institute for Occupational Safety and Health.

The laboratory research led to the development of a PC-based heat transfer model that can address the materials used in PPE, compressed/uncompressed conditions, and wet/dry conditions. Given the thermal input conditions in terms of temperature and radiant heat flux, the model can be used to predict time to 2nd degree burn injury. The model is currently being compared with results from the low heat flux apparatus at NIST, a full-ensemble test apparatus at NIST and with results from Thermal Protective Performance (TTP) Tests on protective clothing. These comparisons are being used to evaluate and validate the model. Once validation is complete, NIST will develop a version of the model that is better suited as a training tool for the fire service. Work is ongoing to incorporate the heat transfer model into the Fire Dynamic Simulator as part of the development of a computer-based firefighting training tool.

Ideally the test methods, measurements and models developed by NIST will be used by the protective clothing industry to optimize the thermal properties of protective clothing and by the fire service as a training program to help firefighters better understand the capabilities and limitations of the gear that they rely on to protect them on the job.

C2.2

Title: State-of-the-Art Research on Firefighter Protective Clothing: The Role of Instrumented Manikins

Author: Barker RL

Firefighters face multiple hazards, including complex thermal threats that range from flashovers to prolonged exposures to radiant and convective heat. The constant goal of laboratory research and testing is to provide data that reliably predict in use performance as well as knowledge that leads to development of improved materials and clothing systems for firefighters. This paper highlights research at NCSU on firefighter protective clothing including research on thermal sensor technologies, burn translation algorithms, models for predicting the thermal protective performance of firefighter suits and studies on the effects of moisture and stored thermal energy on burn injury potential. It describes the state-of-the-art in laboratory testing technology, from component tests to full ensemble tests using instrumented manikins. It demonstrates how advanced instrumented manikins, such as NCSU's PyroMan, are being used to evaluate the thermal protective performance of firefighter turnouts. It describes NCSU's sweating manikin and other advanced facilities for research on firefighter protective clothing. It shows how PyroMan and the sweating manikin can be used together to determine the optimum balance between comfort and protective performance in firefighter turnouts.

C2.3

Title: Overview of the NIOSH / NPPTL CBRN Protective Clothing Research Program

Author: Szalajda JV

The NIOSH National Personal Protective Technology Laboratory (NPPTL) focuses expertise from many scientific disciplines to advance federal research on respirators and other personal protective technologies for workers. This presentation provides a background addressing the specific need to develop standards to protect emergency responders in a chemical, biological, radiological, and nuclear (CBRN) terrorist event, as well as an overview of the standards developed to date. The presentation will include a discussion of the inherent differences between NIOSH Industrial Respirator Standards and Military Standards, and why a new set of CBRN standards was developed. The requirements identification process will also be discussed.

It is anticipated that these standards will be used by manufacturers to develop and produce improved personal protective equipment for protection against CBRN agents. This will benefit firefighters and emergency responders who may not fully understand the capabilities and limitations of their protective gear. Improved protective equipment will optimize the protection afforded these emergency responders.

C2.4

Title: NFPA - Codes and Standards for a Safer World

Author: Teele BW

The National Fire Protection Association (NFPA) is a non-profit, independent, association representing over 75,000 members from more than 80 trade and professional organizations. The NFPA develops codes, standards, recommended practices, and guidelines through a consensus standards development process approved by the American National Standards Institute (ANSI). The NFPA standards development process brings together volunteers representing varied viewpoints and interests to achieve consensus on fire and other safety issues. Each standard is reviewed and revised on a regular basis by an established technical committee. Each committee is comprised of a balanced membership of interested parties representing user groups, labor, manufacturers, research / testing bodies, government, and special experts.

This presentation addresses the NFPA 1971 Standard on Protective Ensemble for Structural Fire Fighting (2000 edition). NFPA 1971 provides guidelines and criteria for the manufacture, testing, and certification of fire fighter protective garments including pants, coats, gloves, footwear, and helmets. This standard describes the test procedure, methods, equipment, and pass/fail criteria to be used to ensure product compliance with the standard.

Session: C3.0

Title: Fall Injuries in Construction I

Moderator: Jinhua Guan

C3.1

Title: Prevention of Construction Falls by Organizational Intervention

Authors: Becker PE, Fullen MD, Akladios M

Falls are the leading cause of fatalities and injuries in construction. While the construction workforce in the U.S. represents 5% of the nation's workforce, it accounts for 49.6% of fall fatalities. The construction safety literature recognizes available engineering controls, work practices, and personal protection, which are effective in preventing construction falls. However the equipment and practices are not widely used in the industry. WVU Safety and Health Extension has developed an organizational intervention research program to prevent falls in the construction industry.

The program implements a construction contractor certification program called Fall-Safe. Fall-Safe is a fall management system that works to improve management use of existing fall prevention methods through use of training and an audit system to provide an accountability system for fall prevention on construction job sites. WVU Safety and Health Extension serves as the certifying organization for contractors in West Virginia, and is assisting contractors in developing office and site fall prevention programs, training of supervision and workers, and quarterly audit of both company and site fall prevention efforts. Considerable project resources have been allocated to marketing the program to contractors. Construction Safety Council and St. Paul Insurance also serve as sponsoring organizations for Fall-Safe in the Midwest.

The site audit of fall prevention practices also serves as the tool for evaluating impact of the program. The audit has been programmed into a PDA that scores contractors on their fall prevention site programs and their compliance with OSHA standards related to construction falls. The evaluation compares the changes in scores for an intervention group of contractors and a control group that does not participate in Fall-Safe over a period of one and a half years.

Analysis of the pilot study group indicates intervention contractors improve both program and site audit scores more than control contractors.

C3.2

Title: Construction Related Non-Fatal Falls in California

Authors: Reinisch F, Fleischer NL, Cavallari J, Scholz P, Materna BL, Harrison RJ

Nationally, falls are the leading cause of workplace death in construction, and the construction industry has the highest injury incidence rate of falls to a lower level. As part of a NIOSH-funded surveillance program in California, physician reports (Doctor's First Reports of Injury or Illness-DFRs), were used to identify non-fatal occupational falls in the construction industry. Data on the occupation, specific industry, and injury code were collected to further characterize falls. Because one third of fatal falls to a lower level in construction are from ladders or scaffolds, the program developed a detailed follow-up interview tool for the subset of falls from ladders and other motorized access equipment (i.e. scissor lifts, boom lifts). California surveillance data on all falls for 2001-2002 and follow-up interview data related to ladders falls from 2002 will be presented.

There were 2810 DFR reports of occupational falls in the construction industry in 2001. Falls on or from ladders 27% (688) were the leading cause of injury; followed by falls on the same level 26% (677); falls from one level to another 14% (367); and falls from, out of, or through structures 14% (367). The greatest number of falls were reported from carpenters (n=495), unspecified construction trades (n=464), construction laborers (n=456), roofers (186), and painters (n=147).

Preliminary interview data from 74 ladder fall cases indicates that 69% (n=51) of all ladder falls involved a stepladder and 28.3% (n=21) involved an extension ladder. Overwhelmingly, ladders were used both for access and as a work platform (80%), explaining why two-thirds (n=49) of fall cases worked with both hands off of the ladder. Many workers (43%) who fell from ladders carried heavy tools and equipment weighing from 5 to 200 pounds. The data highlight task and environmental risk factors for ladder falls and opportunities for prevention through equipment substitution.

C3.3

Title: Estimated Costs of Injuries Caused by Falling Through Roof Openings, Surfaces and Skylights

Authors: Bobick TG, Keane PR, Biddle EA, Spahr JS

Fall-related occupational injuries are serious problems in the U.S. construction industry. An important sub-set of the fall-to-lower-level category involves workers falling through existing roof or floor openings, or through roof or floor surfaces, including skylights. These fall-through injuries are among the most severe cases for median number of days away from work (DAFW).

Data analyses were conducted for 1992-2000 using the Survey of Occupational Injuries and Illnesses (the Annual Survey), maintained by the Bureau of Labor Statistics (BLS). This survey is an estimate of values from a sample of approximately 200,000 private establishments.

To obtain an estimate of costs related to fall-through incidents, the Liberty Mutual "Workplace Safety Index" was used. The Safety Index used their own claims information, along with data from BLS and the National Academy of Social Insurance to determine the total in wage and medical payments paid in 1998.

During 1992-2000, 21,985 serious injuries occurred from fall-through incidents. For 1992-2000, the median DAFW were 35, 25, and 36 for cases involving falls through roof openings, roof surfaces, and skylights, respectively, as compared to 10 DAFW for all types of fall-to-lower-level cases. The Safety Index indicated that the direct costs associated with the 2,069 DAFW fall-through incidents that occurred in 1998 averaged \$37,817.

The total cost of a serious injury is the summation of direct and indirect costs. Generally, indirect costs are assumed to be two to five times the magnitude of direct costs. For this analysis, however, a very conservative estimate is used that assumes direct and indirect costs are of equal magnitude. Thus, the total cost of a 1998 fall-through incident averaged \$75,634. These cost estimates provide employers with the basis to conduct cost-effectiveness analyses for potential workplace interventions, such as guardrail systems or protective skylight screens.

C3.4

Title: *Identifying and Controlling Fall Hazards in Routine and Non-routine Tasks*

Author: Kines PA

Introduction: Occupationally related falls from elevated work surfaces, e.g., ladders, scaffolds and roofs, are often cited as one of the main causes of male fatal and serious occupational injuries. This study examined workers' cognitive, behavioural and motivational processes in perceiving, identifying and controlling fall risks.

Method: The study is based on semi-structured personal interviews and on-site investigations with male workers who reported to an emergency department for treatment of injuries due to falls from heights.

Results: A greater number of workers carrying out non-routine compared to routine tasks perceived, identified and attempted to control fall hazards. The non-routine tasks often involved one-time tasks that arose unexpectedly. In many of the routine tasks, the fall occurred in connection with the worker carrying out the task in a unique way.

Discussion: Common, everyday incidents, such as falls from heights, involve relatively simple worker-machine-organisation environments, and yet it appears that it is in this simplicity that much of the origin of falls rests. There is often a mistaken impression that no special knowledge or skill is required to use ladders, scaffolds, etc., which is exacerbated by the restricted area on which to move and/or work on. In half of the cases in this study, the workers were not usually exposed to fall situations, and elevation fall-prevention training would not likely be a 'logical' aspect of their safety education and training.

Conclusion: The results of this study point to a need for widespread education and training in basic ladder safety, possibly beginning already in primary and secondary school programs, e.g., gymnastics. The study leaves the question: can it be expected that companies invest in equipment, training and organisational scenarios for every possible non-routine (one-time) task that, theoretically, might arise?

Session: C4.0

Title: **Injury Surveillance: Mining**

Moderator: Jeffrey Welsh

C4.1

Title: *Reducing Injuries from the Fall of Rock in Underground Coal Mines*

Authors: Molinda GM, Dolinar D, Robertson S

Reducing Injuries From the Fall of Roof in U.S. Coal Mines

Over a five year period (1995-2000) an average of 620 injuries per year were caused by rock falls in US underground mines. These include many crushing and disabling injuries, and almost all occurred where miners were beneath roof support. NIOSH research has indicated a paradigm shift in traditional thinking about the relative risk of rockfall injuries in coal mines has the potential to dramatically reduce the number of injuries. NIOSH research has focused on identifying:

- Conditions where existing support systems are inadequate, and;
- Best available technology to upgrade the supports.

A roof hazard rating system (SCALE) has been developed which uses roof damage and geologic assessment of roof rocks to indicate a potential injury hazard. The system, calibrated with underground data, can be used in continuous evaluation of the working face. Research at underground mines proves that roof screening on cycle, especially in weak rock, can reduce injuries. Time studies show that additional time for roof screening at the face can be reduced to acceptable levels. There are a number of "best practices" including "pre-linking" of roof screens, rein-

forced and flush cut screens, and 2 in screens for small rocks which may help reduce injuries. Alternative roof support (large pans, short channels, rebolt nuts) are options providing additional roof coverage. Advances in roof bolting machines, including mesh handling systems, walk-thru capability, ventilation tube handling systems, and rock shields, reduce worker exposure to rockfalls and potential materials handling injuries. Sealant and coating products and an innovative air conditioning technique are options for preventing the approximately 10-20% of the injuries caused by the long term deterioration of roof rocks from moisture.

C4.2

Title: An Ergonomics Program Intervention to Prevent Musculoskeletal Injuries Caused by Manual Tasks in Coal Mining: Feasibility Study.

Authors: Burgess-Limerick R, Neal A, Joy J, Straker L, Pollock C, Leveritt S

The aims of the feasibility study were to tailor the ergonomics program and materials to address the unique demands of the coal industry.

This aim was achieved through 10 site visits to three open cut and two underground coal mines. Survey data were collected from a total of 175 staff at three sites (two open cut and one underground), and interviews were held with staff and management at each of the mines. An audit of OH&S management systems relevant to manual tasks was undertaken at three sites.

The training materials and processes were tailored to the coal industry through the use of the information and video footage obtained in the initial visits to each site. The training materials and processes were trialed with 46 staff at one open cut coal mine in training sessions spread over seven days. The training program was successfully adapted to the coal mining context and, following the training, staff were able to assess manual tasks risk, and suggest controls for those risks.

A number of modifications to survey tools and the intervention processes have been made as a result of the experience gained in the feasibility study. As we have found with other industries and workplaces, the use of workplace specific video footage is extremely effective in both gaining trainees attention and conveying the relevant information. Most staff, and especially older staff, demonstrated a high awareness of the risks of injury associated with manual tasks and an interest in reducing injury risks. There was, however, an under appreciation of the importance of risk factors other than forceful exertions prior to the training. The training program was successful in highlighting the importance of other risk factors ie, awkward postures, vibration, repetition and duration.

C4.3

Title: An Analysis of Injuries and Fatalities Related to Tire Safety at U.S. Mining Operations

Author: Dwyer JG

From 1980 through the second quarter of 2001, there were 31 fatalities caused by accidents related to tire safety in mines—nearly 1.5 deaths per year for the 21.5-year period. The average number of fatalities for all mining accidents within the past five years (1996-2000) was approximately 86.4 deaths per year, whereas the number of tire-related fatalities rate during this same period was 2.2 deaths per year (2.6% of all mine fatalities). Although the tire safety fatality rate does not account for a large proportion of the annual fatality rate, it is an area where education, training, and preventative actions could effectively eliminate the majority of tire-related hazards.

The objective of this study was to quantify the accidents and injuries related to tire safety in U.S. mines. Issues such as flat tires, blowouts, or loss of traction during equipment operation can certainly pose hazards to mine workers. However, data analysis indicates that the highest risk of injury from tire accidents is to the workers responsible for tire maintenance and repair, not to the equipment operators. This paper summarizes tire-related fatalities from 1980 through the second quarter of 2001 (the most recent data available at the time of the study) and tire-related injuries for the five-year period from 1996 to 2000. This data can be used as a basis for targeting mine safety programs to reduce injuries and fatalities related to tires.

C4.4

Title: A Systems Analysis of Mining Injury and Fatality

Authors: Camm TW, Dwyer JG

Mining injuries and fatalities are usually the result of a complex interplay of human actions, equipment, environment, and work processes. "Operator error" is often cited as a precipitating cause for an incident, without considering the influence of other contributing factors. A dilemma in examining the root cause of a workplace injury or fatality is the tendency for individuals to take a myopic view based on their experience and professional training—engineers focus on equipment design, managers on work process and task design, safety directors on training, regulators on rules, economists on costs, psychologists on motivation and cognitive ability, sociologists on personal life and social roles, organizational theorists on corporate culture and structure—each contributing to an explanation of the incident, but rarely providing a comprehensive examination.

A systems analysis of workplace injuries and fatalities provides a framework for examining the multiple contributing factors that can affect the health and safety of mine workers. A poorly-designed work site can put unnecessary burdens on both equip-

ment and workers, and an improperly trained work force is more likely to work in an unsafe manner or not recognize hazardous situations. The wrong equipment for the job, or equipment that is not properly maintained will put workers at additional risk. An organizational culture that puts a premium on production at the expense of everything else (including proper maintenance or safety), or that implicitly or explicitly encourages risk-taking behavior diminishes safe work practices and will have an affect on the behavior of workers. In an organization where a combination of such circumstances occurs, the resulting stress is likely to cause a breakdown somewhere in the system and may lead to an unhealthy and unsafe work setting. Using a system approach for risk assessment, steps can be taken to identify and reduce risks.

C4.5

Title: Mine Accident Injury and Illness Exploration Tools

Authors: Lowe NT, Coleman PJ

Mine Accident, and Illness Data Exploration Tools (MAIIDETS) is a Web-based interactive application that allows researchers to explore and analyze information on over 130,000 mines and 830,000 accidents, U.S. wide, as far back as 1975. All queries, whether for mine information, accident figures and/or accident narratives, or exposure, are location based. Thus, a user can not only show tailored information in the form of tables or charts, but also as maps. For example, mine, accident, disaster, and exposure data can be shown relative to political boundaries, hospitals, employment distribution, etc. Although MAIIDETS can search data and report on a mine-by-mine basis, its true strength is that it allows users to take advantage of its dataset creation and accompanying analysis tools to examine and explore the data tables. This ability translates into powerful data exploration and analysis capabilities when combined with ranking, mapping, charting, exporting, and frequency-reporting tools.

The system, if deployed on the Internet, could be valuable to mine analysts and mine inspectors, mine safety personnel, and federal, state, and private mine safety trainers. Users will have the capability to create customized, interactive online maps that can be used by a wide range of organizations and individuals, such as other federal agencies, state and local health departments, policy makers, research institutions, and students. For these users, mine safety emphasis and could be tailored on the basis of accident rates, trends, or distributions, and they will be able to select specific parameters to create the exact output, be it -- map, chart, table, that will suit their needs.

Session: C5.0

Title: Emergency/Disaster Response

Moderator: Herbert Linn

C5.1

Title: Public Safety vs Personal Risk: Injury Compensation for Police Officers and Emergency Responders in the U.S.

Author: Seabury SA

Occupational risk plays a unique role in the provision of public safety. Public safety employees are routinely asked to place their own lives in jeopardy in order to protect the lives and property of others. Given the sacrifices these employees must be willing to make, and the severe consequences that can result if they fail in their mission, it is critical to provide them with appropriate injury compensation. However, there are many factors that can affect the optimal combination of wages and disability benefits that a police department or other public safety agency should offer. If the financial burden of an injury is too high, then employees will become reluctant to undertake risk. For police officers or other emergency responders this reluctance could hurt their job performance and have negative implications for public safety. On the other hand, injury compensation can be expensive, and conceivably it could drain resources away from other necessary inputs. This paper uses principal-agent theory to examine the optimal injury compensation for public safety employees under a variety of assumptions about the ability of employers to monitor workers and the risk preferences of individuals. It then presents results from a survey of state and municipal benefit programs for public safety employees. The actual contracts observed in practice are shown to have a number of features in common with the contracts predicted by the model. Finally, data from the survey are combined with data from the Uniform Crime Reports (UCR) to test the effect of disability benefits on the observed productivity of police officers. The policy implications of these results are discussed.

C5.2

Title: Protecting Emergency Workers During Major Disaster Response

Authors: Jackson BA, Baker JC, Ridgely MS, Bartis JT

Protecting the safety and health of America's emergency response workers during major disasters has emerged as a heightened national concern, especially in light of the 9/11 terrorist attacks and the continuing threat of additional attacks. To address this concern, the National Institute for Occupational Safety and Health tasked the RAND Science and Technology Policy Institute to gather and analyze information on the management of worker safety and health during major disasters, including both natural and man-made disasters; to identify prob-

lems encountered; and to develop recommendations aimed at increasing preparedness and improving the protection of emergency workers engaged in disaster response.

RAND investigators reviewed the literature on major disaster response; conducted extensive interviews with individuals who were involved in responses to major disasters; and convened a workshop on February 27, 2003 to gather input from individuals representing multiple disciplines and organizations with disaster response roles and responsibilities. Analysis of the information obtained revealed the need for increased preparedness and improvements in specific areas including safety and health management, especially during multi-organizational responses; communications; training; hazard monitoring and assessment; and health care and surveillance. The recommendations are aimed at individuals and organizations at the local level with responsibility for managing the response to disasters, but also address roles and responsibilities and coordination issues, pertinent to all other organizations involved in disaster response. Individuals who contribute to plans or policies regarding local response to major disasters are also targeted. This presentation will focus on the methods and findings of this study, and the NIOSH-RAND recommendations for improving disaster site safety and health management.

C5.3

Title: *The Potential for Use of Biological Safety Personnel in a Bioterrorism Response Surge Capacity System*

Authors: Morse SS, Gershon RM, Qureshi KA

Bioterrorism poses enormous challenges for the public health system today. Much of this emanates from the fact that for some types of these disasters, the public health response will require the availability of more personnel than most departments of health have in their employ. At the same time, many biological safety personnel who are employed in the non-public health setting would be willing and able to respond to assist public health during times of disaster. Possible surge capacity emergency response functional roles for biological safety personnel that have been identified include public health lab support, personnel protective equipment use training, infection control consultation, and surveillance duty.

The concept of surge capacity emergency response functional roles will be explained and specific functional role job descriptions will be illustrated.

The learner will be able to define what is meant by the surge capacity system. The learner will be able to define what is meant by the term functional emergency response role. The learner will be able to describe how to test mobilization logistics.

C5.4

Title: *Ability and Willingness of Healthcare Personnel to Report to Duty During Severe Disaster Response*

Authors: Qureshi KA, Gershon RM, Morse SS

Abstract: As terrorism escalates around the world, the role of the healthcare workforce is being re-defined and expanded to include increased attention to disaster preparedness and response for biological, chemical, mass casualty, nuclear and radiological events. A well prepared workforce that is willing and able to report to duty during times of crisis is essential for effective response capabilities, yet little work has been done in this area to examine the actual intentions and abilities of staff to report to work for disaster duty.

This paper will present the results of studies conducted at the Columbia University Center for Public Health Preparedness at the Mailman School of Public Health to identify the ability and willingness of personnel in various sectors of the healthcare system to respond to duty during different types of disaster situations. Ability and willingness as well as facilitators and barriers for reporting were identified for a variety of groups of healthcare workers.

This information is useful for preparedness planning, as employers may initiate strategies to reduce barriers and influence willingness, thus increasing the probability of having a ready and willing workforce for disaster response.

C5.5

Title: *Work Related Injuries and Psychosomatic Problems amongst Police Officers*

Authors: Smailes EM, Gershon RM, Murphy BR, Durrah TL, Hogan EK, Chiu A

Police officers can be exposed to a range of traumatic experiences on the job. They may be injured (needle stick injury), exposed to environments that may lead to health problems (responding to bloody crime scene, and chemical spill), injure others (shoot someone, and make a violent arrest), or know others who have been injured (know the crime victim, and attend a police funeral). Given the stressful nature of police work it is not surprising that police officers report high psychosomatic symptoms (Burke, 2002; Vulcan et al, 1984). However, less is known about the relationship between exposure to different types of injury, such as injury to self and others, and psychosomatic problems.

In this study 1150 sworn police officers from a North Eastern Police Department completed questionnaires on police stressors and stress-related outcomes (migraines, chronic insomnia, and high blood pressure). Results indicate that after controlling for age, gender, race, highest education level, years of

employment, rank, and marital status, making a violent arrest was associated with chronic insomnia, and attending a police funeral was related to reports of high blood pressure. Experiencing a needle stick, making a violent arrest, responding to a chemical spill, and attending a police funeral risks for migraines. These results suggest that there may be some variation in the association between police work and psychosomatic symptoms based on whether the police officer is was injured, inflicted injury, or was aware of someone who was injured in relation to the job. The specificity in these findings have significance for police psychologists.

DAY TWO: WEDNESDAY, OCTOBER 29, 2003

Session: D1.0

Title: The Psycho-social Aspects of Worker Response in Hazardous Workplaces: From Mining, Construction and Agricultural to Terrorism and War (Part I)

Moderator: Kathleen Kowalski-Trakofler,
Charles Vaught

D1.1

Title: The Need for Situational Awareness Assessment in Hazardous Work Environments

Author: Hitchcock EM

Many types of work, such as mining, construction and emergency response services are inherently hazardous due to their dynamic, interactive, and unpredictable environments. One potential means for mitigating the effect of hazardous environments on worker health may be through systematic investigation of factors that impact the development of worker Situational Awareness (SA). The concept of SA is a relatively new and important topic for the aviation psychology community, as the loss of SA has been identified as a major contributory factor in many military and commercial crashes and incidents. Recent arguments have been made implicating the involvement of SA in safe operation of other complex tasks (Kaber and Endsley, 1997). As it relates to hazardous work settings, SA involves the perceptual and mental ability to: (1) perceive the hazardous elements in the scene, (2) establish a cognitive representation of how these elements are interacting, and (3) to identify likely changes in the hazardous conditions based upon (1) and (2), (Endsley, 1995).

Certain safety technologies and training strategies, such as backup alarms, reflective vests and toolbox talks, have been introduced that partially help with the establishment of adequate SA. However, the efficacy of these interventions is diminished in noisy, visually cluttered, and rapidly changing environments. More importantly, there currently is lacking a fundamental un-

derstanding of the cognitive modeling of the environment that constitutes full development of appropriate SA in workers in hazardous settings.

Gaining an understanding of the process of SA development in hazardous work settings will benefit the safety community by enhancing insight into problems of degraded hazard recognition and means to reduce injury and death. Additionally, the effectiveness of future health and safety interventions could benefit from an immediate analysis of their impact on worker SA. An overview of SA assessment techniques and a potential preliminary experiment in the construction sector will be presented, and the important role of SA assessment in future studies of hazardous work environments will be discussed.

D1.2

Title: Information Exchange and Organizational Survival in Dynamic Settings

Author: Vaught C

Abstract: This presentation discusses the manner in which organizations react to environmental change. It is argued that in dynamic settings (such as mining, logging, construction, fishing, etc.) information exchange is a key element in an organization's survival. This is true no matter which organizational setting is being examined. Basically, the organization that has the best information, in the appropriate quantity, at the right time, is the organization that is most likely to survive.

Researchers have also given some thought to the type of organization that is likely to be most viable because of its ability to exchange information in its dynamic setting. The organization must have: 1) a buy-in from management; 2) a culture of trust; 3) support for risk taking; 4) shared learning that involves failures as well as successes; and 5) a commitment to long-term organizational development. One outcome of such organizational viability is that workers will become more proficient at knowledge-based decision making. This is important because it is ingenuity that prevails in the unstructured conditions characteristic of dynamic systems. It also means that training is essential because, in a dynamic work setting, it is necessary for each individual to have information available that will allow him or her to resolve problems quickly, and at the lowest level. This approach to training shifts the locus of control over information flow, decision making, and action to front-line workers, and makes them key contributors to their organization's well being

D1.3

Title: Judgment and Decision-Making in Hazardous Work Environments: A Critical Skill

Author: Kowalski-Trakofler KM

Constantly unpredictable, hazardous environments demand heightened judgment and decision-making skills. Decisions made in volatile work settings have a direct impact on job performance, productivity, and the health and safety of the worker. Research has shown that dynamic environments, particularly emergency situations such as natural or man-made disasters are stressful events for the worker, yet decisions must be made rapidly, often without adequate information.

Accepting the premise that hazardous work environments may be viewed on a continuum, the idea that there are constants along that continuum follows. For example, in a mining or construction environment there would be patterns of behavior and constants similar to those found in a natural disaster environment, or a terrorism incident or even in a war environment. These environments on the continuum would be different in some dimensions such as intensity, exposure, and other, as yet undefined areas. Yet, the environments would be similar in that they may share individual and organizational preparedness and response patterns. This author suggests that judgment and decision-making under the stress of a hazardous environment is one of the comment tenets. This presentation discusses some of the current thinking on decision-making under stress, with knowledge gleaned from various disciplines, including: the sociological, psychological, physiological, medical, and risk assessment literature.

