

N O I R S

**National Occupational Injury
Research Symposium**

**SYMPOSIUM PROGRAM
October 16-18, 2018
Morgantown, WV**

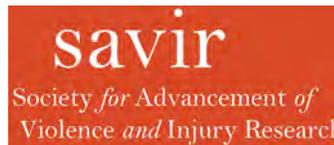
Special Acknowledgement

NOIRS would not be possible without the support
of our co-sponsors: American Society of Safety Professionals,
Board of Certified Safety Professionals,
National Safety Council,
Society for Advancement of Violence and Injury Research,
West Virginia University Safety and Health Extension,
West Virginia University School of Public Health, and
West Virginia University Benjamin M. Statler College of Engineering
and Mineral Resources



AMERICAN SOCIETY OF
SAFETY PROFESSIONALS

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NOIRS 2018 Participants,

I would like to welcome you to the 2018 National Occupational Injury Research Symposium (NOIRS 2018). We are proud of the high quality scientific program supporting this year's symposium theme, Advancing Worker Safety in the 21st Century Through Research and Practice. NOIRS is the only forum exclusively dedicated to the presentation and discussion of the latest methods, findings, and translation activities related to traumatic occupational injury research and prevention. The conference agenda includes cutting-edge occupational injury research from leading national and international scientists. This 7th NOIRS will have participants from the multiple disciplines and fields that contribute to occupational injury research and prevention, including epidemiologists, engineers, statisticians, economists, safety specialists and health communicators.

NOIRS would not be possible without the support of our co-sponsors: American Society of Safety Professionals, Board of Certified Safety Professionals, National Safety Council, Society for Advancement of Violence and Injury Research and the West Virginia University Safety and Health Extension, School of Public Health and Statler College of Engineering and Mineral Resources. Each contributed to planning the scientific program and outreach for the symposium. Also, thanks to the National Safety Council, a special issue of the Journal of Safety Research will highlight research presented at NOIRS. I would like to recognize and thank each of these co-sponsors, not only for supporting NOIRS, but also for their continued support of NIOSH research and prevention programs.

As with the previous NOIRS, this year's program promises to deliver an exciting agenda that represents the breadth and diversity of occupational injury research. Additionally, for NOIRS 2018, we have expanded the program to include more special sessions on topics of interest such as safety culture and climate, motor vehicle safety and the emerging area of robotics. As well, NOIRS continues the NIOSH emphasis on research to evaluate the effectiveness of interventions and move the results of research into practice. NOIRS 2018 will include numerous presentations that address these important components of occupational traumatic injury research and prevention.

Through NOIRS, NIOSH continues to provide a forum for the presentation of state-of-the-art occupational injury research, and the opportunity to develop and foster partnerships and collaborations among researchers, industry, labor and other partners who share a common interest in the prevention of traumatic occupational injuries. Progress is being made in reducing the toll of workplace injury and death; however, sustained, collective efforts are needed to further reduce the devastating impact that traumatic injuries have on workers, their families, and their employers. It is my hope that NOIRS 2018 will once again revitalize our energies and efforts to ensure all workers return home safely each day.

I offer my best wishes for a productive interchange of science and prevention strategies and the development of new partnerships as we work toward our common goal to prevent traumatic injuries and fatalities in the workplace.

Enjoy the NOIRS 2018 symposium!

John Howard
Director, NIOSH

Acknowledgements

NOIRS 2018 is being convened by the NIOSH Division of Safety Research
Dawn N. Castillo, Director
Timothy J. Pizatella, Deputy Director

We gratefully acknowledge our co-sponsors for their contributions and support:

American Society of Safety Professionals
Board of Certified Safety Professionals
National Safety Council
Society for Advancement of Violence and Injury Research
West Virginia University Safety and Health Extension
West Virginia University School of Public Health
West Virginia University Benjamin M. Statler College of Engineering and Mineral Resources

Special acknowledgements are made to the following for their support
and dedication to planning NOIRS 2018

Conference Management Committee

Tim Pizatella [Chair], Dawn Castillo [Co-Chair],
Christie Wolfe, Tonya Jacquez, Tonya Rowan, Sydney Webb

Scientific Program Committee

Christine Schuler [Chair]
Cammie Chaumont Menéndez [Co-Chair]
Carri Casteel, Sharon Chiou, Kenneth Curry, Mark Fullen, Joel Haight,
Hongwei Hsiao, Jennifer M. Lincoln, John Myers, Erica Poff, Jiabin Shen,
Sergey Sinelnikov, Gordon Smith, Lisa Spencer, Lisa Steiner, Brenda Zylstra

Symposium Support Services

NOIRS Website
Joyce Spiker
NIOSH Division of Safety Research

NOIRS Logo Design
Lisa Gibson
Gibson Designs, LLC

Symposium Planning Support

On Par Productions, LLC

GENERAL INFORMATION

Symposium Goal

The goal of NOIRS is to provide a forum for researchers and other professionals to share their findings and experiences aimed at preventing traumatic occupational injury through research and prevention. In addition to presenting current research findings, NOIRS also seeks to foster collaboration among researchers from a broad range of disciplines and perspectives; showcase innovative and state-of-the-art approaches to research and prevention; demonstrate the effectiveness of transferring research results to the workplace for prevention; and promote further research that will advance the goals of the National Occupational Research Agenda.

Assistance During the Symposium

On Par Productions staff are available to assist you with registration, accommodations, messages, logistics, and any other special needs or questions during the symposium. They will be located at the registration area for assistance.