The relationship of stress to judgment and decision-making is an aspect of human behavior that is under-explored. In addition, training requirements for workers in emergent, hazardous or stressful environments are inadequately understood. The Pittsburgh Research Laboratory (NIOSH) has conducted research on the performance of miners exposed to smoke in underground mines and on human behavior in underground mine fires. Miners with previous training reported less stress and anxiety, and performed better in escape from smoke in a mine simulation training exercise than those with no previous training. Understanding judgment and decision-making under stress may contribute to better decisions for workers in exceptionally hazardous environments.

D1.4

Title: Prevention and Mitigation of Traumatic Incident Stress After Exposure to Hazardous Conditions

Author: Pastel RH

Terrorism involving weapons of mass destruction (WMD) may have powerful psychosocial consequences. This paper will focus on how exposure to hazardous conditions can induce stress. Traumatic incident stress has been observed for over a century under a variety of names, including traumatic neuroses, railway spine, shell shock, combat exhaustion, and disaster fatigue. This paper will review the research on traumatic incident stress after chemical, biological, radiological or nuclear (CBRN) accidents and intentional use and how traumatic stress might be prevented or mitigated.

Traumatic incident stress may produce large numbers of casualties who present with flu-like symptoms (e.g., fatigue, malaise, headache, arthralgia, myalgia, dizziness, dyspnea, and weakness) similar to prodromal symptoms seen after exposure to chemical, radiological, or biological weapons. Hyperventilation syndrome may be a physiological explanation for some of the non-specific symptoms. Stress reactions may occur in the absence of physical injury, but can also exacerbate symptoms and distress in those physically injured by a WMD or accidental exposure.

Unlike physical injuries, psychological stress has the stigma of mental illness. However, military experience with battle fatigue or combat stress demonstrate that such reactions are not due to mental illness, but are a normal reaction to an abnormal and overwhelming stimulus. In the military, traumatic stress is treated using the acronym PIE – proximity, immediacy, expectancy. Soldiers are treated close to the battle front, as soon as they become symptomatic, and with a positive expectancy that they will recover and be able to return to their unit. Stress control measures for civilians often speak of the 5 R's – Reassurance of normality, Rest (respite from the situation), Replenish physiologic needs (food, water, sleep), Restore confidence, and Return to duty and reunite with their work team. Breath training to counteract hyperventilation may also be useful.

Session: D2.0

Title: Preventing Occupational Injuries in Alaska through Surveillance and Collaboration

Moderator: George Conway

D2.1

Title: Human Error as a Leading Cause of Occupant Mortality in Air Taxi and Commuter Crashes in Alaska 1990-1999

Authors: Moran KA, Conway GA, Bensyl D

Introduction: Commuter and air taxi crashes are the leading cause of occupational fatalities in Alaska, and pose a significant economic and social impact to passengers and communities. National studies have indicated that "human error" forms the leading probable cause in 70-80 percent of all aircraft crashes. The purpose of this study was to examine Alaska crash data, including probable cause and human performance to identify appropriate risk-reduction strategies to improve occupant survivability.

Method: Using 1990-1999 National Transportation Safety Board (NTSB) records, applying a retrospective case control approach, the authors compared fatal (n=120) and nonfatal (n=577) air taxi and commuter crashes occurring in Alaska for *probable cause* (the leading factor that caused the event) and *pilot performance*.

Results: Preliminary evidence demonstrates that of all crashes with known causes (n=679) 78 percent were attributed to "human error" (87.7% of fatal crashes and 81% of nonfatal). Significant associations were found between fatality and phase of flight (odds ratio (OR)=8.35, 95% confidence interval (CI): 5.36, 13.00); weather (OR=6.44, 95% CI: 3.94, 10.52); and pilot error (OR=2.29, 95% CI: 1.27, 4.13). Those crashes attributable to mechanical defect were significantly associated with a nonfatal outcome (OR=0.35, 95% CI: 0.17, 0.72). A significant association was found between pilot error and FAR operation (OR=1.52, 95% CI: 1.04, 2.22).

Conclusion: Pilot performance in inclement weather, during cruise and maneuver phases of flight appear to contribute disproportionately to the frequency of serious crashes. Possible interventions could include better training and application for pilots in aeronautical decision-making, weather recognition, risk management and emergency procedures. Possible interventions might also include standardized enforcement of operational control and Federal Aviation Regulations. Better initial training in how to fly, training in local conditions/regions, supervision of new pilots, and systematic progression in flight difficulty might also reduce the number of human performance error crashes.

D2.2

Title: Progress in Partnerships for Surveillance and Prevention of Occupational Aircraft Crashes in Alaska

Authors: Manwaring J, Conway GE, Moran K

Background/Introduction: Although pilots of small commuter and air taxi operators in Alaska have one of the highest occupational fatality rates in the nation (410/100,000/year), progress is being made in the prevention of occupational aircraft crashes and fatalities. The effort involves a partnership alliance between the NIOSH, Alaska Field Station, and other agencies and organizations focusing on surveillance and prevention in order to attain the goal of a 50% reduction in crashes/fatalities by 2009.

Methods: A partnership alliance was formed between the Alaska Field Station of NIOSH, the Federal Aviation Administration (FAA), National Transportation Safety Board (NTSB), National Weather Service (NWS), the University of Alaska, Anchorage (UAA), Alaska Air Carriers Association (ACA), and the Alaska Airmen's Association. Aircraft accident data on occupational crashes occurring in Alaska during 1990-2002 were obtained from NTSB and FAA accident reports and entered into a database maintained by the NIOSH, Alaska Field Station – the Alaska Occupational Injury Surveillance System (AOISS) for analysis.

Results: Although occupational aviation fatalities continue to be a problem – with Alaska commercial pilots having the highest occupational fatality rate during 1990-1999 (410/100,000, compared to 150/100,000 for loggers and 125/100,000 for fishermen), there is an overall downward decline in occupational aircraft crashes/fatalities over the 12-year period of 1991-2002 (comparing the two six-year periods of 1991-1996 and 1997-2002, a 39% reduction in aircraft crash fatalities, and a 29% reduction in fatal crashes). Efforts in a previous similar partnership resulted in a drastic reduction of helicopter logging crash/fatalities.

Conclusions: As demonstrated by the downward trend in occupational crash/fatalities and the drastic reduction in helicopter logging crash fatalities in Alaska, partnerships with agencies and organizations can be highly effective in conducting surveillance and preventing aircraft fatalities.

D2.3

Title: *Making Alaska's Fishing Industry Safer: Applied Epidemiology and Engineering*

Author: Husberg BJ, Lincoln JM

The majority of fatal injuries in Alaskan commercial fishing industry are caused by vessel loss and man overboard incidents. The Alaska Trauma Registry (ATR), a database of hospitalized nonfatal injuries, allows us to identify causes and other details for nonfatal injuries in this industry. This paper will cover how injury surveillance information from ATR has led to the specific engineering recommendations to prevent injuries in this industry.

ATR collects information on all patients, in all 24 hospitals in Alaska, who have been injured/hospitalized for more than 24 hours. Over 150 data elements are collected for each case in ATR. Examples collected include cause of injury, nature of injury, body region injured, severity, and a comprehensive injury description text field.

ATR has information for 648 hospitalized nonfatal injuries in commercial fishing industry from 1991 through 1999. Machinery was the cause for most injuries (205), followed by falls (163), struck by an object (100). For nature of injury, the most common type were fractured bone (309), open wound (77), and burns (32). Body region most commonly injured includes upper extremities (203), lower extremities (189), and head (96). A review of narrative field for machinery identified crab pot launcher, crane, and bait chopper as the cause of most machinery injuries.

Surveillance information from ATR has assisted in identifying and prioritizing causes for nonfatal injuries in this industry. Collaboration between NIOSH, U.S. Coast Guard, safety engineers, and the fishing industry has taken place to identify specific injury prevention measures for the injuries identified. These engineering interventions include increasing visibility on deck, guides to help control the crab pot in rough seas, easy to fabricate bait chopper guards, and rail height and seawall recommendations. These recommendations have been published in a handbook for fishermen to use in modifying their vessels.

D2.4

Title: *Fatality Assessment and Control Evaluation in Alaska*

Author: Hull-Jilly DMC

Study Objective: To describe demographics and causal factors of fatal traumatic injuries among workers in Alaska and potential prevention strategies and interventions for workers facing similar risks.

Methods: Data from the Alaska Fatality Assessment and Control Evaluation (AK-FACE) database (1992-2001) and Alaska Occupational Injuries database plus Alaska Vital Statistics death certificates were reviewed and analyzed. Data elements included are incident type, occupation, industry, ICD 9-CM E-codes, narratives, notification source, and post-investigation recommendations.

Results: During 1990 through 2001, 702 work-related deaths were identified. Since August 1992, 570 deaths were recorded in the AK-FACE database. The overall rate of work-related deaths in Alaska is declining. Often, jobs were in acutely perilous environments, on frigid waters and in steep or mountainous terrain. Eighty percent (454/570) of fatally injured workers were white males, the majority between the ages of 25 and 44 years. The leading five occupations were fishers/hunters/trappers (156/570), aviators (98/570), military personnel (46/570), marine crewmen (35/570) and helpers/laborers (28/570). Of the 420 fatal work-related incidents identified, 80% involved one victim. Approximately two-thirds of non-aviation, non-commercial fishing work-related deaths occurred in sparsely populated, remote sites. Significant prevention strategies developed by the AK-FACE program have included redistribution of "Flyer's Rights" wallet-size safety card, timber cutter safety video, and teen employee/business owner safety seminars.

Conclusions: Since 1992, the rate of worker deaths has declined in Alaska. Alaska's high rate of traumatic occupational death is, in part, a function of the distribution of workers in hazardous industries and high-risk environments. The AK-FACE program has enabled a collective of municipal, state, and federal agencies and private sector organizations and companies to develop efficacious multi-agency strategies and interventions to reduce the high rate of occupational fatalities. The intervention strategies by the program and its partners may have played a significant role in the reduction of work-related fatalities.

D2.5

Title: *Surveys of Alaska's Aviation Industry*

Authors: Conway GA, Manwaring J

Purpose: Air travel in Alaska can be hazardous; aircraft crash is a leading cause of death in Alaskan workers. We wanted to ascertain current safety practices, beliefs, and strategies in Alaska's aviation industry.

Methods: We contracted a local university to conduct surveys by mail, telephone, and in-person. Separate instruments were developed for operators and pilots. The sampling scheme was complex. Pilots surveyed were contacted through their employers.

Results: Response rates were 81% for operators and 75% for pilots. Large operators provide more training, more frequent checking of pilot skills and practices, and pay overtime more often than do small operators. Pilots and operators agreed that improved weather reporting, decision-making skills, and regional hazards training could be effective ways to prevent crashes. Remarkably, 48% of large operator and 73% of small operator pilots report that their jobs are no more dangerous than other jobs.

Conclusions: Pilots and operators agreed on many feasible strategies, including better weather utilization and decision-making training. The continuation of a collaborative inter-agency/industry/workforce safety initiative holds promise in these areas. Pilot's reported risk perception contrasts markedly with surveillance data, which show an approximately 100-fold increase in mortality risk for this occupation in Alaska versus all US workers.

Session: D3.0

Title: Motor Vehicle Safety

Moderator: John Powers

D3.1

Title: Workplace Injuries in Unionized Trucking Companies

Authors: Borba PS, Rogers WC

This study used workers compensation claims data from four major unionized less-than-truckload companies belonging to the Motor Freight Carriers Association. The companies account for approximately 3.5% of the employment and work-related injuries for employers in SIC code 421 (trucking and courier services, except air).

Information was collected on 22,700 injuries (11,000 with indemnity benefits) reported between January 1, 1998 and June 30, 2001. Analyses were conducted on the incidence of injuries compared to all industries, demographic characteristics of the workforce and injured workers, and characteristics of the work-related injuries.

Principal findings of the study were: the age of the workforce is much older than all employers; sprains and strains accounted for about half of lost worktime injuries, but such injuries occurred to many different parts of the body; sprains and strains injuries were below average cost injuries; and one in every four lost-time claims resulted in a permanent disability.

D3.2

Title: The Cost to Society of Fatal Occupational Injury to Truck Drivers

Authors: Husting EL, Biddle EA

Motor vehicle crashes are the leading cause of occupational injury deaths in the U.S. The Census of Fatal Occupational Injuries reported 10,568 workers killed in highway incidents for the 8-year period from 1992 to 2000. Forty percent (N=4,241) occurred in a single occupation—truck drivers. Highway incidents account for 70% of all fatalities of truck drivers—a percentage that increased fairly steadily over the 8-year period, from 57% in 1992 to 70% in 1999. Involvement of truck drivers in fatal highway collisions is an important and enormously costly public safety issue.

Establishing the number and rate of occupational truck driver fatalities provides valuable information to assist in determining the focus for prevention and research efforts. These measures also provide the basis for determining the cost of occupational injuries providing another decision making tool for policymakers. Costs of workplace fatalities were estimated using the cost-of-illness approach, which combines direct and indirect costs to yield an overall lifetime cost for a fatal occupational injury.

The total lifetime cost of workplace fatalities for truck drivers involved in highway incidents during 1992-1999 was nearly \$3.5 billion dollars, ranging from \$302 million in 1992 to \$498 million in 1999. Over this period, the mean cost of a single work-related truck driver fatality in a highway incident was estimated at \$780,439 compared to the median cost of \$884,759. The mean cost of occupational fatalities for truck drivers due to other causes ranged from \$839,937 for exposure to harmful substances or environments to \$594,234 for falls.

Economic risk, defined as frequency times cost, can be used to target interventions. Of all event categories, jack-knifed or overturned /no collision fatal incidents were most frequent and had the largest total cost of \$883,027,268. Using this measure, these incidents should be a priority for prevention research.

D3.3

Title: Use of Aggregate Data in Modeling Factors Associated with Truck Driver Injury and Illness and Linkage of Truck and Claims Data

Authors: Blower D, Oleinick A

Background: Little is known about the relationship, if any, between truck configuration and truck driver injuries. Before the current work, appropriate data has not been brought together to study the problem.

Methods: The Ohio Bureau of Workers' Compensation (OBWC) prepared a data extract of all claims filed by workers employed by firms classified as trucking firms by the NCCI Rating Manual. The OBWC administrative files do not include data on the truck firm characteristics or truck operations. However, the Motor Carrier Management Information System (MCMIS) file contains several data elements that describe such characteristics for all interstate trucking firms. For factors such as the type of truck operated and the cargo carried, aggregate data on truck type, truck configuration, and cargo carried could be acceptable surrogates if truck firms are sufficiently homogenous. Linkage was performed using company name and geographic location.

Results: Carriers are relatively homogeneous with respect to type of truck and type of cargo hauled. Truck type can be predicted accurately for about 83% of the drivers by using the predominant truck type for the driver's firm. Carriers focus on a relatively narrow range of cargo types. Over 47% of carriers haul only one type of cargo (typically general freight). Only 7.3% of carriers recorded more than three types of cargo. Many of the cargo types are closely allied. To date, over 70% of worker's compensation claims of trucking firms were linked to MCMIS carrier file, using company name and address. The linking algorithm employed a strategy of incremental normalization of match strings. All matches were reviewed manually.

Conclusion: In industries with relatively homogenous firms, such as trucking, aggregate data can provide adequate surrogates in developing covariates for estimating models. Administrative files can be linked to provide reasonably comprehensive analysis files, even without common unique identifiers.

D3.4

Title: Truck Crash Experiences of For-hire Motor Carriers in the United States: 2000-2001

Authors: Chen GX, Husting EL, Jenkins EL

The truck crash experience of for-hire motor carriers in the United States from 2000 to 2001 was studied to identify risk factors by using the Motor Carrier Information System (MCMIS). MCMIS is a computerized system whereby the Federal Motor Carrier Safety Administration (FMCSA) maintains a comprehensive record of the motor carriers and shippers who are subject to the Federal Motor Carrier Safety Regulations or Hazardous Materials Regulations. MCMIS data includes a Crash file containing data from State police crash reports electronically transmitted to FMCSA.

From 2000 to 2001, there were a total of 82,261 police-reported crashes (3,528 fatal, 37,980 injury, and 39,972 tow-away crashes) involving 19,918 for-hire motor carriers with a total of 1,078,610 trucks. The fatal crash rate was 0.42 crashes/100 trucks for carriers with 1-30 trucks, 0.17 for carriers with 31-200 trucks,

0.15 for carriers with 1,001-4,000 trucks, 0.14 for carriers with 201 to 1,000 trucks, and 0.06 for carriers of more than 4,000 trucks. The rate was 0.6 for individual operated carriers, 0.24 for partnership carriers, and 0.15 for cooperation carriers. The rate varied by carrier's geographic location from 0.22 per 100 trucks for the Region 8 (CO, MT, ND, SD, UT, and WY) to 0.07 for the Region 1 (CT, ME, MA, NH, NY, NJ, RI, PR, and VI). Intrastate carriers had a higher rate than interstate carriers (0.28 vs. 0.16). The rate was 0.24 for coal and coke carriers, 0.23 for produce carriers, 0.22 for cold food carriers, 0.21 for dry bulk and building material carriers, and 0.20 for general freight and metal/sheet/coils/rolls carriers, compared to 0.16 for for-hire carriers overall.

This study suggests some high risk factors related to for-hire motor carrier truck crashes which may warrant further study. Strengths and limitations of using MCMIS data for research are also discussed.

D3.5

Title: Driver Distraction/Inattention and Driver Fatigue as Risk Factors for a Fatal Commercial Vehicle Collision in Kentucky

Authors: Bunn TL, Kurpad A, Struttman TW, Browning SR, Caldwell GG

In a previous study examining occupational vs. nonoccupational fatal motor vehicle collisions (MVCs) in Kentucky, the percentage of fatal occupational MVCs involving driver fatigue and/or driver distraction and inattention was increased relative to fatal nonoccupational MVCs (15% vs. 3% for driver fatigue and 25% vs. 13% for driver inattention/distracted).

This study was undertaken to determine if driver fatigue and inattention may be increased risk factors for fatal commercial vehicle collisions (CVCs) when compared to nonfatal CVCs in Kentucky. Case and control data were obtained from the Kentucky Collision Report Analysis for Safer Highways (CRASH) electronic files for 1998-2001 from the Kentucky State Police Records section. CVCs were selected from all 560,497 MVCs. Cases (n= 51) were drivers who died (fatal) and controls (n= 31,629) were drivers who survived (nonfatal) a CVC. Cases were matched to Fatality Assessment and Control Evaluation (FACE) cases to confirm working status at time of death. Selection variables for cases and controls included vehicle type, position in vehicle, and injury classification.

In descriptive analyses, driver distraction/inattention (31% cases vs. 26% controls), fatigue (10% cases vs. 1% controls), and the vehicle not under proper control (10% cases vs. 2% controls) were factors more frequently involved in fatal CVCs compared to nonfatal CVCs. Additionally, more deceased CVC drivers were not using their seatbelts (47% cases vs. 6% controls), were trapped (55% cases vs. 1% controls) and were totally ejected (24% cases vs. 0% controls) from their vehicles compared to

drivers who survived a CVC. These data suggest that driver distraction/inattention and fatigue as well as other collision factors may be increased risk factors for a fatal CVC. Multivariate analyses including calculation of odds ratios will be performed on these data to measure the effect of these variables alone or combined on fatal vs. nonfatal CVCs.

Session: D4.0

Title: Workplace Violence I

Moderator: Nancy Romano

D4.1

Title: Occupational Violence: Environmental Risk Factors

Authors: Gerberich SG, Church TR, McGovern PM, Hansen HE, Nachreiner NM, Geisser MS, Ryan A, Mongin SJ, Watt GD, Jurek A

Occupational violence has been identified as a major public health problem; certain occupations, including nursing, appear at increased risk. This study was designed to identify the magnitude of, and specific risk factors for, work-related violence among Minnesota Registered Nurses (RNs) and Licensed Practical Nurses (LPNs) - populations accessible through licensing databases.

A comprehensive survey was sent to a random sample (n=6,300) of nurses to determine eligibility and occupational violence (physical [PV] or non-physical [NPV]) experience in the past year (74% response). A nested case (n=475) - control (n=1425) study examined the relation between environmental exposures and PV (75% response). As many as four follow-up mailings were sent after the initial mailings to maximize response.

Univariate and multiple logistic regression analyses were performed to describe the distributions of individual exposures, and to estimate odds ratios and 95% confidence intervals for individual exposures on the outcome of PV. Directed acyclic graphs based on the causal model were used to identify potential confounders. Horvitz-Thompson reweighting assisted adjustment for unknown eligibility and non-response.

Respective rates of PV and NPV per 100 persons per year and 95% confidence intervals (CI) were 13.2 (12.2-14.3) and 38.8 (37.4-40.4). Key findings (ORs and CIs) from case-control analyses included increased risks for: working in long-term care facilities (2.6; 1.9-3.6) and in emergency (4.2; 1.3-12.8) and psychiatric/behavioral (2.0; 1.05-3.7) departments; and in environments with illumination less than "bright as daylight" (2.1; 1.6-2.8). Decreased risks were identified for: working with young populations (0.4; 0.2-0.99); carrying cell phones/personal portable alarms (0.3; 0.1-0.7); and working in three types of facilities other than long-term care and hospital inpatient: home/public health agencies (0.2; 0.1-0.4); outpatient facilities (0.4; 0.2-0.8);

clinics/health provider offices (0.2; 0.1-.5).

Occupational violence is an important problem in this population. Identified risk and protective factors provide a basis for development of intervention efforts.

D4.2

Title: The NIOSH Workplace Violence Research and Prevention Initiative

Authors: Jenkins EL, Hartley D, Bowyer ME, Anderson KR

Homicide accounted for 639 (11%) of the occupational injury deaths in the U.S. in 2001; these numbers exclude the 2,886 workers killed in the September 11 terrorist attacks. In addition, there were an estimated 1.7 million nonfatal workplace victimizations each year from 1993 to 1999. NIOSH has been conducting research on workplace violence issues since its first publication of national data on workplace homicide in 1988. In 2002, NIOSH was charged by the U.S. Congress to "develop an intramural and extramural prevention research program that will target all aspects of workplace violence."

Building upon existing work, NIOSH has developed a number of efforts to enhance existing knowledge regarding the nature and magnitude of workplace violence, risk factors, and prevention strategies. Among these is analysis of data on nonfatal victimizations that include, for the first time, detailed information on industry and occupation of the victim as well as specific information on the relationship of the victim to the offender from the National Crime Victimization Survey (NCVS). The collection of these improved data was funded by NIOSH and is now part of the ongoing NCVS. Additionally, a Workplace Risk Supplement was appended to the NCVS during January through June of 2002. These data will allow description of workplace violence policies and training as well as perceptions of safety and security for a cross-section of U.S. workers. NIOSH has also launched a survey of workers treated in hospital emergency departments for a work-related assault injury.

Five new research grants have been funded addressing a range of high risk settings. A Federal Interagency Task Force that includes participation from the Departments of Labor, Justice, the Office of Personnel Management, the U.S. Secret Service, and others has been formed to provide a forum for coordinating research and prevention activities at the Federal level.

D4.3

Title: *The Evaluation of State-Based Approaches to Workplace Violence Prevention*

Authors: Bowyer ME, Frazer JA

During the 5-year period from 1996 to 2000, there were an average 766 workplace homicides annually in the U.S. In 2001, there were 639 workplace homicides, the lowest number since the Census of Fatal Occupational Injuries began in 1992. It is not clear what factors have influenced this reduction and whether it will be sustained in subsequent years. There were an estimated 1.7 million nonfatal workplace victimizations each year from 1993 to 1997, accounting for 18% of all violent crime during the 7-year period.

As the risks for workplace violence have been more completely described and recognized over the last decade, states and other policy-makers have begun to develop statutes, administrative regulations, or technical assistance information for workplace violence prevention. Unfortunately, there have been no rigorous evaluations of the effectiveness of any of the regulatory or other state-based efforts undertaken to date.

NIOSH has conducted an inventory of state-based approaches to workplace violence prevention to serve as a starting point for in-depth evaluations of the various efforts that have been implemented. Preliminary results indicate that there are some states, such as California and Washington, that have mandated requirements for training or other assessment of workplace violence risks, especially in particular high risk settings such as health care or late night retail. Others, such as Michigan, Minnesota, and Connecticut conduct special training programs related to workplace security. Some states (e.g., Indiana, Minnesota, Alaska) have issued general duty clause citations for workplace violence hazards. The availability of data on workplace violence incidents before and after implementation of various efforts or data on comparable areas with and without interventions will dictate the ability to conduct comprehensive evaluations of the various strategies employed by the States.

D4.4

Title: *Workplace Violence Prevention in the Mental Health Setting*

Authors: Lipscomb JA, McPhaul K, Soeken K, Geiger Brown J, Choi M

Significance: Workplace violence is a significant hazard in the healthcare sector. The National Crime Victimization Survey found assaults among mental health workers were four times that of healthcare workers. In 1996, OSHA published "Guidelines for Preventing Workplace Violence for Health Care and Social Service Workers". The purpose of this study was to evaluate the effectiveness of these guidelines in the in-patient mental health

care setting.

Methods: The OSHA guidelines provided the framework for the intervention in four study facilities while three facilities served as controls. Two measurement tools, a pre-and post- intervention survey and a computerized data system (OIRS) reported assault injuries, were used to evaluate intervention effectiveness one year following program implementation.

Results: Four hundred seventy-six direct care staff completed the pre-intervention survey (94% response rate). At baseline over one quarter of staff reported > 25 threats, and over 50% reported some type of physical injury in the past 12 months. As a group, the OSHA elements were significant predictors of assault ($p < .001$). A high level of management commitment was associated with a reduced odds of violence (OR .32, 95% CI .14 - .75). Work-related variables were significantly related to violence ($p < .001$); 10 of 11 variables entered were retained in the final model. Overall, the model was significant (94.29, $df = 14$, $p < .001$); these predictors explained 39% of the variance in violence directed workers in these cross-sectional data. A comparison of pre- and post-intervention survey and OIRS data is underway and will be presented.

Conclusion: Though the OSHA guidelines were published in 1996, to the best of our knowledge, this NYS project is the first to evaluate their effectiveness in health care. Direct care staff involvement in identifying and implementing violence prevention strategies is anticipated to improve overall workplace health and safety.

Session: D5.0

Title: *Special Populations: Injuries Among Youth and Hispanics*

Moderator: Dawn Castillo

D5.1

Title: *Preventing Youth Worker Fatalities*

Authors: Tierney JM, Higgins DN, Hanrahan LP, Washburn MJ

This presentation describes the Fatality Assessment and Control Evaluation (FACE) program and summarizes in-depth data collected on 59 young worker fatalities in 26 states. These investigations were conducted between May 1986 and February 2002.

Young workers ranged in age from 9 to 17 years, with a mean age of 15.28 years; 21 were working in the agriculture/forestry fishing industry, 12 in construction, 10 in manufacturing, 8 in services and 8 in the retail industry. The majority worked as laborers. Ninety-three percent were male.

Each investigation resulted in the formulation and dissemination

tion of preventive strategies to help prevent future similar occurrences. For an example of state FACE activities, the presentation describes the Wisconsin FACE program's efforts to foster collaboration between regulatory agencies, researchers, educators, occupational safety and health professionals, and to integrate efforts aimed at improving safety for working youth.

D5.2

Title: Anthropometric Differences among Hispanic Occupational Groups

Authors: Spahr JS, Kau TY, Hsiao HX, Zwiener JV

The Census Bureau predicts that Hispanics will represent 25% of the U.S. population by 2050. Employment distributions reveal that Hispanic workers tend to be more heavily represented in higher risk industries and occupations than other racial/ethnic groups. The results from the 2000 Census of Fatal Occupational Injuries (CFOI) program show higher fatal and non-fatal workplace injuries and illness rates for Hispanic workers than for other racial/ethnic groups, and that their rates are increasing.

This study reports anthropometric measurements of Hispanic workers recorded in the Hispanic Health and Nutrition Examination Survey (HHANES), from 1982-1984. These data are the most current measurements available from a national survey of Hispanic civilians. It describes various physical body measurements across Hispanic occupational groups among three distinct ethnic sub-groups: Mexican, Cuban, and Puerto Rican origin. The analysis of the HHANES data shows that weight, size and body segment measurements of some Hispanic occupational groups differ significantly among Hispanics, and differ significantly from other similar occupational groups of non-Hispanic races described in other non-military U.S. anthropometric databases. For example, Hispanics are 5cm smaller than other U.S. racial groups regardless of gender. Cuban-Americans have the tallest stature, Mexican-Americans the broadest shoulders, and Puerto Ricans the smallest body segment circumferences.

Anthropometry is the study of human body size and proportions. In occupational health and safety applications, anthropometric measurements are used to evaluate the interaction of workers with their tasks and tools. Inappropriate fit of PPE or accommodation of the workplace to the size of the worker can compromise their performance and safety. Those who evaluate, design, or modify the human-machine interface for Hispanic occupational groups need to know these anthropometric differences.

D5.3

Title: Fatal Occupational Injuries among Hispanic Construction Workers of Texas, 1997 To 1999

Authors: Fabrega V, Starkey S

Hispanic construction workers, particularly those born outside of the United States, are a growing segment of the Texas workforce and are increasingly the victims of on-the-job fatalities. This study examines occupational fatality characteristics among Hispanic construction workers utilizing records collected by the Texas Workers' Compensation Commission for the Bureau of Labor Statistics, Census of Occupational Fatal Injuries program.

Of the 370 fatalities recorded from 1997 to 1999, 179 cases (45.5%) involved Hispanic workers—109 of who were born in a foreign country. The fatality rate for Hispanic construction workers was 23.5 per 100,000 workers compared to 21.2 for non-Hispanic workers. Many fatality injured Hispanic construction workers shared similar characteristics including: low skill level, young age and foreign birthplace.

Hispanic workers employed as construction laborers, helpers, and roofers had the highest number of fatalities. Businesses with fewer than 10 workers employed forty-two percent of all Hispanic decedents, and businesses with more than 100 employees comprised twenty percent of the fatalities. The leading causes of Hispanic fatalities were: transportation incidents, falls, and exposure to harmful substances.

D5.4

Title: Farm Youth Can Be Reliable Reporters of Their Daily Injury Experiences

Authors: Wilkins JR III, Crawford JM, Koechlin KM, Shotts L, Elliott M, Bean TL

A longitudinal study of children and adolescents 8-18 years of age exposed to agricultural hazards was conducted to empirically develop multivariable risk prediction models of agriculture-related injury and to derive work guidelines that parents and other caregivers could use to judge the age and developmental appropriateness of farm chore assignments. Longitudinal data on all unintentional injury events (and relevant exposures) were obtained through a modified form of Participant Event Monitoring (PEM), where youth were expected to report their injury experiences in a semi-structured daily diary over a 13-week period. The data collection methodology permits estimation of severity-specific injury rates, the focus of this presentation. One aspect of data quality assessment concerned the validity of the youth self-reports of injuries. For all unintentional injuries combined (U.S. data, from WISQARS), and for injuries classified as agriculture-related (national and/or state or regional data from 15 previous studies), plots of both types

of rates as a function of severity were unambiguously log-linear, consistent with the well-known iceberg/pyramid model of injury severity. Plots of both types of severity-specific rates estimated from the present study also demonstrated log-linearity. Further, the slopes of all 4 trendlines were remarkably similar, differing, by type, by no more than approximately 15%. Rates for all unintentional injuries combined derived from the present study were 2-3 times higher than the national rates at each severity, suggesting our methodology significantly reduces under-reporting of unintentional injuries. The agriculture-related rates estimated from the present study were 6-40 times higher at each severity compared to predicted values based on the combined results of all relevant national, regional, and/or state-based studies. It therefore appears that the modified form of PEM we have developed can be implemented with 8-18 year olds to yield reliable daily data on all (and agriculture-related) unintentional injuries.

D5.5

Title: Teenage Construction Workers: Hazards, Experiences and Work Organization

Authors: Schuluman MD, Runyan C, Bowling M, Dal Santo J, Loomis D

Injury and fatality statistics show that construction jobs are among the most dangerous. A complex and variable work environment complements hazard exposure from tools, machines, materials, and other workers. Young workers may use dangerous tools and be exposed to a wide variety of workplace hazards.

This study identifies the hazard exposures, work experiences, and attitudes of young construction workers in North Carolina. Research was funded by NIOSH. Two random samples of teens under 18 working for construction firms were selected from work permits filed with the NC Department of Labor for summer 2000 and 2001. Questions asked via telephone surveys addressed tasks, equipment, working conditions, and unsafe working conditions as well as attitudinal and basic demographic items. A group of young Hispanic workers, identified through community groups, was interviewed in person with a similar questionnaire. In addition, firms employing teenage construction workers were sent a mail questionnaire in order to solicit employer information about safety practices and opinions about young workers.

Results from the telephone interviews show that young workers are in unskilled jobs where they function as handlers, loaders, helpers, or watchers. Many perform tasks that we categorized as dangerous and work at places where noise, dust, power tools, or heavy equipment are present. Self-reported injury was rare and concerns about being injured while working were low. Young Hispanic workers identified language and training as major issues. The major of employers provided some type of

safety training when a young worker was first hired, but the training was usually less than three hours.

Teen construction workers perform dangerous tasks under hazardous conditions with variable amounts of supervision. The results of this study point to the need to examine how young workers in the construction industry are trained and supervised.

Session: E1.0

Title: The Psycho-social Aspects of Worker Response in Hazardous Workplaces: From Mining, Construction and Agriculture to Terrorism and War (Part II)

Moderator: Kathleen Kowalski-Trakofler, Charles Vaught

E1.1

Title: Psychosocial Aspects of Employee Evacuation from High Rise Buildings Under Extreme Conditions

Author: Gershon R

The attack on the World Trade Center (WTC) on September 11, 2001 resulted in evacuation of between 14,000-18,000 employees from structures that were 100 stories high (1/4 mile). The buildings were damaged to such an extent that collapse took 1 hr and 42 minutes for Tower 1 (the North Tower) and 56 minutes for the South Tower (Tower 2). All occupants were killed above the point of impact in Tower 1 (above the 92nd floor), and only a handful survived above the 78th floor of Tower 2. The safe evacuation of the remaining occupants was conceivably possible, yet there were many fatalities. Survivors have experienced a range of emotions, from disbelief that the disaster happened, to clinical signs of post-traumatic stress disorder.

We are currently conducting a study examining the barriers to timely and effective evacuation of workers from the WTC. Both qualitative and quantitative data are being collected from voluntary participants. The constructs we are particularly interested in are the structural, organizational and individual barriers to evacuation. We are especially concerned with the role that preparedness played not only in the participants' decision to evacuate, but on their subsequent psychosocial well-being. Data will be presented from the first wave of in-depth interviews which are now underway.

The results from this study will help to inform policy and procedures in the evacuation of employees from high rise buildings under extreme conditions, and will provide insights on the effect of evacuation on the mental health of survivors.

E1.2

Title: *Work in Dynamic and Hazardous Environments: Where Does the Potential for Intelligent Performance Reside and How is it Acquired?*

Author: Cole HP

Mining, agriculture, and construction occur in dynamic and hazardous work environments as does responding to natural disasters and terrorist attacks. Effective work in these environments involves preventing, limiting, and responding to injury events of various magnitudes. Two questions about effective work in such environments are: (1) Where does the capacity for intelligent responses to such events lie? (2) How is this intelligence (wisdom) acquired? Learning theory provides three answers to these questions.

Behaviorism – Effective responses reside in the habits of individuals. Responses that lead to desired outcomes are learned through reinforced practice and become internalized as habits that lead to automatic, rapid, and proficient responses.

Cognitivism – Intelligent responses reside in the minds of individuals as they process information and make decisions using concepts and skills acquired through formal instruction combined with personal past experience and habits. Learning is mainly a matter of knowledge acquisition and intelligent performance the application of that knowledge.

Socioculturalism – Wise responses depend not only upon individuals' effective habits, accurate, and rapid information processing but also upon the collective intelligence of the social group and the tools used by that group. Learning must include enculturation of group members engaged in solving real-world problems in real-world contexts. Intelligent responses require smart people working within smart sociotechnical systems.

Behaviorism has dominated worker training for non-dynamic and stable environments. Constructivism has dominated the training of individual workers in problem-solving skills and analytic reasoning. Good habits coupled with rapid and accurate information processing are necessary but not sufficient for working intelligently in dynamic, dangerous, and rapidly changing environments. These three perspectives and lessons learned from studies of workers coping with emergency situations in underground mining, fire fighting, rescue and recovery work may provide insights for preparing a wide array of workers for responding to terrorist and mass disaster incidents.

E1.3

Title: *Issues In Training Emergency Responders: Is Preparation for Terrorism Different from Training for "Ordinary" Disasters?*

Authors: Scharf T, Kowalski-Trakofler K, Colligan M, Cole H, Pastel R, Roberts R, Vaught C, Elisburg D, Wiehagen B, Gershon R, Reissman D

Terrorist incidents using weapons of mass destruction (WMD) feel overwhelming - both to the victims and to the professionals who provide emergency and other services in response to such incidents. If the WMD agent is unknown or undetectable (i.e. by the senses, as in radiation) there can be extreme fear and dread. With such overwhelming emotional responses likely, how can we expect responders to be able to reliably make the time-critical decisions necessary to complete a rescue or other tasks and minimize personal and crew exposure to the hazards? More specifically, how can we prepare responders to maintain emotional balance and good decision-making in this type of environment?

The broader question is: should terrorist incidents be viewed as categorically distinct and separate from other workplace emergencies and hazards, or should they be treated as occupying the extreme end of a series of dimensions along which natural disasters, routine emergencies and other hazardous environments may vary? Our hypothesis is that we can characterize the differences between these events along several dimensions, including:

- 1) the specific type(s) and severity of the hazard(s) present, including:
 - a) unknown vs. known degree and type of exposure(s),
 - b) involuntary vs. voluntary nature of the exposure(s),
- 2) the speed and complexity of responses that are demanded of workers,
- 3) the risks for injury, including: uncommon (rare) vs. common (everyday) risks associated with exposure(s), and
- 4) severity of the consequences of exposure(s), including the potential for traumatic incident stress that may result.

The key test is to identify analogous, but more common and less extreme, "routine" or "ordinary" hazards that may help prepare workers for a WMD or terrorist event. Then, existing training for various types of emergencies, including chemical, biological, and radiation hazards, can be extended to help prepare for the magnitude of a mass casualty incident.

E1.4

Title: Lessons Learned from WTC, Pentagon and Anthrax Incidents: Training for Disasters, Managing Critical Incident, and Pre-Incident Stress

Authors: Elisburg D, Moran J, Solomon S, Lippy B

The WTC, Pentagon, and anthrax incidents of 2001 involved thousands of first responders and other rescue personnel as well as skilled support personnel (construction, utility, and other support workers). Many of these workers were onsite for months, rather than the short-term involvement that has characterized the response to many disasters. The scope of the destruction at the WTC, the exposure to a broad range of contaminants, the enormous loss of life, including the loss of many first responders, had a major impact on the physical and mental health of many responders. Screenings by Mount Sinai Medical School after the cleanup effort through November 2002 revealed that half of the 2,200 Ground Zero workers they had evaluated were still exhibiting respiratory difficulties and other medical problems. Sixty percent required referral for psychological evaluation.

The nature of these mass disaster incidents required unusual responses for providing the physical protection of these workers as well as for treating the potential of serious mental stress arising from the horrific nature of the events and the requirements placed on these workers engaged in the rescue and recover activities.

This discussion will include the emerging issues of ensuring workers are sufficiently trained for WMD incidents and for dealing with pre-incident stress training as well as developing critical incident stress management. The panel will focus on the reduction of trauma – both mental and physical - through effective worker training..

Session: E2.0

Title: Construction Injuries I

Moderator: Carolyn Guglielmo

E2.1

Title: Injuries and Illnesses from Wood Framing in Residential Construction, Washington State, 1993-1999

Author: Shah SM

The construction industry is associated with high rates of work-related injury. In 2001, Washington State launched an initiative to decrease injuries in wood frame construction. We used workers' compensation data to describe the injuries and illnesses, claims rates and claim costs associated with framing activities in wood frame construction. From 1993 to 1999, 33,021 state fund claims with direct costs of over \$197 million were accepted

for work-related injury and illness. The average annual accepted workers' compensation claims rate was 45 per 100 Full Time Equivalent employees. Over the study period, statistically significant downward trends were noted in claims rates for all injuries and illnesses (-3.69% annual change; 95% CI: -4.88%; -2.26%), compensable time loss claims (-4.15% annual change; 95% CI: -4.84%; -3.47%), and eye (-6.47% annual change; 95% CI: -7.83%; -5.09%) and fall injuries (-4.72% annual change; 95% CI: -6.50%; -2.93%). However, when these trends were compared to all other construction risk classes except wood frame construction combined, the rates of decrease over the study period were not statistically different. The information in this report can be used to monitor claim trends and to evaluate the effectiveness of initiatives to reduce injury and illness rates in wood frame construction in Washington State.

E2.2

Title: Characteristics of Work Scheduling and Work-Related Injuries in Construction

Author: Dong S

Importance:

Construction workers face rapidly changing workplaces, a high degree of competition, bouts of unemployment, as well as vast overtime. When such pressures are brought to the job, they may affect workers' health and ability to remain safe in the workplace. Therefore, it is necessary to understand work scheduling variables such as work-rest schedules, weekly duration of work, shift work, and extended periods of overtime among construction workers, and the effects on their safety and health.

Objectives:

The objectives of this study are 1) to examine work scheduling in construction and 2) establish any connection between hours of work patterns and safety outcomes among construction workers.

Methods:

The National Longitudinal Survey of Youth, the 1979 cohort (NLSY79) between 1986 and 1996, was used for the data analysis. Injury rates and other statistics were used to measure risk.

Results:

The findings indicate 1) work scheduling in construction differs from non-construction scheduling and 2) overtime is strongly associated with work-related injury among construction workers, especially construction laborers.

Implementation:

The findings may be the first examination of work-related injuries and working hours among construction workers. The results may be used to persuade construction project owners and contractors of a need for more careful planning, staffing, and training to reduce unscheduled and excessive overtime; and

guide construction managers in the implementation of optimal work schedules that would minimize the risks and cost of safety and health to workers, employers, and the public. The results may also suggest appropriate public policy interventions, tailored to construction and industries experiencing similar consequences, to produce work schedules that might help reduce the risk of injuries and illnesses.

E2.3

Title: *Ontario Construction Industry Fatalities –1992 to 2002*
Author: Zaichkowski J

From 1992 to 2002, the Ontario Construction Industry experienced 195 fatalities. During this period, the number of workers increased from 269,000 in 1992 to 354,000 in 2002. Over this same period, the Fatality Frequency rate fluctuated between 4.5 and 8.4 (averaging 6.05) per 100,000 workers per year.

In order to track trends in construction fatalities, the Construction Safety Association of Ontario (CSAO) maintains a fatality causal database. For each fatality, causal data fields are populated including accident type, work surface, age, occupation and project type. Main sources of data are CSAO field staff, Ontario Ministry of Labour (MoL), Ontario Workplace Safety and Insurance Board (WSIB) and the Ontario Coroners Office.

The following are some of the statistics derived from this database:

The 4 largest Categories/Groups of fatal accidents were; falls to a different level 40%, struck by vehicles and equipment 19.5%, struck by falling, overturning or collapsing materials or equipment 18% and electrocution 15.4%.

The Low-Rise Residential sector was responsible for 34% of all fatalities. Of these 45% resulted from falls, 21% were electrocutions and 18% were struck by falling, collapsing or overturning materials or equipment.

In the Low-Rise Residential sector, the use of ladders accounts for 30% of that sector's fatalities. Half of these were falls from ladders and half were electrocutions caused by ladders contacting overhead power lines.

This presentation will provide an in-depth analysis of the breakdown and trends of the causal data for these 195 fatalities, including trade, sector, project type, work surface and accident types. Finally, this presentation will examine intervention strategies initiated by the MoL, WSIB and CSAO.

E2.4

Title: *Injury and Payment Rates for Different Injury Mechanisms among Types of Construction Work*

Authors: Glazner JE, Bondy J, Lezotte DC, Guarini K, Lipscomb HJ

Background: To calculate injury and payment rates for specific types of injuries suffered by workers doing different types of construction work, we analyzed 3683 reports for injuries occurring during the construction of Denver International Airport (DIA).

Methods: A database including workers' compensation (WC) claims and payroll for the 32,081 construction workers who built DIA was linked with data from injury reports. Based on a manual review of narrative text describing the incident, each injury was assigned a single "mechanism of injury event" (MOIE), which refers to the initial energy exchange leading to injury (e.g., the "slip/trip" leading to a fall was coded rather than "fall."). Linking these data sources allowed us to analyze rates of mechanisms of injury events for each type of work. For types of work with at least 100,000 hours of payroll, we calculated injury rates per 200,000 hours worked for each MOIE.

Selected Results: Analysis of injuries for the type of work with the highest WC payment rate, driving/trucking at \$19.60 per \$100 payroll, revealed that the payment rate for slips/trips (\$6.48) was higher than that for motor vehicle/heavy equipment injuries (\$5.98). This suggests that prevention efforts for drivers on construction sites may also have to focus on risks for injuries occurring while drivers are not driving.

Workers doing another type of work, glass installation, with the fifth highest overall payment rate, were almost equally likely to experience straining motion and slip/trip MOIEs (9.62 and 8.71 per 200,000 hours, respectively). The payment rates for slips/trips, however, were much higher at \$13.95 per \$100 than for straining motion (\$3.83). This indicates that slips/trips, while less frequent, are more serious injuries for this group of workers. Such information could reorder prevention priorities.

Session: E3.0

Title: Transportation Injuries

Moderator: Linda Frederick

E3.1

Title: Nonfatal Injuries Resulting from Transportation Incidents

Author: Windau JA

Although transportation incidents account for only about 4 percent of occupational injuries resulting in days away from work, they result in some of the most serious injuries among private sector wage and salary workers. Transportation incidents recorded the third highest median days-away-from-work total in 2001, behind repetitive motion and falls to lower level. Transportation incidents resulted in a median of 10 days away from work, compared with 6 days for all types of events. Thirty percent of the transportation incidents involving days away from work required more than 30 days to recuperate.

The incidence rate for days away from work cases from transportation incidents was 7.4 per 10,000 workers in 2001, a drop of about 17 percent from the rate in 1992. This decline is well below that for all events and exposures combined, which fell 45 percent during the same time period. The number of days away from work cases also declined between 1992 and 2001. Cases resulting from transportation incidents fell about 2 percent, compared with 34 percent for all types of events.

Highway incidents accounted for about two-thirds of the transportation incidents that resulted in days away from work in 2001. Transportation and public utilities and services together accounted for about half the transportation incidents. This presentation will further profile injuries resulting from transportation incidents using data from the Bureau of Labor Statistics' Survey of Occupational Injuries and Illnesses. The discussion will include occupational and demographic characteristics of injured workers, nature of injury and part of body affected, and type of vehicles involved.

E3.2

Title: Pedestrian Injuries Caused by Powered Material Handling Vehicles at a U.S. Heavy Manufacturing Company from 1998 to 2002

Authors: Stout AW, Reeve GR, Graham DM

The purpose of this study was to describe the experience of pedestrian injuries caused by Powered Material Handling Vehicles (PMHVs) in a heavy manufacturing setting from 1998 to 2002; to describe the progress of an intensive intervention effort intended to reduce the number of pedestrian injuries, and to discuss what portions of the intervention had an impact on

reducing pedestrian injuries. The study data were abstracted from a validated occupational health and safety data system through database text searches of all First Time Occupational Visit (FTOV) case narratives for company manufacturing and parts distribution facilities in the U.S., and then a manual review of all retrieved records was conducted to determine actual cases. The 853 cases identified were then stratified as primary hits (direct pedestrian contact with PMHVs) N=448 and secondary hits (pedestrian contact with materials moved or struck by PMHVs) N=405.

The results indicated that PMHV/Pedestrian FTOV rates were relatively unchanged until after an aggressive PMHV Safety Initiative was launched in the 3rd quarter of 2000. Rates had a modest decline in 2001 with an overall rate of 0.235 FTOVs / 200,000 Hours Worked (95%CI: 0.201, 0.272) compared with the 2000 overall rate of 0.304 FTOVs / 200,000 Hours Worked (95%CI: 0.267, 0.344). Rates then significantly declined in 2002 with an overall rate of 0.072 FTOVs / 200,000 Hours Worked (95%CI: 0.053, 0.093). The ratio of primary hits to secondary hits remained approximately even over the 5 year period. A PMHV/Pedestrian Safety Survey was then administered at 4 of the company facilities (one from each major division) to approximately 20 randomly selected subjects (10 PMHV Operators and 10 Pedestrians) at each facility. The results detail what factors of the intervention appeared to have contributed to the overall rate reduction and what factors may have detracted or had no impact.

E3.3

Title: Ambulance Crash-Related Injuries among EMS Workers

Authors: Bobick TG, Proudfoot SL, Romano NT, Moore PH, Current RS, Green JD

Introduction

Ambulance crashes are one of many hazards faced by U.S. emergency medical services (EMS) workers. EMS personnel have an estimated fatality rate of 12.7 deaths per 100,000 workers, more than twice the national average. NIOSH's Division of Safety Research is engaged in a project investigating EMS-worker fatalities from ambulance crashes. This project involves: surveillance data analysis, crash investigations, computer modeling, sled testing of occupant restraint systems, and ambulance crash testing. The project's goal is to define injury risk and evaluate restraint systems for EMS workers. This presentation is focused on an analysis of surveillance data and selected NIOSH crash investigations.

Methods

Data analysis used the Fatality Analysis Reporting System (FARS) of the National Highway Traffic Safety Administration (NHTSA). FARS is a census of fatal vehicle crashes. NIOSH conducted field investigations of fatal crashes, and evaluated

NHTSA reconstruction reports of selected fatal incidents.

Results

From 1991-2000, there were 300 fatal crashes involving ambulances. In these incidents, 82 occupants were killed, of which 27 were EMS providers. Of these, seven were in the patient compartment, five in the right-front passenger seat, 11 in the driver's seat, and four were uncoded.

Discussion

Ambulance drivers experience the majority of less-severe injuries (coded "Possible" and "Non-Incapacitating Evident"), while patient compartment occupants (EMS providers and civilians) are most likely to suffer "Incapacitating" and "Fatal" injuries. In incidents involving fatalities to EMS providers, failure to wear seatbelt restraints appears to be the primary factor. Seat belts do not allow complete access to patients who need appropriate medical attention.

Conclusions

Improved restraint systems are needed for the patient compartment that permit workers to stand and attend to the patient, yet still protect workers during sudden stops or avoidance maneuvers. Also, restraints should be used by all occupants, including the driver and front-seat passenger.

E3.4

Title: Road Compactor Overturn Injury Risk Factors

Author: Myers ML

The Occupational Safety and Health Administration (OSHA) promulgated a ROPS standard for construction vehicles in 1972 that did not include compactors, and OSHA has yet to promulgate this standard. The specific aims of this project were to:

1. Identify the machine, environmental, and human factors that contribute to compactor overturns,
2. Identify design defects of ROPS that result in them crushing operators/drivers during an overturn,
3. Evaluate the likely consequences of overturns of ROPS-equipped compactors if they had not been equipped with a ROPS,
4. Evaluate the potential of ROPS and seatbelt-equipped compactors in preventing injuries as a result of falls from or collisions of the machines if a seatbelt had been used, and
5. Evaluate OSHA's application of the General Duty Clause to enforce the use of ROPS on compactors.

This project addressed the need to protect compactor operators and drivers from injury in the event of an overturn of their equipment. Many of these workers have been killed or seriously injured over the last 30 years, and they continue to be killed or

injured by compactor overturns each year. Most of these injuries occur on compactors that lack a ROPS, but some occur with ROPS-equipped compactors.

The research design is to use OSHA and NIOSH investigation reports of compactor overturns and runovers to determine the risk factors related to these incidents. Data from these reports were placed into a Haddon matrix to analyze the role of machine, environment, and human factors and the temporal dimension (prior, during, and after) of the incident. In addition, a flowchart was constructed for each incident to understand the antecedent factors leading to and the characteristics of the overturn.

E3.5

Title: The Work Zone Analysis System: A Tool to Evaluate Worker Exposure Around Hazardous Equipment

Author: Schiffbauer WH

Worker injuries and fatalities in industrial work zones are a major concern to the National Institute for Occupational Safety and Health Administration (NIOSH). Highway workers (SIC 1611) are at great risk from passing motorists, and construction vehicles. The Mine Safety and Health Administration (MSHA) maintains a database that has identified a high number of mine workers killed or disabled as a result of working near vehicles. Surface drilling operations have been investigated by the Occupational Safety and Health Administration (OSHA) to determine how many workers have lost or have had their hearing impaired by working close to drill rigs. Dust exposure in industrial work environments has also been heavily investigated. NIOSH has developed a research tool called a Work Zone Analysis System (WZAS), which can greatly enhance data collecting and analysis in efforts to mitigate the aforementioned hazards. The basic components of the WZAS are: differential mode GPS receivers, machine vision processors, wired and wireless video links (ground and air-borne), proximity determination devices, and data analysis tools. The WZAS is housed in a mobile trailer which includes: power, a 58 foot mast, a satellite internet dish, and numerous other features. The WZAS will enable NIOSH researchers to perform detailed task analyses of outside work environments. This information will help identify what remedial actions could benefit worker safety. Expected outcome variables include: incidence of workers-on-foot (WOF) within vehicle blind spots; amount of time a WOF is in a blind spot, or within a specified distance of a vehicle; number of WOFs in proximity to operating vehicles; amount of time a vehicle backs up per hour of operation; process operational efficiency; intervention feasibility; areas of exposures to high noise levels; and areas of exposures to high dust levels.

Session: E4.0

Title: Health Care Workers/Sharps Injuries

Moderator: Mark McFall

E4.1

Title: Cost-Effectiveness of Safer Sharp Medical Devices for Prevention of HIV and Hepatitis C Infection in Healthcare Workers

Authors: Fisman DN, Mittleman MA, Harris AD

Background: An estimated 400,000-800,000 sharps-related injuries occur annually in the U.S. These injuries may cause transmission of HIV, hepatitis C virus, and other infectious diseases. Implementing the use of safer sharp devices has been advocated as a means of preventing healthcare worker injury and associated healthcare costs. However, safer sharp medical devices are themselves more expensive than conventional counterparts. Our objective was to evaluate the cost-effectiveness of safer sharp devices on HIV transmission in the healthcare workplace.

Method: Data was obtained from a review of published nursing and medical literature, and from data obtained from the Occupational Safety and Health Administration (OSHA). A decision-analytic model was used to calculate projected costs and health benefits associated with the adoption of safer versions of widely used sharp medical devices. The incremental cost-effectiveness ratio associated with HIV and hepatitis C prevention was calculated. In order to test the impact of uncertainty on model projections, univariate and multivariate sensitivity analyses were conducted.

Results: Each use of a safer, as compared to standard, medical device was projected to result in an increase in life expectancy of 2 x 10⁻⁵ life years, at an incremental cost of \$0.23 per usage. The resultant cost-effectiveness ratio was \$11,500 per life-year gained. This cost-effectiveness ratio became more favorable as the prevalence of hepatitis C in the population increased, and as the per-use probability of injury increased, but remained relatively stable in the face of plausible variation in HIV prevalence.

Conclusions: The cost-effectiveness of safer medical devices to prevent HIV and hepatitis C infection in healthcare compares favorably to other commonly used disease prevention strategies, even when these devices cost three to five times as much as their conventional counterparts. The cost-effectiveness of these devices is greatest when in institutions with high prevalence of hepatitis C infection among patients.

E4.2

Title: Effectiveness of the Bloodborne Pathogens Standard in Reducing the Rate of Sharps Injuries in California Hospitals

Authors: Gillen M, McNary J, Kaneshige L, Imhof L, Cone J

Problem: In 1999, California made sweeping changes to its BBP standard specifically requiring employers to use safer sharps devices. This aim of this study was to assess the rate of sharps injury in hospitals before and after standard implementation.

Methods: A request to submit sharps data for the years 1997-2001 was sent to general acute care and specialty hospitals. Denominator data was obtained from the Office of Statewide Health Planning and Development financial data files. To date, reports have been received from 265 hospitals, (~65% response). Numerator data included the total number of sharps injuries, as well as the number of injuries in nurses. Denominator data included staffed beds, patient days, gross patient daily hospital revenue, and nursing productive hours.

Results: Completeness of facility reporting varied causing the useable data for each year to vary as well. The rate of injury per staffed bed decreased from 0.175 (SD, 0.150) in 1997 to 0.150 (SD, 0.149) in 2001. A decrease over time was also found in the rate per patient day from 0.00084 (SD, 0.00086) to 0.00067 (SD = 0.00065), as well as the rate in RNs per productive 40 hours from 0.00153 (SD, .00156) to 0.00114 (SD, 0.00089). Preliminary estimates of linear change over the five-year time period were statistically significant for each variable tested with all p values <.001, except for LVN productive hours (p = .005).

Conclusions: The mandate to furnish safety devices to healthcare workers appears to have affected overall exposure to BBPs. Findings from a related part of this study indicate a high degree of facility compliance with the major components of the BBP standard. However compliance with the more subtle elements promulgated to assure a sustained level of protection (e.g., employee involvement in product selection) continue to be lacking.

E4.3

Title: Risk Factors for Occupational Blood Exposure: Estimates from the National Study to Prevent Blood Exposure in Paramedics

Authors: Ratcliffe JM, Jagger J, Baden S, Orelie JG, Leiss JK, Boal WL, Tierney JA

Occupational blood exposure puts non-hospital health care workers at risk of infection from human immunodeficiency virus, hepatitis B, hepatitis C, and other bloodborne pathogens. Identification and quantification of risk factors for blood exposure among these workers could aid in developing prevention guidelines and recommendations. For most populations of non-hospital health care workers, previous efforts to identify risk factors for blood exposure have focused on analysis of exposure events, particularly percutaneous injuries. This approach has yielded candidate risk factors, but population-based methods are needed to determine whether they are risk factors and to quantify their effects.

We conducted a national mail survey to identify risk factors for occupational blood exposure among paramedics and to estimate their effects. The National Study to Prevent Blood Exposure in Paramedics was conducted in the fall–spring of 2002/2003 under a grant from NIOSH. A national sample of licensed paramedics was selected in a two-stage design. States were selected in the first stage proportional to the number of licensed paramedics. In the second stage, paramedics were selected by simple random sampling from licensure lists provided by state agencies. Eleven states were selected in the first stage (California, Connecticut, Florida, Illinois, Kentucky, Minnesota, North Carolina, Ohio, Pennsylvania, Tennessee, and Texas). Illinois could not provide contact information for licensed paramedics because of privacy restrictions. Six thousand five hundred paramedics were selected from the remaining ten states.

The response rate was approximately 50 percent. Potential risk factors that were considered included availability and use of personal protective equipment (PPE) and safety devices; managerial environment; knowledge, attitudes, and practices; and limited demographic characteristics. Risk factors were examined for total exposures and for five specific routes of exposure, i.e., needle and lancet sticks; percutaneous injuries from other sharp objects; blood in eyes, nose, or mouth; bites; and blood on non-intact skin.

Session: E5.0

Title: Safety Research Methods II

Moderator: Virginia Lutz

E5.1

Title: Comparison of Fatality Rate Denominator Choices: Population Based Methods

Authors: Bena JF, Richardson DB, Bailer AJ, Loomis DP, Marshall SW

The calculation of fatal occupational injury rates allows researchers to compare risks on a standardized scale, for example deaths per worker-year. As the numerator for fatal occupational injury rates for the United States, researchers often use mortality information from either the National Traumatic Occupational Fatality (NTOF) surveillance system or the Census of Fatal Occupational Injuries (CFOI). Employment data that are used in the denominator of fatality rates often are derived from population based sources such as the Decennial Census and the Current Population Survey (CPS). The Census provides accurate estimates of finely stratified sectors of the population once every ten years, so interpolation or extrapolation is necessary to derive estimates for non-Census years. The CPS is a monthly sample that can be aggregated to form annual estimates of employment. Unfortunately, the small size of the CPS prevents highly stratified analyses due to instability of the estimates.

Using simulated and empirical data, we evaluated the comparability of fatal occupational injury rates calculated using Census and CPS data. Analyses of empirical data indicated that industry- and occupation-specific fatality rates were similar for most sectors, but areas such as Agriculture, Forestry and Fishing differed, suggesting that seasonal workforces may not be properly represented using Census estimates of employment; trends in fatality rates were also similar. Simulations that used inputs based upon NTOF, Census, and CPS values found that trend estimates tend to be similar when employment levels change little or when the trend in employment is linear and employment levels are reasonably large. These comparisons indicate that the Decennial Census can provide data that is comparable, in most instances, to the CPS for the estimation of fatality rate and rate trends, and supply denominator data for more highly stratified analyses of fatal injury risk than are possible to conduct using the CPS.

E5.2

Title: Using Injury Classification Systems with Safety Report Narratives to Inform Occupational Injury Interventions

Authors: Lincoln AE, Sorock GS, Courtney TK, Wellman H, Smith GS, Amoroso PJ

Background. Narrative descriptions of work injury events are often collected as part of occupational injury and illness records and safety investigations. These descriptions can provide useful details and insight into the mechanisms of injuries and opportunities for prevention. However, there exists no recognized approach to analyzing narrative descriptions, recognizing hazard patterns, and deriving interventions to prevent similar injuries from occurring in the future.

Methods. This paper evaluates the key data elements of three classification systems (BLS' OIICS, WHO's ICECI, and US Army's ASMIS) and how they can be used to glean causal information from narratives in safety reports. Strengths and shortcomings of each system were assessed to identify opportunities for intervention and prevention of future injuries.

Results. The ICECI, OIICS, and ASMIS contained 55% (22 of 40), 38% (15 of 40), and 68% (27 of 40) of all possible key data elements from the sample narratives, respectively. The ICECI was effective in capturing injury mechanisms, precipitating and direct objects, intention, and served as a good format for general surveillance purposes. The OIICS was effective for depicting injury mechanisms and human movement at the time of the event, as well as identifying in great detail the object(s) involved. ASMIS provided a highly specific code for task, objects, and offered a range of codes to include surrounding circumstances and precipitating factors.

Conclusion. Despite the logistical and reporting limitations associated with accident investigations identified in this study, use of narratives for the prevention of occupational injuries is encouraging. Improvements can be expected with increased requests for the inclusion of narrative data, development of approaches and software for the analysis of natural language texts, and insight into antecedents associated with injury events. Classification systems need to be based on detailed narrative text that can also suggest injury reduction strategies.

E5.3

Title: Grouping ICD9-CM Diagnoses in Workers' Compensation Administrative Databases to Create Design Variables in Generalized Linear Models for Incidence and Outcome

Authors: Arthur Oleinick, MD, JD, MPH and Daniel F. Blower, PhD, BA

Background: The large number of study cases available in workers' compensation administrative databases offers the potential of adequate power for estimating a number of covariates simultaneously in generalized linear models. However, there has been little work on creating taxonomies for grouping clinical diagnoses for covariate estimation.

Methods: The Ohio Bureau of Workers' Compensation prepared a data extract of all claims filed by workers employed by firms classified as trucking firms by the NCCI Rating Manual. ICD9-CM clinical diagnoses are available for all diagnoses for which payment is approved.

Results: There were 24,131 claims during the study period of 1997-1999 with a combined total of 35,688 diagnoses. 72% of cases had a single diagnosis, 18% had two diagnoses, while 10% had more than two diagnoses.

To date, grouping software developed by project personnel successfully grouped 68% of claims with single and double diagnoses into seven functional areas defined in relation to major joints, including the back (spinal column/spinal cord). An effort has been made to assign all relevant ICD9-CM codes to functional areas so that future study populations can also be grouped. Approximately 32% of claims involve injuries with back diagnoses, 8% shoulder diagnoses and 8% knee injuries.

Within a functional area, sub-groups were defined and a hierarchy created in order to sub-group claims with two diagnoses. Building on earlier work, the claim was assigned to the more serious diagnosis, e.g., rotator cuff tear rather than sprain/strain of shoulder. Classifications by severity in each body area are comparable.

Conclusion: A method for grouping diagnoses by functional body area and severity appears feasible.

E5.4

Title: The Effectiveness of OSHA Inspections in Manufacturing in Preventing Lost Workday Injuries: How it Varies with Characteristics of the Workplaces and the Inspections

Authors: Mendeloff JM, Gray WB

This NIOSH-sponsored study linked OSHA inspection data in manufacturing with confidential establishment-level data from the BLS Survey of Occupational Injuries and Illnesses, covering injuries from 1992 to 1998 and inspections from 1990 to 1998. Other research in the same study had already shown that the average preventive impact of inspections had declined substantially from the 1979-85 period. One objective of this research was to identify the circumstances under which inspections continue to be effective in preventing injuries. We believe this information will be useful to OSHA.

We also had one major hypothesis to test: OSHA inspections were hypothesized to be more effective in preventing injuries where a) employer economic incentives to prevent injuries were weak and b) where workers were more likely to lack both information and bargaining power. As an operational matter we assumed that these conditions were most likely to be met in smaller workplaces and non-union workplaces. We had over 50,000 observations from over 16,000 workplaces. We examined the impact of inspections over a 4 year period.

Our findings were that inspections during 1992-98 were effective at establishments with fewer than 100 workers if the inspection levied penalties. We found no evidence of effectiveness unless penalties had been levied (closely correlated with finding serious violations) and no effects at establishments with more than 250 workers. Holding size constant, penalty inspections were less effective at unionized workplaces. We found no evidence that penalty inspections varied in their effects between Federal OSHA and State Plan states. One surprising finding was that health inspections had a bigger effect on preventing injuries than safety inspections did. An important puzzle is the finding that even when impacts were found on "days away from work" injuries, they were usually not found on "restricted work activity" injuries.

E5.5

Title: How Low Can They Go? Potential for Reduction in Injury Rates

Authors: Shannon H, Vidmar M

Introduction: Workers' compensation lost time injury rates (LTIR) fell considerably in Ontario in the 1990s. Our aim is to estimate how many fewer injuries might occur if all companies achieved rates of 'better' firms.

Method: For each Rate Group (RG, companies engaged in the same business), we examined the distribution of LTIR by company for four years, 1998 - 2001. We calculated the expected number of lost time injuries (LTI) in the RG if all companies had LTIR at the 25th percentile. We added the expected numbers of LTI across all RGs. The total was compared to the total number of injuries that did occur to estimate how many injuries might have been prevented if all companies achieved an LTIR at the 25th percentile. We also plan to make estimates using different percentiles as benchmarks, and adjusting for type of injury.

Results: Preliminary analyses show that with no adjustments the potential reduction (PR) in LTI was 27%. When firms within Rate Groups were stratified by size (<20 or >20 employees), the estimate of the PR increased to 46%.

Discussion: The adjusted PR is high at 46%. We chose the 25th percentile of the distribution so under-reporting would likely not be a problem - at least some companies would achieve this rate by better safety, rather than claims suppression. We might reasonably have chosen a lower percentile, in which case the potential for reduction would be greater. The preliminary analyses suggest that there is still substantial room for improvement in safety in Ontario. Further data will be presented at the conference.

Session: F1.0

Title: Job Safety and Health Intervention Effectiveness: Doing the Right Things

Moderator: Pat Coleman

F1.1

Title: Intervention Effectiveness: Evaluation of Six Workplace Safety Programs to Determine their Contribution Injury Reduction

Author: Vredenburg AG

On any given day, seventeen American workers are killed and 16,000 are injured in work-related accidents, resulting in a cost to business and industry of more than \$110 billion annually. Six management interventions consistently are discussed in the context of safety culture: communication/feedback, management support, hiring practices, rewards, training, and employee participation. This study evaluated the degree to which each of these interventions contributes to a safe work environment. There are few well-controlled studies demonstrating the efficacy of safety programs implemented in work settings; therefore, the six initial subscales were developed based on expert experience and case studies reported in practitioners' articles. Risk managers from 62 participating hospitals completed a 3-part survey developed for this study that solicited data regarding management practices and employee injuries. A factor analysis performed on the management practices scale resulted in the development of six factor scales. A multiple regression performed on these factor scales found that proactive practices reliably predicted injury rates. Remedial measures acted as a suppressor variable. While most of the participating institutions implemented reactive practices (fixing problems once they have occurred), what differentiated the best performers was that they also employed proactive measures to prevent accidents. The most effective step that organizations can take is in the front-end hiring of new personnel and verifying that skills gained through training are being employed the work areas. They should also ensure that the risk management position has a management-level classification. This study also demonstrated that the amount of training in itself does not reduce accidents. By evaluating these safety interventions, this study demonstrated where organizations most effectively channel their resources.

F1.2

Title: Evaluation of a Best Practices Back Injury Prevention Program in Nursing Homes

Authors: Collins JW, Wolf L, Bell J, Evanoff B

Bureau of Labor Statistics data indicate that nursing homes have the highest nonfatal injury rate of all health services industries. Among female workers in the U.S. in 2000, Nursing aides and orderlies comprise the highest risk occupation (prevalence rate = 18%) and reported the largest number of work-related cases of back pain (n=269,000). This NIOSH study, conducted in collaboration with BJC Health System, evaluated the impact of a "best practices" program for back injury prevention in six nursing homes. A laboratory study evaluated the biomechanical stresses on nursing personnel, the safety and comfort of the residents, and the time efficiency of nine battery powered lifts and three manual methods for transferring physically dependent residents. The field study utilized company records on injuries, hours worked, and staff demographics to examine the injury experience and injury-related costs of a cohort of nursing aides, orderlies, and assistants for an eight-year period (1995-2002, 36 month pre- and a 60-month post-intervention). The intervention included state-of-the-art patient lifting equipment to assist with transferring residents in and out of a bed or chair; and bathing, toileting, and weighing tasks. A comprehensive worker training program, a zero-lift policy, and medical management of injured workers was also integral to the prevention program. The program was highly successful in reducing injury incidence (57% reduction) and injury-related costs (44% reduction). Injury rates presented will be stratified by nursing home, age, gender, length of employment, shift, and work-status (full-time, part-time, and per diem).

F1.3

Title: Evaluating the Effectiveness of a Logger Safety Training Program in Reducing Injuries to Loggers

Author: Bell JL

With an estimated lifetime fatality risk of 62.7 per 1,000 full-time workers, it is well documented that logging is one of the most hazardous occupations and industries in which to work. The state of West Virginia based on 1992-97 Bureau of Labor Statistics CFOI data, has one of the highest logging fatality rates in the nation. This study evaluated the effectiveness of a logger safety training program in reducing injuries to loggers. The voluntary program (the West Virginia [WV] Loggers Safety Initiative [LSI]) provided safety training for all members of enrolled logging companies, tailored to their primary work tasks. The program ran for four years, from July 1999 - June 2003. During this same time period, the rest of the WV logging industry, not in the LSI program, showed a general increasing trend in both total and struck-by injury claims rates. Eighty-nine com-

panies enrolled in the LSI for at least part of the 4-year period. These 89 companies grouped together showed a significant decline in both total injuries and in struck-by injuries over the time period from July 1999 - June 2003. Of these 89 companies, 36 companies were present for the duration of the program. They enrolled in Year 1, and remained in the program through Year 4. When examined separately, this group of 36 showed no trend in overall injuries, but a declining trend in struck-by injuries. Additionally, this group had a lower total injury rate and a lower struck-by injury rate in comparison to companies that enrolled in the LSI program for less than 4 years. These preliminary results suggest this training program may be useful for reducing struck-by injuries (of major importance because they tend to be the most expensive and the most potentially fatal of all injury types).

F1.4

Title: Effectiveness of Narrative Approaches to Occupational Injury Prevention Interventions

Author: Cole H

In 1984 Professor Cole and his colleagues began using rate-based and case-based injury epidemiology to develop interactive narrative simulation exercises that teach and assess injury and disaster prevention skills to workers, managers, and safety inspectors. Approximately 400,000 copies of 70 simulation exercises designed for mining industry workers have been used in the US and additional copies in other countries. Narrative simulations also were developed for hazardous materials, construction, environmental protection, agriculture, and health care workers. Theories and design principles that underlie this approach, along with methods by which to evaluate program effectiveness and impact, are described using as an example a farm safety project. The project promoted use of roll over protective structures (ROPS) to reduce the risk of crush injuries to operators during overturns. Pre- and post-intervention telephone surveys were administered to large random samples of farmers in 2 intervention and 2 control counties. Farmers in the intervention counties assisted in developing, disseminating and field-testing a program of interactive narrative and hands-on community education materials. Three years later equipment dealers in the two intervention counties had retrofitted 81 tractors with ROPS compared to 4 in all four counties prior to the intervention. A repeated measures ANOVA found significant increases in intervention county farmers' favorable attitudes ($p = .0001$) toward ROPS as well as increased contemplation of installing ROPS ($p = .0016$) compared to the control county farmers. Intervention county farmers also acquired a significantly greater proportion of ROPS-protected tractors than did one control county ($p = .05$). (An equipment dealer in the other control county implemented his own ROPS promotion program after a friend died in a tractor overturn.) The study design, intervention methods, materials, and results are described. The origins of these methods in earlier studies and their generaliza-

tion to other occupational injury prevention efforts are examined.

Session: F2.0

Title: Construction Injuries II

Moderator: David Fosbroke

F2.1

Title: Construction Injury: Patterns of Factors Contributing to Different Types of Injury Events

Authors: Glazner JE, Bondy J, Lezotte DC, Guarini K, Lipscomb HJ

Background: Patterns of injuries sustained on construction sites are fairly well documented, but less is known about factors contributing to different types of injuries. To explore these, we analyzed narratives from injury reports for 3683 injuries sustained during construction of Denver International Airport.

Method: We reviewed descriptions of injuries to identify the initial energy exchange leading to each injury. This we refer to as "mechanism of injury event" (MOIE), e.g., the slip/trip leading to a fall rather than the fall itself. To classify contributing factors, we adapted Haddon's matrix to encompass 4 primary categories of contributing factors: human, object, environmental and organizational. As many factors as could be identified were coded for each report. These data were linked to coded claims data including Workers' Compensation payment information.

Results: Different patterns of contributing factors emerged for different MOIEs. Victim actions were identified as contributing to the majority of injuries from burns, cumulative trauma, foreign body eye, straining motion leading to overexertion, struck by/against, and twisted by/pulled by. Environmental factors contributed to a majority of injuries with MOIEs of fall (without slip/trip), motor vehicle/heavy equipment, and slips/trips. Tools contributed to the majority of burns and twisted by/pulled by injuries.

Detailed analysis of slips/trips, the most expensive (\$10.6 million) and second most common MOIE, revealed that environmental factors and building materials were more often implicated (84.5% and 23% of injuries, respectively) than were victim actions (15%). Environmental factors contributing to slips/trips included walking surface, terrain, slippery conditions and stairs. Among materials, wire, pipe and lumber contributed most frequently. Information about the injury burden of an MOIE and its contributing factors identified in brief narratives can help focus prevention efforts and guide targeted research.

F2.2

Title: Training Effects on Work-Related Injuries among Construction Laborers

Authors: Dong S, Schneider S, Chowdhury R, Men R

Construction laborer is one of the most dangerous occupations in the United States. Occupational injuries are an enormous burden to construction laborers, their families, and the public. To reduce occupational injuries, many safety training programs have been provided to construction laborers in the last several decades. However, so far, there has been little systematic evaluation of the impact of those training programs. As a pilot study, we assessed the effects of safety training on work-related injuries among construction laborers. Our hypothesis is that safety training can reduce work-related injuries. A combination of data sources was used for the study, including medical records and workers' compensation data of unionized construction laborers provided by the Washington State Department of Labor and Industries, and Laborers' Safety and Training records provided by the Northwest Laborers Trust Fund. Around 8,570 observations matching our selection criteria were included in our study. To measure the effects quantitatively, workers' post training injury experience, in terms of workers' compensation rate, was compared with that of those who did not receive training during the same time period. The characteristics of the construction laborers in the cohort were examined and described. To test our hypothesis, T test, 2 test, and multiple logistic regression model were applied. The initial findings indicate that the training program significantly reduced the workers' compensation claim rate by 34% (95% CI: 0.57, 0.76) after controlling for age, gender, and other potential confounders. We plan on obtaining more workers comp data to expand our cohort over several more years and increase the power of our findings.

F2.3

Title: Disabling Traumatic Injuries in Construction -- Fractures and Their Antecedents

Authors: Courtney TK, Matz S, Webster BS

Construction is recognized worldwide for relatively high risks of occupational morbidity and mortality. The US construction industry increased its share of private sector employment by 11% from 1996 to 2000. However, its share of private sector injuries and illnesses and cases involving days away from work increased by 19% and 23% respectively over the same period. While data on construction injury frequency are reasonably available, less is known about the disability duration due to occupational injuries in construction and the specific events associated with the most disabling traumatic injuries.

The construction claims experience (n = 35,790) of a large worker's compensation insurer with national coverage was examined to identify the leading types disabling occupational morbidity in the US construction industry. Disability duration was calculated from indemnity payments data using previously published methods. Injury event narratives were analyzed to more specifically classify contributing antecedents for fractures.

The average disability duration for an injured construction worker was 46 days with a median of 0 days. The most frequently occurring conditions were low back pain (15%), foreign body eye injuries (8.5%), and hand lacerations (7.7%). The traumatic injuries with the longest disability durations were fractures of the ankle (median = 55 days), foot (42 days), and wrist (38 days). Same level and elevated falls were the principal exposures for the wrist, while struck by incidents and elevated falls accounted for the majority of foot and ankle fractures. Falls involving ladders, scaffolding and vehicles were typical. The findings suggest the importance of increasing primary prevention resources for slips and falls along with other traumatic injury events.

F2.4

Title: Reducing Risk of Musculoskeletal Disorders Through The Use of Rebar Tying Machines

Author: Vi P

In Ontario construction, Rodworkers have a higher proportion of lost-time musculoskeletal injuries to the back and upper limbs than other construction trades. MSI claims are the highest cost claims incurred by Rodworkers. Rodworker MSI claims are also more expensive than MSI claims in other trades.

Past research suggests that to reduce physical load on rodworkers, interventions should be directed at reducing the frequency of awkward trunk postures, particularly during ground level rebar construction. One way to improve posture is to use an automatic rebar-tying gun. This is an electric tool that when applied where two bars cross, and the trigger is pressed, it feeds wire around the bars, twists it, and cuts it.

To evaluate potential risk reduction of musculoskeletal injury, a controlled experiment was conducted at the International Association of Bridge, Structural, Ornamental, and Reinforcing Ironworkers Local 721 Training Centre using nine apprentices. Participants were asked to perform rebar tying tasks in order to evaluate biomechanical stresses. For each trial, participants either tied rebar using the traditional hand-tying method or used the rebar tying machine (MAX RB392). A videotape of the participant working-posture was recorded for each trial. Wrist postures, and muscle activities were simultaneously collected using a DataLog from Biometric Inc. (UK).

Results of the experiment found a significant reduction in low-back loading and wrist activity when using the rebar tying gun. Based on these findings, it is concluded that working with the rebar tying gun can decrease the risk of musculoskeletal injuries to rodworkers. A detailed overview of the injury statistics, methodology and results of the experiment will be presented. Findings from further studies (started in March 2003) using the rebar tying machine in real construction applications will be reported.

F2.5

Title: Using Narrative Reports to Identify Factors Contributing to Construction Injury

Authors: Bondy J, Glazner JG, Lipscomb HJ, Guarini K

Background: While occupational injury rates can identify high risk groups, they have limited value in explaining injury etiology because obtaining precise measures of relevant exposures, which may be complex and transient, is difficult. In contrast, even short narrative descriptions have been shown to contain useful information about factors contributing to injury. We applied an adaptation of Haddon's Matrix to injury report narratives for 4148 injuries sustained in the construction of Denver International Airport (DIA) to determine whether its systematic application could elucidate factors contributing to construction injuries.

Methods: Reports were coded into a qualitative software package (QSR N5) in two stages. First, a single reviewer coded base information about the injury: body part, nature of injury, and a single "mechanism of injury event (MOIE)," which refers to the initial energy exchange leading to injury (e.g., the "slip/trip" leading to a fall was coded rather than "fall."). Second, injury reports were organized by MOIE and coded independently by two reviewers for all Haddon Matrix factors contributing to the injury event. Coding differences that the two reviewers could not resolve were referred for adjudication to other members of the research team and then to DIA safety experts.

Results: 236 injuries could not be coded for MOIE and contributing factors. Of the remaining reports, reviewers coded up to 12 factors per report, with a mean of 2.7. Given the brief nature of the narratives and complexity of the factors being inferred, use of multiple coders and involvement of safety experts were critical. Haddon's Matrix forced reviewers to examine narratives more thoroughly than they otherwise would have, eliciting more information. Flexible coding software accommodated the evolution of both MOIE categories and Haddon's Matrix over the course of the project. Organizing review of contributing factors around MOIEs improved the efficiency and quality of review.

Session: F3.0
Title: Fire Fighters

Moderator: Linda Frederick

F3.1

Title: A Profile of Thermal Imaging Camera Ownership in the United States Fire Service

Authors: Proudfoot SL, Fahy RF

Background

While structure fires have steadily decreased over 20 years, the rate of firefighter fatalities inside burning buildings has increased from 1.8 to 3 deaths per 100,000 fires. Most of these deaths occurred when firefighters became disoriented, were caught in a collapse, or were overtaken by rapid fire spread. Thermal imaging cameras (TICs) allow firefighters to "see" in obscured-vision conditions. TICs detect heat energy rather than light, translating heat signatures into recognizable images. Fire service-related applications include search-and-rescue, and locating hidden fire behind walls and ceilings.

Methods

The National Fire Protection Association (NFPA) added a question to its Annual Fire Service Survey (FSS) in 2001 to get a nationwide count of TICs. Preliminary data from the survey were analyzed to determine characteristics of departments based on TIC ownership. Data from the United States Fire Administration's (USFA) Needs Assessment were also incorporated.

Results

With two-thirds of the FSS cycle completed, 23.9% of departments have answered the TIC question; of those, 35.5% have at least one TIC. Career fire departments own 49.9% of the TICs, while volunteers own 50.1%. Career departments comprise 11.5% of all departments, while volunteers make up 88.5%.

The USFA reports that while 24.4% of the nation's fire departments now own TICs, 43.9% have no plans to purchase a TIC. The remaining 31.7% plan to obtain TICs within five years.

Conclusions

The data show an even distribution of TICs between career and volunteer departments; however, with the total number of career departments being a fraction of the number of volunteer departments, a much higher proportion of career departments own TICs. Career departments generally protect larger populations and respond to more structure fires. Additional applied research is needed regarding TIC utilization in the fire service, together with specification standards and standard operating procedures.

F3.2

Title: U.S. Firefighter Fatalities at Structure Fires

Author: Fahy RF

Since 1977, the number of U.S. firefighter deaths annually at structure fires has dropped 59 percent, a finding often credited to improvements in protective clothing and equipment, fire ground procedures and training. Over the same period, however, the number of structure fires has declined by 54 percent. It is important to determine to what degree the decrease in deaths may have been driven by the drop in the number of fires.

A comparison of the decline in both measures shows that the trends track fairly closely, indicating that the drop in deaths may have been, to a great degree, a result of the reduction in the number of fires. So, then, are firefighters just as likely to die today as they were 25 years ago?

A review of the data shows that the rate of heart attack deaths at structure fires (inside and outside) has been dropping since the early 1980s, as has the rate of non-heart-attack deaths outside at structure fires. One area showing marked increases over the period is the rate of traumatic injury deaths while operating inside structures. In the late 1970s, traumatic deaths inside structures occurred at a rate of 1.8 deaths per 100,000 structure fires and by the late 1990s had risen to almost 3 deaths per 100,000 structure fires. Almost all non-heart-attack deaths inside at structure fires were the result of smoke inhalation, burns and crushing or internal trauma. The major causes of these injuries were lost inside, structural collapse and fire progress (including backdraft and flashover). Although individually there were no consistent trends when looking at cause of injury, together there was a clear upward trend.

In order to reduce the number of firefighter deaths inside structure fires, it is crucially important to understand how they are happening and why they are increasing.

F3.3

Title: Firefighter Fatalities 1998-2001: Overview with an Emphasis on Structure-Related Traumatic Fatalities

Authors: Hodous TK, Castillo DN, Braddee R, Pizatella, TJ

This presentation reviews the causes of all firefighter line-of-duty-deaths from 1998 through 2001, and presents National Institute for Occupational Safety and Health (NIOSH) recommendations and discussion specifically regarding the subgroup of fire fighter fatalities related to structural fires. There were 410 line-of-duty deaths among US firefighters during 1998-2001, plus an additional 343 who died at the World Trade Center disaster on September 11, 2001. The 410 fatalities included 191 medical (non-traumatic) deaths (47%), 75 motor vehicle-related

fatalities (18%); and 144 other traumatic fatalities (35%). The latter group included 68 fatalities that were associated with structures, typically involving collapses, trapped firefighters, or rapid fire progression. Despite modern equipment and training, this group of fatalities has not decreased over recent years. Additional efforts are needed to help firefighters determine when an interior attack must be abandoned before catastrophic conditions develop.

F3.4

Title: *Analysis of Mine Fires and Fire Injuries at U.S. Underground and Surface Mines: 1999-2001*

Author: De Rosa MI

Fire and fire injury and fatality data from MSHA accident reports and verbal discussions with mine personnel were analyzed for the period 1990-2001 to arrive at fire incidence and injury risk rates for underground and surface coal and metal/nonmetal mines. The analysis also discusses other variables such as ignition sources, detection and suppression methods, and major types of equipment involved. During this period, 1,041 fires occurred, resulting in 488 injuries and 7 fatalities, and 50,957 lost workdays (included are 6,000 lost workdays for each fire fatality). While there is some overlap of major ignition sources and equipment involved in injuries reported for underground coal mines compared to underground metal/nonmetal mines, the analysis also identifies several major differences in the ignition sources and equipment for the two mining sectors.

For surface operations, the analysis indicates that the ignition sources and equipment involved were essentially the same for both coal and metal/nonmetal mining sectors. The analysis represents an essential tool for assessing fire research and prevention needs for both coal and metal/nonmetal mines.

Session: F4.0

Title: *Occupational Injuries: Social and Economic Issues*

Moderator: Laura Blanciforti

F4.1

Title: *Comparing Costs of Fatalities from Two Fatal Occupational Injury Surveillance Systems in the United States*

Authors: Biddle EA, Marsh SM

There are currently two national surveillance systems compiling occupational fatal injury data: the National Institute for Occupational Safety and Health (NIOSH) National Traumatic Occupational Fatalities (NTOF), and the Bureau of Labor Statistics (BLS) Census of Fatal Occupational Injuries (CFOI). Both systems were designed to capture the number and circumstances of all work-related fatal injuries and are used by re-

searchers to illustrate the burden of occupational fatalities. NIOSH developed a model to estimate the costs of fatalities from either system providing researchers another measure of this burden.

Because each system uses a different approach to count fatalities, the annual number of fatal occupational injuries reported varies by system. A comprehensive comparison (Biddle and Marsh, 2002) concluded that using death certificates alone, NTOF identified approximately 84% of the total count obtained by CFOI. Furthermore, counts differed by case and worker characteristics. A contributing factor to the differences was that NTOF reports usual industry and occupation while CFOI reports industry and occupation at the time of injury.

Cost estimates from the NIOSH model are driven by the number of fatalities reported and earnings of the employee at the time of death. Because earnings are dependent on the occupation and industry reported by the fatality surveillance system, costs of fatalities by system also vary. For example, during 1992-1997 CFOI reported 3,091 fatalities in services occupations and the mean cost estimate was \$767,695; NTOF reported 2,473 fatalities in that occupation group but the mean cost estimate was \$770,215. Similarly, the number and mean cost for manufacturing was 4,471 and \$797,372 compared to 4,364 and \$768,149 for CFOI and NTOF respectively.

The surveillance system selected to calculate the counts and costs of occupational fatal injuries will impact the resulting estimates and thus the injury prevention and control program planning, policy analysis, evaluation, and advocacy efforts.

F4.2

Title: *Challenges for Workplace Injury Prevention in a Changing Canadian Health Care Sector*

Author: Alberg NM

Canadian health care reform strategies in the 1990's concentrated on a transition from in-patient care to community based care. After initial downsizing of acute care beds and reductions in staffing, the resultant mix of patients and caregivers took on a different look. This new picture brought changes in the profiles of workplace injuries for health care providers. The injured workers, although "new" to the job, were still older than "new" workers in other industry sectors.

The difference in the type of care and in the mix of staff between acute care facilities and Personal Care Homes (PCH) has generated two streams of workplace injury. Both frequency and pattern of injury are different when Health Care is dichotomized into acute and long term care facilities. This presents distinct issues for intervention planning by safety and health professionals. The multiplicity of tasks in acute care facilities brings a wide range of safety and health concerns. In contrast, the

PCH's present a fairly homogeneous profile of injury.

A 10 year review of trends in Manitoba WCB injury claims from the Health Care sector demonstrates a picture of injuries which approximates the frequency and severity profile of the Construction sector. The challenge for safety and health professionals in Health Care is to work with administrators to instill the importance of consistent best practices for this changing work and workforce. This presentation will profile the trends and patterns of injuries in the Manitoba Health Care sector, highlighting the needs of identified risk groups regarding safety and health training.

F4.3

Title: New Perspectives in Construction Health and Safety Research: Investigation of the Complex Relationships Between the Worker, the Work Environment, and the Socioeconomic Context

Author: Brunette MJ

Unfortunately, construction is still recognized as one of the most dangerous industries. In the United States construction workers have higher rates of occupational fatalities, injuries and illnesses compared with other industries and with construction in other developed countries. According to the latest BLS annual survey, of all work-related deaths in 2000, 19.5% (or 1,154) occurred among construction workers. The dynamic nature of the construction industry poses a challenge for conducting studies: construction workers perform several physically demanding work tasks with varying levels of exposures and risks. At the same time, the temporary and transitory nature of construction workplaces make workers change employers and work sites frequently. The majority of investigations on consequences of occupational injuries and diseases among construction workers have focused on the traditional facets of economic costs ignoring the role that social, cultural and other "hidden" economic factors play in workers' health and safety. Recent studies have revealed that substantial social and economic costs are hidden or unrecognized. Overall, identification of the magnitude of injuries and diseases for employers, workers and families, government and society has not been well documented. In this presentation the need to incorporate the use of a macro approach into occupational safety and health research among construction workers and recommendations for narrowing the research gap to better understand the socioeconomic impact of injuries and illnesses will be discussed. Recent published evidence on the socioeconomic consequences of injuries and diseases will also be reviewed. The need for multidisciplinary research, improved quantitative and qualitative methods, and inclusion of underrepresented work groups will be emphasized.

F4.4

Title: What Kinds of Injuries Do OSHA Inspections Prevent?

Authors: Mendeloff JM, Gray WB

Beginning in 1992, the BLS Survey of Occupational Injuries and Illnesses began to collect more detailed information about injuries that involved "days away from work" (DAW). This research took advantage of that new information to study the types of injury "events" that were prevented by OSHA inspections. We linked OSHA inspection data from 1990 with confidential BLS establishment level data from 1992 to 1998. The key independent variable was whether there had been an inspection with a penalty in any of the 3 years preceding the years for which we had injury change data. We controlled for industry, year, establishment size, and changes in establishment hours worked. We had over 50,000 observations from over 16,000 establishments.

With help from OSHA staff, we had tentatively identified event types as more or less likely to be related to OSHA standards. The event types in the "more related" category were: "struck by or striking against," "caught in or between," "falls from heights," "eye abrasions," and "exposure to harmful substances." The event types in the "less related" category were: "bodily reaction and exertion," "struck against," and "falls on same level." Collectively, these categories included 95% of all DAW injuries.

Impacts on DAW injuries were found only at workplaces with fewer than 250 workers. We were surprised to find that the most statistically significant preventive effects were found for "bodily reaction and exertion" injuries. The other categories which revealed statistically significant preventive effects were "eye abrasions" and "exposure to harmful substances."

An important implication of these findings is that the preventive effects of inspections are not necessarily limited to the types of injuries that are directly related to OSHA standards. Penalty inspections appear to sometimes induce managers to make changes that go beyond compliance with standards.

F4.5

Title: Depression, Women and Occupational Injuries

Author: Peele PB

Aim: It is well known that depression complicates the medical management of injuries. What is not known is what role depression plays in the occurrence of occupational injuries. Even mild clinical depression can cause decreased vigilance and attention span, increased irritability, insomnia (resulting in daytime sleepiness), and difficulty concentrating. These behaviors are known precursors to occupational injury. This

project explores the relationship between occupational injury and depression.

Method: 121 employees with new work-related injuries and 140 controls (employees without work-related injuries) from a variety of employers in the Pittsburgh region completed a self-reported depression screening instrument (PHQ-9). Responses were scored for the presence and the severity of depression and we compare the two groups using univariate and bivariate analyses. Newly injured employees report significantly more depression ($p < 0.05$) than controls. We use logistic regression to examine the influence of depression, employment history, marital status, age, and sex on the probability of injury.

Results: We find that while women in this study are no more likely to be depressed than men, depressed women are 6.2 times more likely to be injured than non-depressed men and 4 times more likely to be injured than depressed men.

Conclusions: These data suggest that depression plays a significant role in workplace injuries, particularly for women. Given this, employers should have an interest in diagnosing and treating depression in their workforce as part of a comprehensive injury prevention and safety program. We discuss the implications of the results for employers and clinicians.

Session: G1.0

Title: Innovations for Improving Fire Fighter Safety in Structure Fires

Moderator: Steven Proudfoot

G1.1

Title: Review of NIOSH Fire Fighter Structure Fire Fatality Investigations

Author: Tarley JL

The National Fire Protection Association and the U.S. Fire Administration estimate that on average, 105 fire fighters die on the job each year. From 1992 through 2001, 283 firefighters lost their lives while responding to structure fires (excluding the 340 firefighters who died during the terrorist attacks on the World Trade Center September 11, 2001). NIOSH investigates occupational fire fighter fatalities to characterize the circumstances surrounding those events for the purpose of developing, evaluating and disseminating prevention recommendations in report form to fire fighters and fire departments across the country. A review of NIOSH's Fire Fighter Investigation reports indicates that from 1997 to 2001 at least 20 fire fighters lost their lives and 5 fire fighters suffered severe injuries after becoming "lost" or "disoriented" while inside a burning structure. The objective of the case series presented here is to describe details from four specific investigations in which fire fighters became lost or disoriented due to poor visibility. The need for fire fighters to effectively navigate in low visibility

conditions and to be visible to others for tracking and rescue efforts will be discussed. It is crucial to identify visibility products that are available and determine the extent of their usage. Additional discussion will take place to determine ways to collectively focus our research efforts to address these safety concerns.

G1.2

Title: Fire Fighter Visibility: Which Way is Out?

Author: Powers JR

From 1991 through 2000 303 firefighters lost their lives while responding to structure fires. NIOSH's Fire Fighter Investigation reports from 1997 to 2001 indicate approximately 20 fire fighters lost their lives after becoming "lost" or "disoriented" while inside a burning structure. An important factor to consider is that visibility can be reduced to zero in a matter of seconds, especially after water is applied to the fire.

Numerous NIOSH Fire Fighter Investigation reports mention eyewitness accounts of hearing a low air alarm, seeing the fire fighter leave the area, but the fire fighter never exits the building. When the fire fighter is located he/she is found in an area totally unrelated to where he/she was originally. Many accounts of fire fighters who do manage to get out safely mention that the hose line was very difficult to follow due to low visibility or overlapping lines and not knowing which one to follow or which direction to go.

There are numerous products available that can be beneficial in assisting fire fighters with visibility problems inside of a structure. These include lighted/reflective ropes, Personal Alert Safety System (PASS) devices, high power lights at entryways, etc. The USFA's Technical Rescue Technology Assessment [1995] mentions lighted/reflective ropes and PASS devices as they relate to rescue efforts. However, a question to consider is "How many fire departments really know what is available when it comes to visibility products?"

This session will discuss visibility products, how they are used, and what needs to be done. It will be an open discussion to try to focus research in this much needed area of fire fighter safety.

Session: G2.0

Title: Workplace Violence II

Moderator: Lynn Jenkins

G2.1

Title: Minnesota Nurses' Study: Impact of Violence Prevention Policies

Authors: Nachreiner NM, Gerberich SG, McGovern PM, Church TC, Hansen HE, Geisser MS, Ryan AD

Violence prevention policies are recommended as part of a comprehensive approach to address occupational violence. However, little empirical literature supports these recommendations.

This study was based on data collected for the Minnesota Nurses' Study of work-related violence against nurses. Among 6,300 nurses randomly selected from the licensing database, 79% responded to the comprehensively designed Phase 1 survey; 13.2% reported experiencing work-related physical assault in the past year. In the Phase 2 case-control study (3:1 ratio), 1,900 nurses (response 75%) were questioned about potential risk factors for violence, including work-related violence prevention policies. Types of policies assessed included the following: reporting procedures; violence definitions; consequences for those who used violence at work; confidentiality; and training requirements. A comprehensive causal model served as a basis for analyses and interpretation. Through a validation sub-study, responses were compared between nurses and employers regarding the presence of policies. Sensitivity analyses were performed for exposure misclassification and the presence of an unmeasured confounder.

The percentages of nurses reporting the existence of policies ranged from 22% (policies requiring flagging charts of violent patients), to 81% (policies regarding how to report non-physical violence), with 10% to 32% of nurses reporting uncertainty whether policies existed. Results of multiple regression analyses (controlling for workplace, perceptions of administration's attitude toward violence, department, and types of patients) indicated the odds of physical assault decreased for having a zero tolerance policy (OR=0.5, 95% CI: 0.3, 0.8) and policies regarding types of prohibited violent behaviors (OR=0.5, 95% CI: 0.3, 0.9). Analyses adjusted for non-response and non-selection resulted in wider confidence intervals. Results of sensitivity analyses provided further confidence that some work-related violence policies may be protective.

G2.2

Title: Workplace Homicide During Robbery: A Case-Control Study

Authors: Marshall SW, Loomis DP, Kline KK, Wolf S

We conducted a case-control study to determine risk factors for homicide in the event of a workplace robbery. Robbery is the leading cause of workplace violence.

Cases were all workplace robbery-homicides in North Carolina from 1994 to 2001. Controls were a random sample of workplace robberies in North Carolina. Both cases and controls, therefore, were robbery events in workplaces. Cases were robberies that resulted in a homicide, whereas controls were non-homicide robberies. A range of risk factors were examined, including lighting, visibility, staffing policies, security arrangements, and staff training.

In multivariate logistic regression models, we found presence of video surveillance equipment reduced the risk of homicide (OR=0.51; 95%CI: 0.26, 0.99). Situations in which the scene of the robbery was visible from outside the workplace had a lower risk of homicide (OR=0.70; 95%CI: 0.32, 1.57), as did workplaces with staff trained in responding to a robbery (OR: 0.48; 95%CI: 0.24, 0.97).

Factors related to firearms, multiple perpetrators, staff working alone, and staff offering resistance, on the other hand, increased the risk of homicide. Robberies in which firearms were present had a greater risk of homicide (OR: 3.31; 95%CI: 2.21, 7.11), as did robberies in which more than one perpetrator was present (OR: 4.0; 95%CI: 2.21, 7.12). Robberies in which staff offered active or passive resistance to the perpetrator appeared to have an increased homicide risk (OR: 1.87; 95%CI: 0.66, 5.30). Robberies in which only one staff person was on duty had a higher homicide risk (OR: 2.4; 95%CI: 1.41, 4.20).

Our results indicate that modifications to the environmental design of the workplace, relating to visibility and video surveillance, reduce the risk of homicide in a robbery. Administrative practices relating to staff training and number of staff on duty were also effective. The results provide information useful in designing prevention programs.

G2.3

Title: *Implementation of a Workplace Robbery and Violence Prevention Program*

Authors: Peek-Asa C, Casteel C, Kraus JF

Introduction: Robberies are the leading motive for work-related homicide and assault. Intervention programs designed to reduce robberies and related injuries have been limited to convenience stores. In addition, evaluations have not addressed compliance to intervention programs as a factor in program effectiveness.

Methods: The Workplace Violence Prevention Program (WVPP) provided a customized robbery and violence prevention program to a stratified random sample of 314 small, high-risk businesses in Los Angeles City. An additional 96 comparison businesses that did not receive the intervention were enrolled. For both intervention and comparison businesses, a comprehensive security program assessment was conducted at baseline and at two follow-up visits. The WVPP intervention included individualized consultation, printed materials, training brochures, and a video. Crime rates in intervention and comparison businesses were examined for 12 months pre- and post-intervention using police reports.

Results: By the second follow-up visit, implementation of each program component had increased significantly in the intervention businesses, while the level of implementation did not change in comparison businesses. Employee training was the most frequently implemented intervention component. Neighborhood crime level, primary language spoken by the business owner, and the number of employees were all related to level of implementation. While crime rates generally increased for all businesses from the pre- to post-intervention periods, businesses with high compliance to the program experienced a decrease in overall violent crime and robbery.

Conclusions: Participating businesses were willing to voluntarily implement components of the intervention program, and greater implementation was directly related to reductions in crime.

G2.4

Title: *The Impact of a Comprehensive Violence Prevention Intervention on Training Parameters*

Authors: McPhaul KM, Soeken K, Geiger-Brown J, Choi M, Lipscomb JA.

Significance: Limited intervention evaluation data is available to policy makers, employers and workers on effective workplace violence prevention strategies in healthcare. Factors associated with effective violence prevention training are not understood. The purpose of this analysis is to examine the impact of a comprehensive violence prevention intervention on violence prevention training frequency, staff perception of training quality, and staff confidence in their violence prevention skills. We hypothesize that a comprehensive violence prevention intervention with joint labor-management endorsement will improve training parameters such as frequency and quality and enhance staff confidence in their violence prevention skills. Furthermore, we anticipate that violence prevention training parameters as measured post-intervention will be associated with fewer staff assaults post intervention.

Methods: Pre- and one year post-intervention staff surveys were administered to direct care workers in seven mid-Atlantic state mental health facilities (n = 476, response rate 94%). Four facilities (one forensic, two adult and one children's) implemented the intervention. Three facilities (one children's and two adult) participated as controls. Training frequency, perception of training quality, and staff confidence in violence prevention skills were assessed. Self-reported threats and assaults experienced by staff in the last twelve months were also measured.

Results: In the baseline survey analysis, staff assessment of training quality predicted staff confidence in violence prevention skills (adjusted $r^2 = .294$; $p = .000$). At baseline training frequency, quality, and confidence in violence prevention skills did not predict assaults in this population of mental health workers. Post-intervention training parameters will be compared to the pre-intervention data and examined for change by intervention site status. Multiple regression analysis will be conducted to determine the relationship between post-intervention training parameters and assaults on staff. It is anticipated that training effectiveness is optimized when part of a comprehensive strategy to reduce staff injuries from assault

Session: G3.0

Title: Injury Hazards I

Moderator: Timothy Pizatella

G3.1

Title: An Acute Fatality While Applying a Spray-On Truck Bed Liner

Authors: Chester D, Hanna E, Pickelman B, Rosenman KD

There has been an increased concern about the health effects of a new application of isocyanates; spray-on truck bed liners. The spray-on truck bed liners are a 2-component system mixed at the spray nozzle. The most popular spray-on liners are polyurethane (isocyanate and polyol) and polyurea (isocyanate and amine resin). The application is commonly occurring, not during the manufacture of the truck, but as an aftermarket accessory item by small businesses. The Michigan Fatality Assessment and Control Evaluation (MIFACE) research program recently investigated a work-related death of an individual who died while applying a polyurethane spray-on truck bed liner. We will present the results of our investigation, including the medical history of the individual, autopsy findings, results of interviews with fellow workers, results of interviews of next of kin, our on-site findings and recommendations to prevent a similar occurrence.

G3.2

Title: Safety Hazards to Workers in Modular Home Installation

Authors: Becker, Paul E, ScD, Fullen, Mark D, MS, Takacs, Brandon C, MS

The process of installing (setting) a modular home is an entirely different process from that of a traditional stick-built house. The safety hazards that are created from these activities alone create a high hazard site. This presentation will describe the results of pilot research that addressed safety hazards to exposed workers installing (setting) modular homes. The pilot research was conducted by West Virginia University Safety and Health Extension through the Center to Protect Workers' Rights Small Study Program funded by NIOSH.

While conducting safety training for a modular home installer, WVU recognized the unique and serious safety hazards involving modular home installations. The purpose of this study on the installation of modular homes was to identify problems, make recommendations for improvement and suggest further research that is needed.

Of all of the industrialized housing market segments, modular home production has seen the greatest growth, although it currently holds the smallest percentage. Modular building

production is not exclusive to residential construction. Modular manufacturers build everything from storage outbuildings to large hotel resorts.

Through the years, manufactured and modular housing operations have experienced a high frequency of workplace incidents and injuries. They have remained among the top 10 high-risk industries, as measured by Bureau of Labor Statistics annual surveys of occupational injuries and illnesses.

WVU conducted Job Safety Analyses on four separate modular home installations. WVU had employees and employers completed questionnaires to obtain data about the experience and knowledge of the workers and companies involved in the pilot study. WVU also interviewed the companies' on-site personnel to better determine the industry relationships and how they all interact. This pilot study accomplished its goal of determining the hazards of this process and recommending controls that could reduce the risk of injury or death to a construction worker in this industry.

G3.3

Title: Occupational Injury Events Leading to Hospitalization

Authors: Tyler KL, Jackson LL

Objectives: To estimate the number of nonfatal occupational hospitalized injuries and illnesses treated in emergency departments and to characterize the injury events.

Methods: Data were obtained from the National Electronic Injury Surveillance System (NEISS). NEISS is a national probability sample of United States 24-hour hospital emergency departments.

Results: In 1999, there were 69,800±16,800 (±95% confidence interval) nonfatal occupational injuries and illnesses treated in emergency departments that resulted in hospitalization among workers 15 years and older. These hospitalized injuries occurred at a rate of 5.3 per 10,000 full-time equivalent workers (FTE). Males accounted for 57,100±14,300 (81%) of hospitalized injuries and had a rate (7.5±1.9/10,000 FTE) that was about 3 times higher than for females (2.3±0.6/10,000 FTE). Overall, 70% of injury events leading to hospitalization involved contact with objects and equipment (26,200±5,400) and falls (22,700±6,500), and predominantly occurred to males (89% of all contact with objects; 79% of all falls). Manufacturing injuries most commonly involved contact with objects and equipment (6,500±2,300) and falls (1,500±900), although falls were less prevalent. Among construction workers, who had the highest number of falls, the proportion of falls was greater (6,500±3,300) than contact with objects and equipment events (5,300±2,000). Falls among males were usually to a lower level (74%) and most commonly occurred within the construction industry. Most falls

among females took place on the same level (63%) and predominantly in the services and wholesale/retail trades industries.

Conclusion: Prevention of the most severe workplace injuries must focus on contact with objects and equipment and falls, taking industry into account.

G3.4

Title: Development of a New Electrical Injury Protection System-Selection of RF Transmitter Mounting Location on the Human Body

Authors: Zeng S, Powers JR, Jackson LL, Conover DL

To protect electrical workers near an energized electrical circuit, a new electrical injury protection system is being developed that measures how close a worker is to a live circuit by using a worker-worn low-power radio-frequency (RF) transmitter and a receiver that is plugged into the live electrical circuit. The transmitter emits RF electromagnetic waves through a worker's body to the energized electrical circuit allowing the receiver to judge the worker's proximity or electrical contact by analyzing the RF signal strength. The uniformity of the RF emission strength through the body, which is mainly determined by body-mounting location of the RF transmitter, affects the accuracy of the RF-receiver proximity/electrical contact measurement.

After the approval by the CDC/NIOSH Human Subject Review Board, nine human subjects were tested to measure the strength of RF emissions through different parts of their bodies to an electrical circuit. Two practical RF-transmitter-mounting locations, wrist and upper-arm, were tested by attaching an RF signal source (100-150 kHz). The RF signal path is: RF signal source – body transmitter-mounting location – body extremity/forehead – air (omitted in electrical contact simulation) – electrical circuit – RF spectrum analyzer. Non-uniform RF emission levels were observed through hands and forehead to an electrical circuit. The greatest RF signal strength difference of 9.47 dB (mean) was observed between the left-hand emission and right-hand emission when the RF signals were transmitted from the subject's right wrist. As the RF transmission location was moved from right-wrist to right-upper-arm, the above RF emission strength difference was reduced to 4.20 dB (mean). This RF-emission-uniformity difference may be attributed to the different electrical-path lengths between the signal transmitter location and RF-emitting parts of the body.

Thus, continued development of the protection system will use the upper-arm as the RF-transmitter mounting location to most accurately measure human-to-electrical-circuit proximity and electrical contact.

G3.5

Title: Welding-Related Ocular Injuries

Authors: Lombardi DA, Pannala R, Sorock GS, Wellman H, Courtney TK, Verma GS

PURPOSE: Welders are exposed to multiple sources of ocular injury. There are few published studies of US data examining the activities and processes proximal to a welding-related eye injury. This study describes a one-year sample of welding related injuries from a large US-based provider of workers' compensation (WC) insurance.

METHODS: For the year 2000, 26,413 WC claims with eye as the primary body part injured were abstracted. Using a narrative text search we identified 1,349 claims where occupation was listed as welder. Additionally, 826 non-welders injured while engaged in a welding-related activity (e.g., pipe fitters) were identified using a narrative search of the injury and accident description, manual class and SIC code data fields.

A coding system was developed with categories for activity when injured, initiating process, mechanism of injury, object or substance causing injury and any mention of personal-protective equipment use (PPE). Descriptive analyses of demographics, injury and occupational characteristics, and the narrative coding categories were conducted.

RESULTS: Welders accounted for 5.2% of all eye injury claims. Most cases were male (97%) with an average age of 35 years and were from manufacturing (70.4%), service (11.7%), and construction (8.4%) related industries. Eye injuries were predominantly unilateral (82.3%). Foreign bodies (72.7%) and flash burns (19.4%) were the most frequent natures of injury. At the time of injury, welding (31.7%) and grinding (22.5%) were the common activities. In 56.3% of cases, the mechanism of injury was 'struck by a propelled or airborne object'. Injuries occurred most often during normal mechanical processes (70.6%). Results for non-welders were generally similar, however flash burns (38.5%) and bilateral injuries (34.9%) were more frequent in this group.

CONCLUSIONS: Workers performing welding-related tasks should be trained to recognize all potential ocular hazards. To prevent ocular injury, the effective use of proper safety equipment (PPE) should be stressed.

G3.6

Title: Workplace Injuries and Illness Trends in the Electric Energy Industry: Initial Results from a Comprehensive Occupational Health and Safety Surveillance System

Authors: Kelsh MA, Yager JW, Ramachandran K

EPRI (aka the Electric Power Research Institute) has established an occupational health and safety database designed to provide more precise and detailed information about work-related injuries and illnesses among electric energy workers. This database provides the capability for epidemiologic surveillance, annual injury/illness reporting, health and safety research, program evaluation, and cost estimation. In addition, a web-based interactive reporting system provides a flexible means of examining health and safety trends. Seven years (1995–2001) of personnel, injury, and claims data from eight companies have been obtained to date and integrated into a single data system in which injury trends were summarized by company, occupation, injury characteristics (region of body affected, nature of injury and injury source), and demographic factors (age and gender). Participating companies were of different workforce sizes and had varying personnel, injury, and claims management systems. Over 480,000 person-years of follow-up and 10,000 lost time and recordable injuries/illness events were observed in the seven-year period. Sprain/strain injuries accounted for the largest percentage of injures and days lost from work. Fractures account for the second largest amount of days away from work. The most commonly affected body regions were the back and hands. For these eight utilities, 142 full time equivalents (FTEs, 1 person working 1 full year) were lost due to injury or illness; 72 of these were due to strain injuries, 24 due to fractures. Analyses conducted on demographic factors reveal there is a higher incidence of injuries among female workers for selected trade and field occupations, mainly non-office work occupations. Age also affects injury rates and days lost among selected occupational groups. Additional characteristics of injury occurrence among these workers are presented and discussed.

Session: G4.0

Title: Agricultural Safety II

Moderator: Tony McKenzie

G4.1

Title: Magnitude and Etiology of Agricultural Injuries among Households with Children: Regional Rural Injury Study-II

Author: Gerberich SG

Although agricultural morbidity and mortality rates have consistently exceeded those for all occupations, combined, no current systems can provide accurate data on the magnitude of, and risk factors for, agricultural injury. This study was con-

ducted to: identify the burden of all injuries, using a data collection system that can serve as a basis for surveillance; and identify risk factors for agricultural operation-related injuries to persons <20 years of age.

A cohort of agricultural operation households in a five-state region involved 3,200 operations randomly selected for each state (total n=16,000), from the United States Department of Agriculture's National Agricultural Statistics Service (NASS) Master List Frame; 16,538 persons (8,488 children <20 years) participated. Data were collected using a computer assisted telephone interview for the two six-month periods of 1999 to identify all injury events and demographics for all household members. Agricultural exposures of interest were collected for those <20 years, using a simultaneous nested case-control design (cases=203; controls=755).

Personal risk and injury event rates were adjusted for within-household correlation, non-response and unknown eligibility. Univariate and multivariate analyses were conducted for the case-control study; logistic and poisson regression were used to investigate the relation between exposures of interest and agricultural-related injuries, using relevant methods to address confounders.

Respective overall annualized injury rates, for those <20 and 20+ years of age, were 146 and 176 per 1,000 persons. Primary sources of agricultural injuries were animals (41%, 32%) and falls (31%, 23%); 17% and 14% identified >7 days of lost agricultural work time. Increased risks (ORs; 95% CIs) for those <20 years were: operating or riding in a motor vehicle (3.5; 2.1-6.1); riding on (2.1; 1.4-3.0) or operating (1.8; 1.1-2.8) a tractor; operating large (1.7; 1.05-2.7) or small (1.7; 1.1-2.6) equipment; and working with horses (2.4; 1.5-3.6), sheep (2.1; 1.1-4.0) or beef cattle (1.8; 1.2-2.7).

G4.2

Title: Task-Specific Injury Rates for Youth Exposed to Agricultural Hazards

Authors: Koehlin KM, Wilkins JR III, Crawford JM, Shotts LF, Elliott M, Bean TL

The objective of this work is to determine injury rates for specific farm tasks in which youth commonly engage. Rates are based on data from the NIOSH-funded investigation entitled, "Empirical Derivation of Work Guidelines for Youth in Agriculture" (J.R. Wilkins III, PI). Youth ages 8 to 18 and a parent or guardian were recruited through 4-H clubs in Central Ohio over three years (1999-2001). For up to 13 weeks each, youth provided longitudinal data on the amount of time (in minutes) spent daily on each of 52 farm-related activities through use of a semi-structured daily diary. Youth also recorded multiple characteristics of all injuries experienced, including which activities they were doing when the injuries occurred. This allows for

the calculation of task-specific injury rates with exposure time denominators rather than overall person-time denominators (which underestimate injury risk). Task-specific injury rates per 100 hours of actual exposure time varied from less than one to more than 10 injury events. Task-specific rates with respect to age, sex, and other youth-based factors have been analyzed and will be presented.

G4.3

Title: A Case-Control Study of Injuries among Central Ohio Farm Youth

Authors: Crawford JM, Wilkins III JR, Koechlin K, Shotts L, Elliott M, Bean TL

In 1999, a longitudinal study of injury risk among farm youth was undertaken in central Ohio. Youth were recruited through OSU Extension (4-H Youth Development), were asked to complete a Self-Administered Questionnaire (SAQ), and were administered developmental tests (IQ, strength, hearing, balance, neurobehavioral status, and anthropometry). In addition, they were asked to prospectively record daily agricultural work activities and all unintentional injuries for a period of 13 weeks. A total of 407 youth provided (nearly) complete data. Among the items on the SAQ were details of injuries occurring during the lifetime of the youth which required medical treatment. The present study compared youth reporting being injured in the 2 years prior to enrollment in the study (n=121) to those reporting no injuries or injuries that occurred more than 5 years prior to enrollment (n=214). A logistic regression model found elevated risk of injury associated with youth frequently engaging in high-risk behavior (OR=1.96, 95% CI 0.96-3.99), sometimes engaging in high-risk behavior (OR=2.06, 95% CI 1.08-3.92), high parental rating of youth physical skills (OR=1.83, 95% CI 1.05-3.20), low youth perceived risk of ever using alcohol, tobacco and other drugs (OR=1.90, 95% CI 1.06-3.41), low adult perceived risk of cleaning/bedding animal stalls by hand (OR=1.82, 95% CI 1.05-3.18), being in the 3rd or 4th quartile of national age- and sex-specific Body Mass Index norms (OR=2.07, 95% CI 1.12-3.82), strongest tertile of shoulder strength (OR=2.27, 95% CI 1.18-4.37), being in the 3rd or 4th tertile of postural sway length [having less balance] (OR=1.95, 95% CI 1.07-3.54), and authoritarian parenting style (OR=1.89, 95% CI 1.07-3.33). The adjusted OR for the continuous age variable was 0.83 (95% CI 0.71-0.97). These results suggest that youth developmental factors, youth and adult attitudes about risk, and parenting style may influence risk of medically-attended injury.

G4.4

Title: Summer Work and Injury among Youth on Family Farms

Authors: Zierold KM, Garman S, Anderson HA.

In the United States, farming ranks among the industries with the highest rates of worker injury and death. Working on family farms children of all ages do many hazardous tasks, including driving tractors, working in grain bins, working with animals, and planting and harvesting crops. Limited information exists on work and injury among children working on family farms.

In October 2001, a cross-sectional survey was administered to five school districts and one large urban school in Wisconsin. In total, there were 562 middle school children aged 10-14 years old and 398 high school students aged 15-19 years old reported working on family farms. The tasks most commonly reported among both groups were (1) harvesting and planting crops, (2) working with animals, (3) lawn mowing and (4) painting. When asked about working with hazardous materials, 31% of middle school children responded "Yes" and 41% of high school students responded "Yes."

Overall, 24% of middle school students reported being injured at work and 31% of high school students reported being injured at work. Many of these injuries were severe enough to affect the students work, play, or school activities for 3 or more days. Variables that were significantly associated with injury included being male, being non-white, having a near-miss experience, being asked to do something dangerous, working after 7pm at night, and working 10 or more hours per week.

As the federal laws are now, restrictions to youth in agricultural employment do not apply to youth who are employed by their parents on a farm owned or operated by their parents. Based on the prevalence of injury and the severity of injury occurring on family farms, review of child labor laws is warranted.

G4.5

Title: Risk Factors for Farm Work-Related Injuries: A Nested Case Control Study in the Agricultural Health Study Cohort

Authors: Sprince NL, Zwerling C, Whitten PS, Lynch CF, Burmeister LF, Thu K, Logsden-Sackett N, Park H, Gillette P, Alavanja MCR

This case-control study, nested in the Agricultural Health Study, aimed to assess risk factors for farm-related injuries among Iowa farmers. Out of 5970 eligible farmers, 431 injured cases and 473 controls were identified. Of the 431 injured subjects, 377 reported a single injury over the past year, while the remaining subjects reported two or more injuries over the past year. Fifty-two subjects required hospitalization for their injury. Hand, finger, and back injuries were the most frequent. Machinery-re-

lated injuries (45%) and livestock-related injuries (26%) were the major sources of injury. Falls (17%) were the most frequent event causing injury.

We identified risk factors associated with overall farming injuries. Age less than 40, higher education, presence of large livestock, increased hours spent on the farm, taking medications, and wearing a hearing aid were all associated with an increased risk for overall farming injuries. Next, we conducted multivariable analyses on subsets of injuries to test the hypothesis that different injury outcomes are associated with different risk factors. We found that hearing difficulties or wearing a hearing aid were risk factors for all injury subgroups. Subgroup-specific risk factors included arthritis as a risk factor for both animal-related injuries and falls; less farming experience and CAGE responses suggesting alcoholism were risk factors for machinery-related injuries. These findings may indicate that while experience and attentiveness are crucial aspects of working safely with machines, being agile and able to respond to animal movement is crucial for working safely with animals and for avoiding falls on the farm.

Awareness of farm tasks and farmer characteristics associated with injuries in specific on-farm activities can be integrated into activity choices and can provide the focus of prevention programs/protective equipment for farmers at highest risk for injury.

POSTER SOCIAL

P01

Title: Injury Atlas II - Occupation Level View of Lost Time Injuries - Ontario Construction Trades - 1997-99

Authors: McVittie DJ, Neves F, Zaichkowski J

The Construction Safety Association of Ontario (CSAO) had previously compiled comprehensive occupation level views of Lost Time Injuries for the period 1987-89. Data for the same populations were reviewed for the period 1997-99. Data for each of 21 construction occupations were analyzed and presented.

The 1987-89's data comprised 53,803 injuries and 1,175,396,110 hours worked compared to 15,504 injuries and 925,475,311 hours worked in 1997-99. Total LTI frequency rate (LTIs per 200,000 hours) for 1987-89 was 9.15 compared to 3.35 for the 1997-99 period.

Worker activities at the time of injury were categorized into Material Handling, In-Transit, Direct Installation, Other categories. The influence of housekeeping was also examined. In most cases, the ranking of attributes did not change significantly (i.e. the top 5 factors in any field were the same in both data sets).

Analysis also strongly suggests that the reduction in injury rates is the result of real changes across many different sectors and not the result of changes in the administration or management of claims.

In the 1987-89 data, the injuries within the different classes of activities were 34.9%-Material Handling, 20.3%-In Transit, 25.9% Direct Installation and 18.9% Other Activities. In the 1997-99 data, the values were 32.3%,19.5%,42.6% and 5.6% respectively. The proportion of Material Handling and In-transit injuries are essentially unchanged. The change in Direct Installation and Other Activities may reflect real change in the way workers are injured, or, may simply reflect differences in the application of counting rules by different groups of reviewers.

The overall impact of housekeeping on injury rates appears to have declined significantly (14.0 % of all injuries 1987-89 to 5.5% in 1997-99). This is consistent with anecdotal evidence from CSAO field staff that housekeeping and materials management have improved significantly in most sectors during the intervening 10 years.

P02

Title: Farm Work Practices and Farm Injuries among Women and Men in Colorado, 1992-1997

Authors: Stallones L, Beseler C

Despite the work women contribute to overall agricultural production, the relationship between farm work patterns and farm injuries among women has not been extensively assessed. The purpose of this study is to describe the relationship between hours spent working on specific farm tasks and work related injuries among women and men.

A cross sectional survey of farm operators and their spouses was conducted in an eight county area of Colorado. Personal interviews were conducted between 1992-1997. Farms were selected using a stratified random sampling technique. Detailed information was obtained from each respondent regarding work at specific farm tasks (animal handling, crop production, farm materials handling, farm maintenance, transport of agricultural produce, all other farm tasks) and hours spent working each season at the specific farm tasks.

Average number of hours worked at specific tasks were computed. Injury rates by task were computed per 100,000 hours worked among women and men. Rate ratios were computed comparing the women to men injury rates.

Women were involved in all job tasks assessed. Individuals who worked more hours, on average were more likely to have experienced a work related injury. Women were at higher risk of injury than men when involved in animal handling (rate ratio 1.6), farmstead material handling (rate ratio 1.19), and other

farm chores (rate ratio 9.65). Men were at higher risk of injury when involved with farm maintenance activities (rate ratio 0.36), crop production (no women were injured), and transport of agricultural produce (no women were injured).

When controlling for hours spent at specific tasks, there was no evidence that women were at reduced risk of injury compared to men when involved with animal handling, farmstead material handling, and other farm chores.

P03

Title: Effects of Company Size on Non-Fatal Injury Rates in Construction

Authors: McVittie DJ, Neves F

The effects of company size on Lost Time Injury Rates in construction in Ontario, Canada were previously examined using data for 1988-1993 inclusive. Those data showed a clearly inverse relationship between the frequency of Lost Time Injury (LTI) and size of company. (See Table 1). Analysis of the trends showed that the largest construction companies were not only performing better in terms of Lost Time Injury rates, they were continuing to improve at a faster rate than the smaller firms.

Analysis of more recent data (1996-2001 inclusive) shows the relationship between company size and LTI rates is consistent in that larger firms still have the lowest LTI frequencies, however, their rate of continued improvement is not as great as that of the smaller companies.

Further analysis of the performance of different sized companies shows that most firms operate with a zero injury frequency in any given year. Even in the largest employers (those employing more than 100 Full Time Equivalent (FTE) workers, 32 of 144 (22%) firms operated with no Lost Time Injuries in any given year. Analysis of the insured hours worked shows that approximately 58% of all construction worked in Ontario over the study period was performed without an LTI. If the employer population is expanded to include firms with only 1 LTI, the proportion of work done with 1 or fewer LTI's becomes 76%.

The belief that injuries are "common and expected" in construction needs to be addressed to conform to the fact that most construction firms operate without incurring a Lost Time Injury in any given year. Firms which incur multiple LTI's in any given year are clearly the "exception to the norm" and they need to recognize that these are abnormal events. This may reflect the increased fatigue associated with greater work hours.

P04

Title: California Fatality Assessment and Control Evaluation (FACE): Summary of Occupational Fatalities in Los Angeles County 1992-2001.

Authors: Styles LE, Cierpich H, Rogge J, Harrison RJ

The California Department of Health Services, in collaboration with the National Institute for Occupational Safety and Health (NIOSH), has established the California Fatality Assessment and Control Evaluation program (FACE) for the surveillance and investigation of workplace fatalities. The FACE program seeks to link multisource reporting of fatal occupational injuries with timely investigations to identify work-related risk factors, make recommendations for preventing fatalities, and facilitate workplace prevention programs. Preliminary results from 1992-2001 show that the leading cause of occupational fatalities in Los Angeles County was homicide (40%), followed by transportation-related (18%), falls (11%), suicide (6%), electrocution (5%), fire/explosion (4%). This presentation will describe the demographics and the industry and occupation of those who died at work. Investigated deaths will be summarized and at the conclusion of the session, the participant will be able to list 5 recommendations to prevent similar workplace fatalities.

P05

Title: Haulage Truck Safety at Surface Mine Dump Sites

Authors: Mayton AG, Turin FC, Wiehagen WJ

Dump site safety regarding surface mine haulage trucks remains an important issue for future review and investigation to reduce serious injuries. For improving safety at surface mine dump sites, safe work procedures and practices for haulage trucks are encouraged and discussed. The information provided is based on years of experience and informed practice for safe operations at dump sites. NIOSH IC 9454 identified stationary dumping and backing up as activities associated with more than 90 percent of serious injuries to haulage truck drivers. Among others, these two activities are highlighted and discussed in the context of important practices and procedures to ensure safe work operations at dump sites.

P06

Title: Worker Age and Type of Injury in Ontario Construction

Authors: Vi P, McVittie D

There is a widespread belief that young construction workers are more likely than older workers to suffer non-fatal injuries in the workplace. To test the validity of this belief, the Construction Safety Association of Ontario conducted a study of all lost-time injuries (LTIs) from 1996 to 2001.

LTI data obtained from the Workplace Safety and Insurance Board (WSIB) of Ontario and employment data, obtained from Statistic Canada, was used in this study. LTI data was grouped into three categories (slip and falls, struck by object, and overexertion), and workers were divided into six age groups.

The analysis of the LTI rate (a rate of injury per 100 workers) for each age group showed that age is a factor in some non-fatal injuries. There is an inverse linear trend for "struck by object" injuries in relation to age (1.42 per 100 workers for the 15-24 age group versus 0.67 per 100 workers for the 55-64 age group). There is an inverted "U" relationship between age and "overexertion" injuries, with the highest injury rate occurring in the 25-34 age group. There was no significant trend for "slip and falls" injuries.

The study also analyzed the gross frequency distribution of injury type by age group. This revealed findings similar to the LTI rate analysis, with the exception of "slips and falls" injuries, which showed a positive linear trend.

The study concluded that there is a relationship between the age of workers and the types of injuries. There is a significantly higher risk of "struck by object" injuries in the younger age groups. For older workers, the risk of "slips and falls" is higher. To prevent injuries in construction, the industry should consider age-specific interventions.

P07

Title: *An Evaluation of Scaffold Safety at Construction Sites*
Authors: Halperin KM, McCann M

Problem: This study evaluated supported scaffold safety practices in construction. **Methods:** A 150-point checklist was used to evaluate supported scaffold safety practices at 113 sites in nine areas of the Eastern United States. **Results:** Thirty-six scaffolds (31.9%) were either in danger of collapse or were missing planking, guardrails or adequate access. There was a strong statistical correlation between structural flaws and fall protection hazards, and between proper scaffold safety practice and 1) competent persons with scaffold safety training, 2) use of separate scaffold erection contractors, and (3) scaffolds that were not simple frame types. A slightly weaker correlation was found with union status of the scaffold erector, and no correlation was found with geography, site size, number of scaffold users, and trade working on the scaffold.

Discussion: Recommendations are made for safer scaffold practice, including a simple 4-factor scaffold inspection method. **Impact on Industry:** Implementation of the 4-factor method could result in a cost-effective way to identify unsafe scaffolds.

P08

Title: *Animals Involved in 20 Agricultural Fatalities*
Authors: Hetzler WE, Davis AW

Nebraska Fatality Assessment and Control Evaluation (NE FACE) Program: Animal Involved Farm Fatalities in Nebraska, October 1993 through June 2002 -- Davis, A; Hetzler, WE

Background: Nebraska has over 53,000 farms scattered throughout a wide area and farming is one of our most hazardous occupations. Farmers and ranchers perform thousands of daily tasks, many of those around animals. Animal-related incidents are a leading cause of serious farm injuries to both children and adults in Nebraska. These traumatic incidents often result in disabling or fatal injuries.

Purpose: To identify and describe trends in animal-related fatalities and disseminate preventive strategies to those who can intervene in the workplace.

Methods: Nebraska entered into a cooperative agreement with NIOSH in 1993. Using protocols developed by the NIOSH FACE program, animal-related fatality cases were identified, First Reports reviewed, and in some cases on-site investigations were conducted. Using the Haddon model, investigators were able to identify multiple causes and develop multiple prevention strategies.

Results: 20 cases were identified. 14 cases involved direct involvement with the animal, while 6 involved indirect involvement. 13 cases involved cattle, 4 horses, 1 hogs, 1 dog and 1 llama.

Conclusions: Recommendations to prevent future similar fatalities include complying with national safety standards and educating both youth and adults in animal safety practices. To disseminate the recommendations, the NE FACE program developed a FACE FACTS sheet that summarized these 20 cases and detailed the prevention recommendations and collaborated with the Omaha and Lincoln Safety Councils who distributed 2,500 FACE FACTS to businesses throughout Nebraska and Western Iowa. The FACE FACTS sheet was placed on the NE FACE web site and numerous presentations have been given to the agricultural community. This poster was presented at the Nebraska Agromedicine Consortium, and was displayed at Husker Harvest Days, the largest Agricultural show in the Midwest.

P09

Title: Roadway Work Zone Traffic Speed Control Study

Author: Zaichkowski J

In the Province of Ontario between 1993 and 1999, there were 6 Highway Work Zone fatalities resulting from workers being struck by public-way traffic.

A further indication of risk in highway work zones is the number of near misses that occur at any one site. Although there is little authoritative data on the number of near misses, one need only look at the large number of displaced and damaged delineating barrels or scuffmarks left on concrete barriers within the work zone to realize that the potential for serious accidents appears to be high.

Motorists entering a work zone are faced with warning signs, arrow boards, delineators, lane realignments, lane width reductions and lane closures. A driver's full attention is required to react safely to these changing conditions. Driving at excessive speed reduces the amount time that a driver has to react to these situations and is perceived as a main cause of many potentially catastrophic accidents that can involve near-by workers.

Simple, reliable and effective means of controlling traffic speeds through highway work zones are required to reduce the risk of injury to workers from public traffic.

In 2002, the Construction Safety Association of Ontario undertook a study to:

1. Quantify the speed of traffic traveling through established highway work zones and
2. Introduce simple interventions into existing traffic control systems to establish their effect on traffic speeds through the work zone.

In 2002, the study focused on two highway work zones. The data collected included the number, time, date, speed and size of each vehicle that passed, pavement temperature and surface moisture.

The presentation focuses on the rationale for the study, procedures and technology (Nu-Metrics Hi-Star NC-97) used and the roles of the road authority, contractor and police. Data collected in 2002 and 2003 will also be presented.

P10

Title: Back Injuries among Nurses: Change the Nurse or Change the Task?

Authors: Tiesman HM, Nelson A, Peek-Asa C

Background: Occupational back injury is a significant problem for nurses. Back injury sequelae is multi-factorial with physical, social, behavioral, and psychological factors playing a role. This case-control study examines individual risk factors for back injuries in a Veterans Administration nursing population.

Methods: Forty-two reported nursing back injuries were identified from an electronic hospital injury database between July 1, 1998 and July 1, 2000. Controls were obtained through a computerized nursing database and individually matched to cases by unit of service. Surveys and introduction letters were mailed using the internal mail system. Reminder cards and phone calls were used to maximize response rates. The tool was a self-administered survey addressing basic demographics, nursing background, working practices, and occupational back injury history.

Results: The cases were primarily female (92%), white (53%), married (53%), and RN's (50%). Twenty-eight percent of cases worked in long-term care and 26% worked in spinal cord units. Thirty-eight percent regularly moved patients without assistance. Cases had a mean age of 46.4 (sd=9.52) and a mean BMI of 27.3 (sd=5.5), and averaged 9.6 years (sd = 6.3) of employment at the VA. Preliminary analyses using crude odds ratios show older age (OR= 1.25, 95% CI=0.31 - 4.97), job title of either Nurse Assistant or Licensed Practical Nurse (OR=2.00, 95% CI = 0.62 - 7.46), family history of back injury (OR=1.75, 95% CI = 0.44 - 8.15), having children at home (OR=1.83, 95% CI = 0.62 - 6.04), and four or more years of employment in the VA (OR=3.00, 95% CI = 1.04 - 10.55) were associated with occupational back injury. Limited power led to wide confidence intervals.

Conclusions: The individual factors associated with back injury in this study are not feasibly modified. Prevention approaches should instead focus on interventions that modify the lifting task, such as incorporation of new lifting technologies.

P11

Title: Iowa FACE Program Agricultural Injury Fatalities

Authors: Heick RJ, Johnson W, Lundell JA, Rautiainen RH

Occupational fatalities claim the lives of more than 6000 workers in the United States each year. Farmers and others engaged in agricultural work are among those at greatest risk of fatal occupational injury, second only to mining occupations.

The Iowa Fatality Assessment and Control Evaluation (FACE) Program began in 1992. Information gathered on occupational fatalities is analyzed to identify trends in fatal injury by demographic characteristics, geography, industry, and cause.

The Iowa FACE Program identified a total of 604 occupational fatalities between 1995 and 2002. Of this total, 222 (36.75%) occurred among those employed in agriculture. Fatal occupational injuries were coded with the standard ICD-9 E-codes. To more accurately and consistently classify agricultural injury fatalities, additional coding was performed utilizing the Farm and Agricultural Injury Classification (FAIC) Code, developed by the American Society of Agricultural Engineers (ASAE) in 1998. Following assignment of both E-code and FAIC coding, the resulting groups of agricultural fatalities were compared to validate the use of FAIC coding in identification of agricultural fatalities.

This presentation will describe the population-based incidence and characteristics of agricultural injury fatalities in Iowa from 1995 through 2002, and will discuss associated coding issues. Agricultural fatalities present unique difficulties when attempting to assign appropriate coding under the standard ICD-9 E-code system. As an example, E-code 9190 is assigned for injury which results from use of agricultural machinery and E-code 9192 is assigned for injury resulting from use of lifting machines and appliances. Difficulty arises when a farmer is killed while using a machine not traditionally associated with agriculture, such as a skid-steer loader. By definition, the E-code would be 9192, forcing an agricultural injury to be coded in another category. Over time, these injuries will be lost in the count of agricultural fatalities, leading to an underestimate of the true risk.

P12

Title: Communicating Severity of Hazard with the Signal Word on a Safety Sign

Authors: Jensen RC, McCammack AM

Signs are used extensively in workplaces to identify hazards and provide instructions for appropriate behavior. A fundamental element of safety signs is the signal-word panel located at the top of the sign. The colors and words in this panel are intended to convey information about the hazard identified. One type of hazard information concerns the severity of injury/illness associated with the hazard. The standard of the American National Standards Institute (ANSI) uses three severity categories: 1) death or serious injury, 2) minor or moderate injury, and 3) property damage. The standard specifies that if the severity is death or serious injury, the signal-word panel should have the signal word Danger on a red background or the word Warning on an orange background. This study investigated the effectiveness of signal words for conveying information about severity.

The sample population consisted of 59 college students tested in nine small groups. Twelve signs were shown to them in random order. Five of the signs had a gray signal-word panel with a black signal word. The signal words were Deadly, Danger, Warning, Caution, and Notice. The signs differed only in signal word. Subjects rated their impressions of the signal words using an ordered rating scale derived from the ANSI standard.

Results indicated that signal word had a highly significant effect on ratings using a Friedman's Rank Sum two-way analysis. Post-hoc analysis indicated Deadly rated highest, followed by Danger. Below these words were Warning and Caution. Warning and Caution were not significantly different from each other. The lowest ratings were for the signal word Notice.

According to the ANSI standards, Danger and Warning should convey the same severity message. This experiment found otherwise. Subjects rated Danger significantly higher than Warning on the severity scale.

P13

Title: Costs and Morbidity in Work-related Motor Vehicle Crashes

Authors: Peele PB, Xu Y

Aim: To assess morbidity and associated costs in work-related motor vehicle crashes (MVC).

Method: Data from City of Philadelphia (City) from 1999-2001 was retrospectively collected (approximately 29,000 workers). Data collected includes Pennsylvania MVC reports and workers' compensation medical claims. Pennsylvania MVC reports accident information such as weather conditions, road conditions, vehicle information, and driver and passenger information. We link MVC reports with City workers' compensation medical claims data which contain injury dates, procedure codes, diagnosis codes, payment information, and accident cause codes. We observe motor vehicle accidents by accident cause code in the medical claims for this population of workers to find employees who have received medical services in conjunction with a work-related MVC to estimate actual employer costs for work-related MVCs within the workers' compensation system. We use Pennsylvania MVC reports in conjunction with workers' compensation medical claims to describe the number of work-related MVCs that involve formal medical care and to capture morbidity related to those MVCs.

Results: In 1999 and 2000 combined, 2,725 unique MVCs reported on State MVC forms involved a City vehicle. Among those MVCs, 838 individuals received formal medical care under a MVC-related workers' compensation claim resulting

in an average, per claimant medical expenditure of \$2,368. Not surprisingly, back and neck injuries were the most common body parts injured, accounting for 31% of all medical care for MVCs. Physical therapy accounted for over 20 percent of all medical care delivered to employees involved in MVCs while clinical office visits accounted for only 4% of all care. Surprisingly, only 11 percent of injured employees lost any workdays and only 1 percent lost more than one week of work associated with MVCs.

Conclusions: Work-related MVCs constitute an important and significant burden on both workers and their employers.

P14

Title: Web-based Safety Toolbox Database

Author: Lee S

With a high rate of accidents, the Korean construction industry continues to be ranked behind most other industries with regard to field safety. Following the continuous accidents due to the lack of awareness of potential hazards in the workplace, the Ministry of Construction and Transportation, and Ministry of Labor in Republic of Korea are exploring the way to prevent the accidents in work place and during the service of public facilities. As one of these efforts, the need of the development of unified database for safety management activities is discussed. Due to the individual and separate development of safety related manuals by private construction industry, there need to have an informationized standardization for safety management activities. Based on the process modeling of major projects including its work breakdown by work activities and procedures, the web-based safety toolbox database will be developed, incorporated with major local construction contractor as well as with the reference of OSHA's in U.S. This intends to have the field reviewed and inspected by unified format of documents and procedures, such as the checklist, free-assessed by client, contractor, designer, and supervision team, towards an actual monitoring system in site. Eventually, more efficient management on safety prevention will be resulted in by public driven efforts, and this paper will present above project as overseas case study.

P15

Title: Agricultural Injury among Rural California High-school Students

Authors: McCurdy SA, Kwan JA

Agricultural injury causes approximately 100 deaths and 32,000 non-fatal injuries annually among children on U.S. farms. There are few data describing agricultural work and injury experience for this group. We are conducting an observational longitudinal study of work and injury among rural California high school students to characterize agricultural work, injury and associated risk factors.

We contacted 15 rural California public high schools with programs in agricultural studies. Subjects complete an annual survey addressing demographic characteristics, school course work in agricultural safety, work, and injury experience.

The initial group of students enrolled to date comprises 644 students from ten high schools. The mean age is 15.9 y; 68% are male, and 63.5% are White, with the remainder primarily Hispanic. Thirty-eight percent live on a farm. Parents and teachers were cited as the most important source of agricultural safety information by over two-thirds of respondents. Over 90% agreed or strongly agreed that safety precautions were important and necessary, even if they slowed tasks. Nearly half agreed or strongly agreed that they were less likely to be injured doing farm work than peers. Sixty-seven subjects (10.4%) reported an injury characterized by the need for medical care or at least one-half day of lost or restricted work or school time in the preceding year. Injury was associated with living on a farm (OR 2.1) and current smoking (OR 2.2). Report of always or nearly always using a seat belt was protective for injury (OR 0.5). Machinery and animal work were the most common activities associated with injury.

Rural California high school students working on farms are at risk for agricultural injury. Prevention programs should focus on smokers and tasks involving machinery or animals. Reduced injury risk in persons consistently using seatbelts is likely due to cautious personality traits in such individuals.

P16

Title: Work-Related Time-Activity Patterns among Youth Exposed to Agricultural Hazards

Authors: Wilkins JR III, Crawford JM, Koechlin KM, Shotts L, Elliott M, Bean TL

A longitudinal study of children and adolescents 8-18 years of age exposed to agricultural hazards was conducted to empirically (i) develop multivariable risk prediction models of agriculture-related injury and (ii) derive work guidelines that parents and other caregivers could use to judge the age and developmental appropriateness of farm chore assignments. Putative risk indicators of interest include a wide range of youth- and caregiver-based factors. Data on work-related exposures which increase the risk of unintentional injury have been obtained through a modified form of Participant Event Monitoring (PEM), where youth were expected to report the frequency and duration of each of 52 agriculture-related jobs/chores/tasks in a semi-structured daily diary over a 13-week period. After 3 years of data collection, 407 youth (169 boys, 238 girls) reported on 4098 weeks (28,686 days) of work-related time-activity data (in addition to the frequency and duration of engaging in sports/exercise). Daily data on paid work (on or off farm), sleep patterns, and occurrence of unintentional injuries were also obtained.

Statistical analyses focused first on describing the frequency and duration patterns for each of the 52 farm jobs/chores/tasks (which fell into the following categories: animal feeding/handling, cleaning, handpicking, farmstead repair/maintenance, handling silage/hay/straw/feed/seed, operating mobile farm machinery, operating/driving farm vehicles, operating/using stationary farm equipment, farm equipment/machinery repair/maintenance). In addition to investigating variation in both frequency and duration of job/chore/task by age, sex, and season/time of the year, we have attempted to identify (i) high frequency/low duration, and low frequency/high duration, chores, (ii) how often the daily reports suggest risk not only of unintentional acute traumatic injury, but also of potential chronic biomechanical overloading, and (iii) sources of bias in the work-related self-reports.

P17

Title: A Case-Crossover Pilot Study of Slips, Trips and Falls in Health Care Workers

Authors: Sorock GS, Wellman HM, Lombardi DA, Courtney TK, Collins JW, Bell JL, Wolf L, Gronqvist R

The U.S. Bureau of Labor Statistics reported in 1998 that slips, trips and falls (STF) account for the third largest proportion (20%) of non-fatal occupational injuries in private industry. Among health care workers in hospitals, the incidence rate of lost work-day injuries from STFs was 50% higher than the rate for all private industry (40.8 vs. 27.0 per 10,000 FTEs). We therefore began a case-crossover study to describe the circumstances of STFs in the hospital environment and to evaluate the role of potential transient risk factors in their occurrence.

Health-care workers who reported a STF to the occupational health department in four mid-western hospitals were recruited into the study. Fifty-one subjects were interviewed by telephone. Eighty-eight percent were women with a mean age (SD) of 45 (12.3). Most subjects were nurses (47%), clerks/registrars (16%) or housekeeping staff (12%). Forty-three subjects (84%) reported falling preceded by a slip (44%), a trip (28%), neither (16%) or both a slip and a trip (12%). Of 51 STF events, pain (27%) and contusions (25%) were the most common injury outcomes; five subjects (10%) reported a fracture. Sixty-three percent of the STFs occurred while walking in a transitional area, e.g., from wet to dry or dry to wet surfaces (33%), one type of floor surface to another (24%), or even-to-uneven surfaces (18%). The percent of subjects exposed to transient risk factors at the time of the STF were compared with the total person-time exposed to each factor in the previous work month. Preliminary analysis suggests that walking on a different pathway than usual, on contaminated floors (most often water or cleaning solutions), and being distracted or rushing may increase the risk of a STF in the hospital setting. The case-crossover design is a feasible method for studying the determinants of STF events.

P18

Title: Ergonomic Walkthrough Evaluations of a Pre-Manufactured-Home-Fabrication Plant

Authors: Zwiener JV, Pan CS, Chiou SS, Kau TY, Mozingo K

Drywall workers who perform work on pre-manufactured-homes have an increased risk of injury due to the highly repetitive nature and prolonged duration of their work tasks. The objective of this study was to examine the risk factors involved with drywall installation in a pre-manufactured home fabrication plant; and further, to determine possible interventions to reduce those risks. Eleven drywall workers (7 installers and 4 finishers; mean age = 35 ± 13 years) with working experience (mean experience = 11 ± 10 years) participated in this study. Each drywall worker was observed and videotaped for three hours. Two raters reviewed the tapes using a carpentry ergonomic checklist (Bhattacharya, 1997). This checklist was designed to provide a workplace assessment for three major ergonomic risks – posture, repetition, and slip/fall hazards. Postures of six body segments and tool uses were given scores of 1 to 5 based on a weighting system where biomechanical loading is associated with different postures (Bhattacharya, 1997). A score of 1 represented a neutral posture whereas; a score of 5 represented an awkward posture. Repetition scores for three body segments were calculated by multiplying the frequency by the assigned weighting factor for each posture. Analyses of variance showed that repetition in the upper extremities was a problem when taping, applying joint compound, and sanding for finishers. For installers, repetition of tasks (measuring and cutting, carrying, and securing drywall) showed problems in all three body regions- torso, lower extremities, and upper extremities/wrist. Findings of this study indicate that higher repetition result in severe ergonomic risks for the pre-manufactured home fabrication workforce. The daily activities of drywall workers that lead to the repetitive nature of the job need to be rectified by frequent work breaks, or through task rotation, and change in order to reduce the risk of injury.

P19

Title: Heat-related Fatalities In North Carolina

Authors: Mirabelli MC, Richardson DB

Introduction. Heat-related mortality is a well-documented effect of exposure to environmental heat. However, the epidemiology of occupational heat injury may differ from that of non-occupational heat injury. In this study we investigate heat-related mortality in a Southern state, compare characteristics of occupational and non-occupational fatalities, and provide case descriptions of occupational fatalities attributed to environmental heat.

Methods. We identified all deaths in North Carolina between

1977 and 2001 that were directly attributed to environmental heat. Medical Examiner records were reviewed for 161 decedents aged 10+ years to obtain information about occupation, on-the-job status, and environmental and work conditions at the time of each heat injury. Characteristics of fatal occupational injuries were compared to those of fatal non-occupational injuries. Fatality rates were calculated using employment information from the Decennial Census.

Results. During the 25-year observation period, rates of fatal heat injury declined in the general population and among workers. Twenty-five percent (n=40) of the decedents experienced heat injuries while working. Decedents who died on-the-job tended to be younger (median age: 41 years) than decedents who died in non-occupational settings (median age: 61 years). Occupational fatalities occurred most often among males employed in construction (n=14) and agriculture (n=18). Deaths in the agricultural industry were predominantly among Black, and more recently Hispanic, workers. Narrative portions of Medical Examiner records describe instances of agricultural workers, mainly field laborers harvesting row crops, dying unnoticed and without medical attention.

Conclusions. Heat-related injury continues to be an important problem for workers performing physically demanding tasks, especially during summer months. The incidence of heat-related death may seriously underestimate the public health impact of this problem; fatalities should serve as sentinel events indicating dangerous working conditions. These findings justify involving workers, employers and labor organizers in public health programs to prevent illness and injury while working in hot weather.

P20

Title: A Communication Intervention for Technology Transfer of NIOSH Field Portable Analytical Methods

Authors: Buzzard-Ott SD, Williams TA, Welbourne JL, Booth-Butterfield SJ, Clough-Thomas KS, Lawryk NJ

NIOSH researchers have recently developed new field portable analytical methods for measuring airborne metals. With the introduction of these new methods, NIOSH recognized the need to transfer these methods to potential end-users. To accomplish this, NIOSH implemented a communication intervention with the goal of increasing the use of the methods through communication. The intervention included a three step process: 1) conduct message pretesting on a random sample of industrial hygienists prior to sending the intervention, 2) implement the intervention, and 3) evaluate the effectiveness of the intervention and make mid-course modifications. The intervention included a multi-channel, multi-exposure technique and was disseminated to all members of the American Industrial Hygiene Association (AIHA).

AIHA members completed message testing and annual evaluations. Participants were asked to review materials (advertisements and brochures) on the new NIOSH field portable methods and to complete a survey regarding their thoughts and opinions toward the materials. Industrial hygienists preferred easy to read information presented in a low graphic style. The message testing results provided the framework from which the communication intervention was developed. The intervention consisted of advertisements in the AIHA Journal, a website, and direct personal mailings. All materials focused on the benefits of using the methods. An annual evaluation assessed the effectiveness of the intervention and provided information needed to make mid-course changes. Findings showed a positive change in behavior, and identified four barriers toward using the methods, which were addressed in a second intervention. This discussion will focus on message testing procedures, findings, and the overall effectiveness of the intervention on the self-reported use of the new NIOSH field portable analytical methods.

P21

Title: Research Program to Develop Optimal NIOSH Alerts for Farmers

Authors: Williams TA, Buzzard-Ott SD, Welbourne JL, Clough-Thomas KS

This NIOSH research project applies psychological and communication theories to experimentally manipulate features of the NIOSH Alert and then examine the effects of these manipulations on the effectiveness of the Alert. The goals of the project are to: (1) increase the degree to which workers are motivated to elaborate upon the health and safety message presented in the Alert and (2) to create messages that contain strong arguments. To design the experimental Alerts, researchers have manipulated the NIOSH Alert Preventing Injuries and Deaths from Skid-Steer Loaders with concepts from the Elaboration Likelihood Model and Imagery.

Farmers were recruited to review an experimental version of the Alert and then complete a survey assessing their risk awareness, comprehension of the message, message elaboration, recall of the recommendations, attitudes toward the recommendations and behavioral intentions. Field research has been conducted at 3 locations: (1) the West Virginia State Fair, (2) the Mid-West Ag Expo, and (3) the Ohio-Michigan Equipment Dealers Association. Results from the first two field studies showed that farmers who received the Alert containing goal attainment imagery found the Alert easier to visualize, stronger, more convincing and more attention getting than the standard Alert. Farmers who received the Alert containing goal attainment imagery reported heightened perceptions of risk awareness and more positive attitudes toward engaging in safety recommendations. In addition, they reported that they would be more likely to pass the information on to other farmers. Analyses on

the most recent field study are currently being conducted and will also be presented.

P22

Title: Hazards Associated with Military Service: Fatal Motor Vehicle Crashes among Veterans of the Gulf War Era

Authors: Lincoln AE, DeBakey S, Cowan DN, Kang HK, Hooper TI, Gackstetter GD

PURPOSE: Motor vehicle crashes (MVC) are the leading cause of death among military personnel, and deployment in a combat theater has been associated with an increased risk of fatal MVC within military populations, such as the Gulf War (GW). We evaluated selected variables as predictors of fatal MVC among GW era veterans using existing Department of Defense, Department of Veterans Affairs, and Department of Transportation databases.

METHODS: This is a nested case-control study of a cohort comprised of 696,516 Gulf War veterans and 746,291 non-deployed veterans. 1,343 cases of fatal MVC occurring between 1991 and 1995 were identified from the cohort by linkage with the Fatality Analysis Reporting System (FARS). Ten controls were selected per case, matched by gender and year of case ascertainment. We examined data on demographic and military characteristics; hospitalizations and outpatient visits; self-reported behaviors, lifestyle, and psychosocial factors; and possible GW exposures as potential risk factors for fatal MVC.

RESULTS: Fatal MVC on US public roads that caused the death of the driver were not randomly distributed across our study population. Fatalities involving female drivers were few (n = 28). Male fatalities were more likely to be younger, less educated, enlisted, deployed to the GW, in combat occupations, and never married compared to controls. Cases were also more likely to have had an inpatient hospitalization for substance abuse or previous MVC while on active duty.

CONCLUSION: These findings are consistent with previous studies that have reported military deployment as a risk factor for fatal MVC. We also identified prior hospitalizations for specific causes increase this risk. We did not discover meaningful differences in risk-taking behavior between GWV and NDV. Additional studies to investigate potential risk factors for all MVC, not just fatalities, are warranted so that appropriate interventions can be designed and evaluated.

P23

Title: Extended Work Schedule and Risk of Occupational Injury

Authors: MacLennan PA, McGwin G, Jr., Barbone F, Rue LW, III

PURPOSE: Extended work schedules (e.g. more than one job, > 40 hours worked per week) may be related to a number of health outcomes through several intermediate steps. Stress and fatigue at work may be associated with specific mental conditions, musculoskeletal disorders and ischemic heart disease. This study evaluated the association between exposure to extended work schedule and occupational injury.

METHODS: Utilizing the 1996 through 1998 Medical Expenditure Panel Survey (MEPS) household component, panels 1 through 3, a nested case-control study was used. Cases and controls were actively working and aged > 17 years. Cases were identified through the MEPS medical conditions file as reporting a work related injury (ICD9 800-999) during the follow-up period. Controls were matched (5:1) on age (+/- 1 year) at injury date, race and gender. For the 30 day period before the case injury date, subjects' average number of jobs (1, >1), peak number of jobs (1, >1), average (<40, >40) and peak (<40, >40) hours worked per week were calculated. Risk ratios (RRs) and 95 % confidence intervals (CIs) measured the association. Conditional logistic regression was used to calculate risk ratios (RRs) and 95 % confidence intervals (CIs) for the association between

RESULTS: Small but significant associations were found for average number of hours >40 (RR=1.33, 95% CI=1.09-1.62), and peak number of hours >40 (RR=1.48, 95% CI=1.22-1.78).

P24

Title: Work-RISQS — A Web-Based Injury Research Tool

Author: Jackson LL

The National Institute for Occupational Safety and Health has developed a public web-based Work-Related Injury Statistics Query System (Work-RISQS; <http://www2.cdc.gov/risqs/>) for researchers and other data users. Through user-defined queries, Work-RISQS provides estimates of the number and rate of nonfatal occupational injuries and illnesses treated in U.S. hospital emergency departments (ED). Work-RISQS data are collected through the National Electronic Injury Surveillance System (NEISS) by using a national probability sample of U.S. hospitals.

Work-RISQS provides overall and sub-population estimates—in 1999, among workers of all ages there were 3.9 ± 0.8* million

ED-treated injuries/illnesses and a rate of 3.0 ± 0.6 incidents per 100 full-time equivalent workers (FTE, >14 years). Men, 15 years and older, incurred $2,489,000 \pm 443,200$ injuries/illnesses at a rate of $3.5 \pm 0.7/100$ FTE, whereas young men, 15-17 yrs, experienced only $53,300 \pm 12,500$ injuries, but had one of the highest rates (6.4 ± 1.6 injuries/100 FTE). Other query parameter options include the nature of injuries and incident characteristics. For example, drilling down in the leading injury event category of contact with objects (44%; $1,724,700 \pm 368,600$) shows that there were $686,000 \pm 159,800$ "struck by" injuries; of the "struck by" injuries $200,800 \pm 54,100$ were "by a slipping handheld object;" and of the "handheld objects" $112,000 \pm 29,800$ were knives and $16,500 \pm 5,400$ were hammers. Queries for rarer demographic subgroups or injury circumstances may not yield results because of the limited number of cases within the 67-hospital sample (~50,000/yr) or the lack of detail in the original ED record. Nevertheless, Work-RISQS results are reported singularly or in multiple result cross-tabulations (with confidence intervals) at a surprising level of detail. Work-RISQS can assist in characterizing and monitoring a variety of workplace injury issues including aspects of the Healthy People 2010 objectives for reducing the rate of young worker and occupational eye injuries.

* \pm 95% confidence bounds

P25

Title: The Use Of BLS Annual Survey Data For Hypothesis-Generating Studies And The Issue Of Datasets For Modeling

Authors: Nguyen NT, Oleinick A

Introduction: This study adds to the very limited literature using Bureau of Labor Statistics data from the annual survey of occupational injuries and illnesses to study injury incidence and outcome.

Methods: This report uses three-factor BLS count data for DAFW injuries for truck drivers and all occupations combined from five Great Lakes States. The counts include nature of injury (sprains, strains and tears), parts of body affected (lumbar, shoulder and knee) and age or number of Days Away from Work (DAFW) for 1995 and 2000. The distributions by DAFW and median DAFW among truck drivers and all occupations were compared and then the distributions by age at injury were compared to determine whether a confounder for DAFW outcome could explain differences in DAFW observed.

Results: For lumbar sprains/strains, there was no consistent pattern of longer periods of DAFW for truck driver groups in both years. For shoulder sprains/strains, there appeared to be consistent patterns of longer DAFW and older ages for injured truck drivers in the five states so age appears to be a consistent patterns over time of longer periods of DAFW for the truck

driver groups in both years. The age distributions were not substantially different between the two occupational groups.

Conclusion: Truck drivers with sprains, strains and tears in the shoulders and knees have longer DAFW than do all occupations combined, but older age appears to confound the finding only in shoulder injuries. BLS data appear to be an important potential source of hypothesis generation for formal epidemiologic studies. Efforts should be made by BLS to create accessible data sets for use in modeling issues

DAY THREE: THURSDAY, OCTOBER 30, 2003

Session: H1.0

Title: Investigating the Non-Reporting of Occupational Injuries

Moderator: Maria Brunette

H1.1

Title: Determinants of Claim Filing among Young Injured Workers

Authors: Lakdawalla D, Reville RT

Workers' compensation is intended to serve as a universal health insurance system for the injuries and illnesses to workers that result from employment. It is provided to nearly all American workers, who cannot opt out of the system. Logically, therefore, one would expect workers to seek compensation for nearly all workplace health conditions, especially those workers without recourse to other types of health insurance. However, this simple story does not stand up to even cursory examination. Using nationally representative data on young workers, from the National Longitudinal Survey of Youth, we uncover several facts that are surprising, in light of these hypotheses. First, more than 40% of workers reporting injury on the job do not file workers' compensation claims. Moreover, nearly 60% of injured workers with other health insurance tend to file workers' compensation claims, but only 52% of injured workers without health insurance tend to do so. Not only does workers' compensation insurance seem to be underutilized, but also it is particularly underutilized by people without any other health coverage. This is surprising, because people without health insurance tend to have more severe injuries. Among uninsured workers who get injured on the job, 44% tend to lose wages as a result; for insured workers, the proportion is just 26%. Similarly, the injured uninsured lose an average of 38 workdays, while the insured lose an average of just 22. The group of workers with more severe injuries and no alternative to workers' compensation insurance choose to file claims less often. The results suggest that uncertainty over coverage by workers' compensation may lead to poor health outcomes among workers with occupational injuries and illnesses but without health insurance.

H1.2

Title: *Injury Reporting in the Railroad Industry; Cause For Suspicion*

Authors: Rosenberg BJ, Levenstein C, Azaroff L

Over the last decade, railroad worker injuries have steadily plummeted to less than half the 1990 rate (680 serious injuries in 1990 to 832 in 2000, and 10,002 sprains in 1990 to 437 in 2000), while fatalities have fluctuated from a high of 47 in 1993 to a low of 24 in 2000 with no apparent trend (Railroad Safety Statistics, 2000). Given that fatalities are usually a relatively fixed proportion of less serious injuries, these figures are puzzling and suggest a reporting problem. While there are clear reasons why contingent workers, immigrant workers, non-unionized and other vulnerable populations may be reluctant to report injuries, railroad workers are not in this category; they are overwhelmingly white and unionized. If the surveillance system breaks down in this "elite" population, it is important to understand the reasons for the failure, the social and economic consequences of the failure, and how it can be fixed. This paper reports on research investigating the strengths and failures of the railroad industry occupational health and safety surveillance system.

H1.3

Title: *Distributional Effects of Filing a Workers' Compensation Claim*

Authors: Roberts K, Biddle J

There is a fairly large literature that has examined the effect of work-related disability on earnings (See for example, Biddle, 1998; Boden & Galizzi, 1999; Reville, 1999). In most cases, this research uses data from workers' compensation administrative databases matched to employment security records or estimates losses based on workers' compensation benefit levels (See for example, Leigh et al, 1997). In some cases, these are studies of compensated losses, that is, losses net of workers' compensation benefits and in others the estimates are of uncompensated losses. Regardless, evidence indicates support for a human capital framework that suggests that health is a factor in productivity and poorer health resulting from the work-related injury does lead to lower earnings. There are two drawbacks to these sorts of studies.

First, because most of these studies are based on datasets from workers' compensation administrative databases, they include only those who have filed a workers' compensation claim. However evidence suggests that a significant number of workers injured on the job do not file for workers' compensation benefits (See for example, Biddle & Roberts, forthcoming). Second, these studies examine average earnings losses and ignore distributional effects.

The purpose of our paper will be to examine the distributional

effects of claiming on lost earnings. Our paper will use a data set that includes workers identified as having a work-related repetitive trauma injury by a treating physician and also includes recognized measures of injury severity specific to injury type. Only part of this sample filed for workers' compensation benefits, thus enabling us to identify claimers from non-claimers while controlling for injury severity. We will examine the direct effect of claim status, gender, and race on earnings loss distribution, as well as possible interactions between gender and claim status and race and claim status.

Session: H2.0

Title: *Injury Hazards II*

Moderator: Elyce Biddle

H2.1

Title: *Incidence, Risk Factors and Costs of Carbon Monoxide Poisoning in West Virginia Workers*

Authors: Islam SS, Chaudhari A, Edla SR

Background: Exposure to carbon monoxide (CO), a by-product of incomplete combustion of carbon-containing material, can occur in a variety of industrial settings. Although lethal exposures have declined in the past decade due to availability of CO monitors, estimates of true incidence rates and risk factors have not been well documented.

Methods: Using claims data from the state managed West Virginia Workers' Compensation, we estimated incidence rates, risk factors, sources and costs of compensated CO poisoning for the period 1995-2000. The risk associated with specific industries and occupations was assessed using relative risks and proportional injury ratios.

Results: During the study period, there were 182 compensated injuries associated with work-related carbon monoxide poisoning. The six-year incidence rate was 4.5 per 100,000 person years. The agricultural sector had the highest incidence rate (24 per 100,000 person years), followed by the construction industry (7.4 per 100,000 person years). Workers in special trade contractors had a 2.6 (95% CI 1.4-4.8) fold increased risk compared to workers in all other industry classes; workers in unclassified retail stores were also at an elevated risk (RR 2.5; 95% CI 1.3-4.9). In particular, high-risk occupational groups were cooks in schools, electricians in state/local government, cooks and teachers in day care centers, and health workers in ambulance services. The most frequent sources of CO poisoning were gasoline-powered engines (28%), and furnaces (20%).

Conclusion: This study showed the magnitude of carbon monoxide poisoning among West Virginia workers. The risk stratification should assist policy makers in directing preventive and educational efforts towards high-risk workers.

H2.2

Title: Traumatic Injuries among Embalmers

Authors: Gershon RM, Durrah TL, Qureshi KA

There are approximately 70,000 funeral service practitioners (FSP) in the United States, with about 30,000 licensed to conduct embalming of deceased human remains. This understudied health care work population may be at increased risk for a number of occupational injuries and illnesses. Because they are frequently overlooked or grouped together with other health care workers, very little is actually known about their occupational health risks, including their risk of traumatic injuries in the workplace. Many aspects of their work, however, suggest that they may in fact be at risk for increased injuries, such as back injuries and lacerations and puncture wounds.

In 1998, we conducted a large scale cross sectional survey of the health risks in funeral service practitioners, including a subset of female funeral service practitioners. Questionnaire data on job activities, workplace risk factors, injury prevalence and type, and health status was collected from over 800 FSP. This presentation will focus on specific hazardous job tasks and activities that are potentially hazardous, including handling of contaminated sharps instruments (such as trocars). Recommendations for future studies and possible interventions to minimize risk will also be discussed.

H2.3

Title: Traumatic Injuries in a Cohort of North Carolina Commercial Fishermen

Authors: Kucera KL, Marshall SW, Loomis DP

Background: Traumatic injuries are an occupational hazard for commercial fishermen. Lacerations, contusions, strains, and sprains are common for this population. A cohort of commercial fishermen was established April 1999 to look at injuries and their surrounding circumstances in North Carolina.

Methods: Of 219 North Carolina commercial fishermen, 215 filled out baseline questionnaires at the beginning of follow-up self-reporting traumatic injuries suffered in previous 12 months while commercial fishing.

Results: This cohort was predominantly white (214/215) and 88% (190/215) male. Age ranged from 18-65 years and mean of 43 years. Forty percent (85/215) of fishermen had completed high school; approximately 30% had less than 12 years and more than 12 years of education respectively. Fishermen were engaged in more than one type of fishing. The two main types were finfishing (159/215) and crabbing (154/215). Other types were shrimping (82/215), oystering (61/215), clamming (50/215), or other (35/215). Eighty-three (39%) fishermen reported an injury in the previous year: 82% (68/83) of injuries occurred

while fishermen were on the water and 42% of these injuries occurred hauling up the net. Seventy-six fishermen had one injury, six had two injuries, and one had three injuries for a total of 94 reported injuries. Half of the injuries were penetrating wounds (44/94) and a quarter were strains/sprains (23/94). Half of injuries were to the hand/wrist/digits and 13% were to the back. Of the penetrating wounds, 87% (39/44) were to the hand/wrist/digits, 32% (14/44) were infected, and 80% (35/44) were caused by contact with finfish, shellfish, or sea animal. Of the strains/sprains, 48% (11/23) were to the back and 26% (6/23) were to the shoulder. Seventy percent (16/23) of strains/sprains were caused by moving heavy objects.

Discussion: In this cohort of fishermen, the most reported injuries were penetrating wounds to the hand/wrist/digits and strains/sprains to the back.

H2.4

Title: Hazards and Suggested Control Methods for the Wood Pallet Manufacturing Industry

Authors: Malkin R, Lentz TJ, Niemeier R

Purpose: To identify hazards associated with the wood pallet manufacturing industry and suggest control methods.

Site visits to seven pallet manufacturers were made to determine the reasons for the high incidence rates for traumatic injury in the industry. We identified numerous sources:

- 1) Extensive use of forklifts without backup beepers or any other warning devices. Crushing of forklift operators was possible when a load was unbalanced and the lift overturned or when a worker was loading pallets on to a tractor trailer and the trailer moved away. Although carbon monoxide (CO) levels in three plants had CO levels that were less than 50 ppm, one location had CO levels from forklift exhaust that was measured at 109 ppm.
- 2) Improper saw safety without effective guards. Some saws had no guarding, particularly the large band saws used to recycle pallets, and large chain saws. Saws continued to rotate when they were in the "off" position, and no warnings were given to other workers.
- 3) Ergonomic deficiencies in pallet manufacturing were noted and were mainly related to stretching to assemble pallets, bending to retrieve wood, lifting pallets that were too heavy, and twisting and turning while lifting.
- 4) Incomplete use of PPE when required. Many workers did not wear hearing protection although it was provided by the company. We also viewed workers who did not wear safety glasses.
- 5) Poor housekeeping practices. Sawdust covered floors and machinery at many companies created a

slip and fall hazard and provided a good medium for mold growth.

6) Nail guns were frequently used by employees in ways that were potentially dangerous and resulted in lacerations from firing the gun into one's body.

In this presentation, we will summarize our findings and suggest interventions to improve occupational safety.

H2.5

Title: Evaluation of a Training Exercise for Teaching Drillers about Noise and Hearing Protection

Author: Barrett, EA

Workers at drill sites are among the millions of employees in the United States regularly exposed to high levels of noise on the job. Many of these persons regard noise as a nuisance rather than an occupational hazard. NIOSH-PRL chose an administrative approach to address this issue and has developed an invisible ink training exercise called Drill Rig Incident. The goal of the exercise is to inform workers about noise, hearing loss, and hearing protection. The training exercise begins with background information and a problem. The problem is systematically resolved as information is revealed in a series of 11 questions, each with several choices of answers. Responses to each choice are printed within brackets using special ink. Trainees choose their response and draw a special ink developing pen between corresponding brackets on an answer sheet. Words appear that provide feedback about whether or not the answers they selected are correct.

The effectiveness of the training exercise was evaluated using a split group, pretest - posttest experiment and a self-reporting measure. Subjects were randomly assigned to either a pretest or a posttest group. They were tested before or after the intervention to determine if the objectives of the instruction were achieved. Results indicated that subjects scored significantly higher in the posttest. An eight-item Likert-scale, self-reporting measure was used to determine validity and utility of the exercise. Over 73% of the subjects indicated they "learned something new from the exercise" and nearly 90% said they "will use some of the ideas presented to protect their hearing". The utility of the exercise was high as almost 90% of the subjects reported that "the way the material was presented is a good way for me to learn".

H2.6

Title: Disabling Occupational Injuries In U.S. Restaurants

Authors: Courtney TK, Filiaggi AE, Wellman, HM

The restaurant industry is one of the 3 largest US employer groups. While the industry typically has a below average non-fatal injury incidence rate, restaurant workers comprise one of the largest groups of injured workers in the U.S. each year. Studies published to date have addressed particular hazards or special populations (younger workers) within the restaurant business. However, there has been no national, descriptive study linking the types of disabling worker injuries to their potential determinants.

The present study utilized Bureau of Labor Statistics' (BLS) annual survey of occupational injuries and illnesses (SOII) data on cases with days away from work (DAFW) to identify and describe the leading disabling injuries in the restaurant industry (SIC 58- Eating and Drinking Establishments). Using a special data call and reduction strategy, injuries were examined by part of body, nature of injury, exposure-event and source combinations in terms of their frequency, incidence rate and severity (median DAFW) for 1999.

Sprains, strains, and tears of the back (n = 12,252; incidence rate = 22.7/10,000 workers) and leg (3,503; IR = 6.5) and lacerations of the finger (8,777; IR = 16.2) and hand (2,390; IR = 4.4) were among the most frequent disabling restaurant worker injuries. The injuries resulting in the highest median number of DAFW included peripheral nerve disorders of the wrist (68 days) and fractures of the foot (50 days), hand (49 days), and arm (15 days). The most frequent disabling injury events in restaurants were same level falls to the floor (25.3%), overexertion due to lifting (15.3%), and contact with hot materials (13%). When combined with data on source, the results suggest the importance of interventions directed at slips, trips and falls; overexertion from the handling of bulk materials, cookware, and dinnerware; and exposures to hot materials and cutting implements.

Session: H3.0

Title: Machinery and Coal Mining Injuries

Moderator: James Harris

H3.1

Title: Determination of Safe Roof-Bolter Speeds Through Computer Simulation

Authors: Bartels JR, Ambrose DH, Kwitowski AJ

This paper is based upon results of a study that determined the impact of roof bolting machine appendage speed on the likelihood of operators being hit such as colliding with moving appendages. NIOSH researchers at Pittsburgh Research

Laboratory performed this study to reduce workers' risks from exposure to moving appendages on underground mining machinery. Accident investigation reports do not usually contain enough information to aid in studying this problem and laboratory experiments with human subjects are also not feasible because of safety issues. As an alternative, researchers developed a computer-based three-dimensional model and simulation approach as the primary means to gather data on mishaps. The computer simulation was augmented by a laboratory validation. Significant findings are presented on operator-machine hits as related to boom speed, operator size, seam height, operator response time and risky behaviors. Collisions versus speed, operators' posture, and seam height proved the most significant factors in the data obtained from the model. Relative importance of each factor was determined by prioritizing the factors by significance using statistical analysis. By simulating an operator's random behavior and the machine's appendage velocity, researchers can accurately identify hazards, and use that information to form safe design parameters for mining equipment. Computer modeling and simulations provided an alternative and safe approach to data gathering in that there was no need for human subjects and logistics – test sites and costs associated with experiments. The use of this type of methodology, computer model and simulation, shows potential to conduct safety studies of other human machine interaction situations.

H3.2

Title: *Developing an Innovative Multi-disciplinary Approach: Electric Arc-induced Injuries in the Mining Industry*
Authors: Kowalski-Trakofler KM, Brnich MJ, Cawley JC, Homce GT, Vaught C, Yencheck, M.

This presentation discusses an innovative, multi-disciplinary method developed by PRL researchers to examine ways to reduce the incidence and severity of traumatic injuries resulting from electric arc blasts in the mining industry. The problem is 1) defined and 2) the methodology detailed. In addition, 3) preliminary results are presented with 4) a discussion of future direction.

Maintenance or repair of electrical equipment is responsible for approximately one-half of all mine electrical injuries and fatalities and often results in electrical arcing and burn injury to workers. Two-thirds of nonfatal mine electrical injuries are burns. Electrical arc burn injuries are also a serious problem in other industries, for example, in construction. The PRL project is focused on the identification and development of specific interventions to reduce worker exposure to electrical arc energy. The goal of the problem-solving focus was to move beyond one-dimensional thinking. The methodology presented was developed within Socio-Technical Systems Theory which views the problem from a holistic, comprehensive, inter-disciplinary viewpoint. This theory is guided by two principal concepts. One, most task-oriented situations involve a social system of

people needed for the work and a technological system made up of the tools and technology necessary to get the work done. Second, these interrelated systems of people, tools and activities are in turn part of a larger environment that includes and is influenced by the socio-technical system. The open-structure approach to real world situations highlights the need for a basic understanding of organizational phenomena. Within this framework, PRL researchers with expertise in electrical and mining engineering, sociology and psychology developed an approach to understand and analyze this serious problem. In addition to the methodology, preliminary results of the data analysis and future directions will be discussed.

H3.3

Title: *Caught-In Injury Protection System for Wood Chippers*

Authors: Ammons DE, Powers JR, Newbraugh BH

Data from the Census of Fatal Occupational Injuries from 1992 - 1997 show that there have been 920 deaths due to a worker being caught in running machinery. The data also shows that 225 of these occurred while the workers were servicing, loading, or clearing material from the machine. To address the need for improved worker safety and decrease the likelihood of being caught in running machinery, the Division of Safety Research, National Institute for Occupational Safety and Health, integrated a proximity warning and shutoff circuit into a simulated wood chipper. The project began as a radio frequency based intervention for caught-in injuries and evolved into a capacitive proximity sensor that provides warning and shutoff signals when the worker enters the chipper's feed chute.

The capacitive proximity sensor consists of two subsystems. The first subsystem consists of sensing electrodes integrated into the feed chute of the chipper. The second subsystem is a programmable control circuit used to detect warning and shutoff levels and activate the corresponding alarms and shutoff mechanisms respectively.

The capacitive proximity sensor has undergone laboratory testing in a simulated feed chute. Field testing of the sensor is scheduled to begin in 2004. The overall design of the safety system as well as the results of the lab testing will be discussed.

H3.4

Title: *Amputations at a U.S. Heavy Manufacturing Company From 1998 to 2002*

Authors: Reeve GR, Stout AW

The purpose of this study was to describe the patterns of amputation injuries in a heavy manufacturing setting from 1998 to 2002, and to determine what job functions pose the greatest risk for these injuries. The study data were abstracted from a vali-

dated occupational health and safety data system through a review of First Time Occupational Visit (FTOV) case detail reports involving amputation. One hundred four (104) cases were identified for the 5-year period (20 in 1998; 21 in 1999; 27 in 2000; 15 in 2001; and 21 in 2002). The rate of amputations has been consistently low, ranging from 0.02 to 0.03 FTOVs / 200,000 Hours Worked. Still, these injuries resulted in 2,480 Days Away from Work and 4,004 Restricted Work Days. The results showed that 94% of the amputations involved fingers with the remainder involving the lower extremities and the ears. The most common Type of Contact associated with amputations was found to be "Caught Between, In, On, or Under". The most common Source of Injury associated with amputations was found to be "Fixed Machinery", and the most common Task/Activity associated with amputations was found to be "Operating Machine/Tool/Equipment". Fourteen percent of the cases involved gloves "catching" on rotating parts of hand tools or fixed machinery. Skilled Trades workers were greatly over-represented in the case series. They comprised approximately 40% of the cases when they consisted of only 12% of the hourly work force. The results suggest two areas for targeted intervention: 1) better guarding of hand tools and machinery with small rotating shafts to prevent gloves from precipitating an amputation or avulsion; and, 2) reinforcement of correct practices for workers in the skilled trades for guarding and lock-out when servicing or repairing equipment.

H3.5

Title: Development of a Safety Intervention in Small Metal Working Shops

Authors: Parker DL, Brosseau L, Pan W, Sammant Y, Munshi K

The Minnesota Machine Guarding Study has been funded to evaluate the effectiveness of a peer-based technical and educational intervention designed to reduce exposure to amputation hazards among workers in small machining/metal working shops. The primary hypothesis of this study is that availability and use of machine guarding will be greater after an intervention directed at owners and workers in comparison to a minimal intervention group. While many companies provide services to assist in the development of work-related safety programs, their effectiveness in increasing worker safety has never been evaluated in an intervention trial.

The PRECEDE/PROCEED model described by Green (Green and Kreuter, 1991) is providing the conceptual framework for the planning of the study. This model was chosen for its applicability to a wide variety of settings where improving health is the ultimate goal. The model specifies multiple factors that may hinder or facilitate the likelihood of reducing shop hazards be identified. Within this framework, Social Cognitive Theory will serve as our behavioral model for intervention design to assist the research team with the identification of these factors as they relate to machine guarding installation and use.

This presentation will summarize the findings from the Advisory Board and the methods established to understand a complex industry with many small and independent business establishments. Findings to date indicate the importance of industry-based experts in order to: (1) understand the nature of potential hazardous exposures; (2) the complexity of developing a means of hazard assessment; and (3) clearly establish industry-based priorities in order to better serve owners and workers. The Advisory Board has also been instrumental in the recruitment of business establishments for the development of evaluation and intervention methods.

Session: H4.0

Title: Fall Injuries in Construction II

Moderator: Guang Chen

H4.1

Title: Load Testing of Job-Built Guardrail Systems

Authors: Fiorini D, Vi P

In the construction industry, temporary guardrails are often the first, and best, line of defense against falls. Many workers are found to fall where the use of guardrails are required but not used. There are very few cases of workers falling through a guardrail if it is simply present (and constructed according to material and spacing requirements in regulations).

In many jurisdictions, regulatory authorities specify loads that temporary guardrails must withstand. Some regulations also specify requirements for material, spacing and orientation of specific guardrail systems. Through preliminary testing, Construction Safety Association of Ontario found that typical temporary lumber guardrail systems built according to regulatory design specifications could not meet the load requirements specified in the regulation.

Upon investigation, it was found that little documentation or test data exists to support the loading requirements for guardrail systems in Ontario (or other jurisdictions). In order to determine both the merit of values used in guardrail regulations and the effectiveness of commonly used guardrails, CSAO subsequently carried out seventy-five tests on five different temporary lumber guardrail systems. The guardrail assemblies were constructed according to configurations and materials specified in Ontario's Construction Regulation. CSAO used several different fasteners common in the industry, and subjected all guardrail assemblies to an increasing static load to the point of failure. A Chatillon Remote-500 strain gauge and DataLOG P3X8 data acquisition unit were used to record the loading on the system to failure.

Test results demonstrate a need for regulatory review of loading criteria. Existing job-built systems do not meet the loading

requirements, yet the systems appear to be effective in guarding against fall hazards. Stronger, more stringent designs are possible, however, may create problems for users to build, discouraging their use altogether.

H4.2

Title: Use of Text Data from Injury Reports/Investigations to Understand Construction Falls

Authors: Lipscomb HJ, Glazner J, Bondy J, Lezotte D, Guarini S

Falls from height (FFH) are a significant cause of morbidity and mortality among construction workers. Working with data from the building of Denver International Airport, we combined three data sources – payroll data, coded Workers' Compensation (WC) data, and text descriptions from First Reports of Injury and injury investigations – to create a more comprehensive picture of such injuries than is possible from coded WC data alone, which typically lack both information on populations at risk and detail about circumstances surrounding the injury.

Payroll and WC coded data were used to calculate injury rates and associated costs. Text descriptions were analyzed to identify circumstances surrounding falls and prevention opportunities. Contributing factors were categorized using a modification of Haddon's matrix designed to identify contributions of agent, host, environment and organizational factors.

FFH occurred at a rate of 1.8 per 100 full-time workers, accounting for 15% of injuries. They resulted in an average of 298 paid lost workdays and were responsible for a disproportionate share of WC payments: \$500 per full-time worker per year and over \$30,000 average cost per injury. Slips/trips preceded one-third of FFH; most of these involved motor vehicles or heavy equipment. Thirty percent of FFH involved movement or collapse of work surfaces, usually ladders, scaffolds, motor vehicles or heavy equipment.

While coded WC data are easier to analyze, text data allow both exploration of factors not identified at the time of data collection and better understanding of the context in which injuries occur. In these analyses, we identified the significant contribution of motor vehicles and heavy equipment to the burden of injury due to FFH as well as the contributions of slips/trips and collapsing surfaces. These findings were not apparent from coded compensation data. Haddon's matrix provided a framework to identify multiple points of intervention.

H4.3

Title: Postural Adaptation at Elevated and Sloped Surfaces

Authors: Simeonov P, Hsiao H, Ammons D

Falls from roofs continue to be a major cause of death and disabling injury in construction. The elevated and sloped roof surfaces seriously challenge postural control and increase the risk of losing balance. Understanding how workers adapt to the extreme roof environments and identifying the limits for successful balance control will allow development of recommendations for safe work practices, and new fall-prevention techniques.

Twenty-four construction workers performed three consecutive standing trials on sloped surfaces (0, 18, 26, 34) at height (3m) and on the ground with close references included or excluded from their visual field. Standing balance was determined from the center-of-pressure movement recorded from a force platform. Dependent variables included sway velocity and mean power of anterior-posterior sway in twelve 0.25-Hz-wide frequency-bands in the range 0-3Hz. Trial effects and factor interactions were used to make inference about the adaptive patterns in workers' balance control.

The results indicate that balance control at elevated and sloped surfaces, involves an initial period of postural adaptation, characterized by a burst of 0.5-1.5-Hz-sway power (up to 5 times the baseline values) during the first standing trial. Balance control at steeper slopes required higher sway frequency for longer time periods. At slope 34, task repetition led to progressive increase in 1.00-1.25-Hz-sway variability, indicating a tendency of postural degradation. Task repetition without close visual references caused increased mean values and variability in 1.25-1.50-Hz sway, while with visual references it resulted in progressive decrease of these parameters.

Overall, the study results imply that workers in roof construction are at an increased risk of losing balance immediately after stepping on a sloped roof. Visual references can considerably improve postural adaptation on sloped roofs. Roof surfaces with 34 (8/12) slope are at the limits for postural adaptation, and thus increase the risk of falling.

H4.4

Title: Fall Prevention vs Fall Arrest in Ontario Construction

Author: Garritano E

Many people engaged in OH&S view fall arrest systems as the primary intervention to reduce injuries resulting from falls.

Analysis of detailed claim information from CSAO's Accident Causal Data System shows that over 80% of Non-

Fatal injuries resulting from Falls to a Different Level occur in situations where fall arrest or travel restraint systems would be ineffective or impractical. Other interventions such as proper use of ladders, scaffolds and other work platforms, adequate guarding of floor openings, use of 3-point contact while climbing up or down ladders or getting on or off equipment are more likely to impact positively on the very high proportion of LTI Falls.

CSAO analysed over 2200 claim descriptions for Non-Fatal Lost Time Injuries (LTI's) for Falls to a Different Level (as opposed to slip and fall to the same level) occurring in Ontario's construction industry during 1997-1999.

Three reviewers, all with construction experience, independently reviewed the free text injury descriptions, working surface, project-type and construction-type for each LTI. Based on the claim information and familiarity with the type of work being performed by the injured worker(s), the reviewers classified them into the following groupings where the reviewer himself would, in the circumstances described:

1. Likely use Fall Arrest or Travel Restraint System (e.g. working on a sloped roof, erecting or dismantling steel structures)
2. Possibly use Fall Arrest or Travel Restraint System (e.g. insufficient information to determine the circumstances)
3. Not likely use Fall Arrest or Travel Restraint System (e.g. working from a step ladder, bench, scaffold or other platform)

Separate analysis of Fatal Fall Injury reports was conducted to determine if Fall arrest is a more appropriate intervention for that subset of Injuries.

Session: H5.0

Title: Back Injury Prevention

Moderator: Alfred Amendola

H5.1

Title: Use of Mechanical Lifts Reduced Injury Rates Among Nursing Personnel

Authors: Evanoff B, Wolf L, Aton L, Canos J, Bohr P, Collins J

Aims: To evaluate the effectiveness of mechanical patient lifts in reducing injuries among health care workers, and to describe an educational intervention to increase lift use.

Methods: We conducted a pre-post intervention study examining changes in injury and lost day rates in 5 long-term care facilities and 36 nursing divisions in 4 acute care hospitals. Stand up and full body lifts were deployed with a 2-hour train-

ing session. Data on injuries and lost days were collected through OSHA 200 logs; data on utilization of lifts were collected through employee interviews. Rates of injuries and lost days were expressed in terms of events per 100 full-time equivalents (FTE).

Results: Nursing personnel on intervention units had decreased rates of recordable injuries in the post-intervention period compared to the pre-intervention period (RR=0.82; 95% c.i.=0.68 – 1.00). Changes were also seen in rates of injuries resulting in lost days (RR=0.56; 95% c.i. 0.41-0.78) and in total lost days due to injury. Larger changes were seen in long-term care facilities than in acute care hospitals. Interviews were completed by 190 health care workers. Self-reported frequencies of lift use by registered nurses and by nursing aides were higher in the LTC facilities (10% and 50%, respectively) than in acute care hospitals (6% and 34%). The most common reasons given for non-use of lifts included lack of perceived need for lifts, insufficient training, and lack of time.

Conclusions: We conclude that the implementation of patient lifts can be effective in both the long-term care and the acute-care settings. Higher reported frequency of lift use was associated with greater reductions in injuries and lost days; further reductions in injury rates may be possible with increased use of lifts. We have recently begun to study the effectiveness of a more comprehensive educational intervention to increase the use of lifts.

H5.2

Title: The Use of Workers' Compensation and Medical Claims Data for Surveillance of Acute Back Injuries Among Health Care Workers

Authors: Pompeii LA, Dement J, Lipscomb HJ, Ostbye T

Health care workers are at risk of back injuries due to the physically demanding tasks they are required to perform, such as patient lifting. By combining workers' compensation records, private health insurance claims, and human resources data we sought to develop a more comprehensive surveillance system of back injuries among a cohort of 12,500 health care workers employed at a tertiary level medical center.

Between 1997 and 2001, a total of 901 employees filed 1,057 workers' compensation back claims. Claims were more likely to be filed by female workers (76%), and workers ages 30 to 49 (64%). Claims filed by African-American employees was disproportional to the percent employed, with 44% of claims filed by these workers who represent 26% of the medical center workforce. Almost 75% of the African-American claimants were employed in physically demanding jobs, including nursing (32%), dietary (22%), and housekeeping (20%). Nursing personnel filed more claims (44%) for back disorders com-

pared to all other work groups.

Outpatient medical claims data were linked with information concerning work demographics and job assignment in order to examine rates of health care utilization for the treatment of acute back injury (ICD-9 846-847-back strains and sprains) in 2001. Crude rates of utilization were highest among in-patient nursing personnel (22.2/1,000 workers), compared to all other workers (16.1/1,000 workers). An adjusted Poisson model indicated that in-patient nursing personnel were 1.5 (95% CI: 0.8, 2.9) times more likely to file a claim compared to all other types of workers, after controlling for age and race.

Back injuries can result in chronic conditions and the magnitude of their morbidity may not be fully appreciated through analyses of workers' compensation data alone. The use of these data indicated that the extent of these injuries, especially among nursing personnel, extends beyond what is attributed to workplace injury.

H5.3

Title: VISN-Wide Deployment Of A Back Injury Prevention Program For Nurses: Safe Patient Handling & Movement

Authors: Nelson AN, Matz MW

Much effort has gone into systems to reduce the impact of occupational back injuries suffered by healthcare workers. However, the incidence and severity of injuries as well as the costs continue to rise. Thus, the primary goal of this project was to create safer working environments for nurses who provide direct patient care. This program provided a comprehensive, systematic approach that incorporated carefully selected interventions operationalized in England, the military and other non-healthcare industries. The project was designed to facilitate provider acceptance as well as knowledge transfer and was implemented in twenty-four nursing home and spinal cord injury units determined to be high risk for musculoskeletal injuries.

To address the project goal, a Back Injury Prevention Program for Nurses that successfully integrated evidence-based practice, technology, and safety improvement approaches was developed. The impact of the program was evaluated on acceptance, adherence, effectiveness, competency, job satisfaction, musculoskeletal discomfort, incidence and severity of injuries, program cost, and expected cost savings.

A key element of the Back Injury Prevention Program for Nurses is the use of ergonomic risk assessments to create safer working environments. An outcome of the risk assessments was the recommendation of patient handling equipment. When the equipment was in place, use of Algorithms for Safe Patient Handling and Movement along with a Patient Assessment/Care Plan was instituted to determine exactly what equipment is needed for each patient. Also, in order to prevent recur-

rences of injuries, an After Action Review Process was used to evaluate the cause of injuries. A "Safe Patient Handling and Movement Policy" tied together the program elements and stressed the use of non-punitive measures. Finally, Back Injury Resource Nurses (BIRNS) on high-risk units maintained safe work environments by implementing the use of the program elements. As importantly, BIRNS promoted a "Culture Of Safety" within these high-risk units.

H5.4

Title: Musculoskeletal Disorders Among Dental Students

Authors: Thornton LJ, Barr AE, Jessop AB, Gaughan JP

Introduction:

Research has shown that dentists are at risk for work-related musculoskeletal disorders in the neck, shoulders, upper extremities, and lower back. While dental students perform the same type of work, there has been no scientific evidence to suggest that they are at risk for adverse health outcomes.

Objectives:

To identify clinical tasks that place students at risk, determine the existence of symptoms, determine if a relationship exists between WRMSD's and symptoms and, determine the risk factors present in those tasks.

Methods:

Two pilot studies were conducted. In the first study, senior, junior and sophomore dental students from four dental schools completed a standardized questionnaire. In the second study, RULA and Strain Index assessments were used to evaluate the physical risk factors (duration, exertion, repetitiveness and posture) during a dental procedure (drill, hand tool and, mirror). Seven students/seven patients volunteered to participate. This study represents the first time that assessment methods have been used in the dentistry.

Results: There was a total response rate of 61% (670/1100). Sixty-one percent (358/590) of all respondents reported that during the last year they had experienced symptoms of discomfort related to work at dental school. Symptoms of discomfort in the neck represented 48% (281/590), shoulder 31% (181/590), back 44% (259/590) and, hands 20% (120/590). The proportion of affected body areas among the study population was highly significant ($p=.000$). RULA: The grand scores for the drill, hand tool, and mirror task elements consistently showed scores of 5 or higher for all participants. Strain Index: The hand tool and mirror task elements showed scores of >3 but <7 among five test subjects. The mirror task element scored >7 in six participants.

Conclusion:

Preliminary studies have found students to be at risk. Further investigations should focus on evaluating cost-effective ergonomic interventions at the dental school level.