Parking

The Morgantown Marriott at Waterfront Place offers valet parking along with self-parking. There are two parking garages, one located across from the front of the hotel and the other is attached to the back of the hotel and is closest to the conference rooms.

Shuttle Service

The Morgantown Marriott at Waterfront Place offers complimentary shuttle service to downtown Morgantown, local restaurants, and the Morgantown Airport for registered hotel guests. Shuttle service is available within 2 miles of the hotel. Call the hotel's front desk to schedule shuttle service.

Cell Phones

Please have your cell phones on vibrate/mute during sessions. If you need to answer a call, please step out of the meeting room to do so.

Smoking

Smoking is not permitted anywhere in the hotel. Smoking is permitted in places outside designated by ash buckets.

Symposium Bags

The NOIRS 2018 symposium bags are sponsored by the Board of Certified Safety Professionals.

Breaks

The breaks during the symposium are sponsored by the West Virginia University Safety and Health Extension and School of Public Health.

Tuesday Evening Networking Event

A networking event will be held in the Waterfront Morgantown Event Center, Exhibit Hall B, on Tuesday, October 16, 2018, from 5:30 p.m. – 7:30 p.m. Hors d'oeuvres will be served. A cash bar will be available. This event is sponsored by the National Safety Council.

Wednesday Evening Poster Presentation and Networking Event

A poster presentation and networking event will be held in the Waterfront Morgantown Event Center, Exhibit Hall B, on Wednesday, October 17, 2018, from 5:30 p.m. – 7:30 p.m. Poster authors will be available for discussion and questions. Hors d'oeuvres will be served. A cash bar will be available. The event is sponsored by the American Society of Safety Professionals.

NOIRS 2018 AT A GLANCE

DAY 1: TUESDAY, OCTOBER 16, 2018

Time	Tuesday				
7:30 - 8:30 am	Registration (Salon A-C Foyer)				
8:30 - 10:00 am	Opening Plenary (Salon DE)				
10:00 - 10:30 am	Break*				
10:30 - 12:00 pm	Concurrent Sessions A				
	A1	A2	A3	A4	A5
	<i>Salon D</i>	Salon E	Salon ABC	Salon FGH	Wharf AB
	Implementation Science and Translation Research in Occupational Health & Safety Settings: Part 1 – Introduction and Process Models	Surveillance of Work-Related Motor Vehicle Crashes Using Matched Census of Fatal Occupational Injury/Fatality Analysis Reporting System (CFOI/FARS) Data	Hot Topics in Worker Safety	Workplace Violence	Agriculture: From Injury to Intervention
12:00 - 1:30 pm	Lunch Beginning at about 12:15 pm, the documentary film “A Day’s Work” will be shown in Salon D. Bring your lunch.				
1:30 - 3:00 pm	Concurrent Sessions B				
	B1	B2	B3	B4	B5
	Salon D	Salon E	Salon ABC	Salon FGH	Wharf AB
	Implementation Science and Translation Research in Occupational Health & Safety Settings: Part 2 – Methods for Approaching and Evaluating Implementation Studies	Collaborating with Industry Partners to Understand Work-Related Motor Vehicle Crashes	Falls in Construction	Fatality Incident Investigations	Topics in Surveillance
3:00 - 3:30 pm	Break*				
3:30 - 5:00 pm	Concurrent Sessions C				
3:30 - 5:00 pm	C1	C2	C3	C4	C5
	Salon D	Salon E	Salon ABC	Salon FGH	Wharf AB
	The Role of Safety Culture in Safety and Health Management in Mining, Oil and Gas Extraction Industries	NIOSH-Sponsored State-Based Fatality Assessment and Control Evaluation (FACE) Program	Special Topics in Workplace Vehicles	Surveillance Methods	Economics of Worker Safety
5:30 - 7:30 pm	Networking Event (MEC, Exhibit Hall B) Hors d’oeuvres served; cash bar Sponsored by National Safety Council				

* Sponsored by WVU Safety & Health Extension and School of Public Health

NOIRS 2018 AT A GLANCE

DAY 2: WEDNESDAY, OCTOBER 17, 2018

Time	Wednesday				
7:30 - 8:30 am	Registration				
8:30 - 10:00 am	Concurrent Sessions D				
	D1	D2	D3	D4	D5
	Salon D	Salon E	Salon ABC	Salon FGH	Wharf AB
	Collaborative Robotics – New Era of Human-Robot Cooperation in the Workplace	Safety Climate/ Safety Culture	Fatal Occupational Injuries	Shift Work and Injury	Injury Prevention and Economics
10:00 - 10:30 am	Break*				
10:30 am - 12:00 pm	Concurrent Sessions E				
	E1	E2	E3	E4	
	Salon D	Salon E	Salon ABC	Salon FGH	
	Fatal Injuries in the U.S. Construction Industry	Young Worker Injuries/ Fatalities	Safety Climate: Application to High-Risk Work	Know Your Target, Hit Your Target, Move Your Results into Safety Practice	
12:00 - 1:30 pm	Lunch Beginning at about 12:15 pm, Lunchtime Topic Tables will be set up in MEC Lobby. Bring your lunch.				
1:30 - 3:00 pm	Concurrent Sessions F				
	F1	F2	F3	F4	
	Salon D	Salon E	Salon ABC	Salon FGH	
	Lessons from Surveys of Construction Stakeholders	Current Research on Truck Driver Safety	Safe Patient Handling	Use of Claims Data to Advance Safety	
3:00 - 3:30 pm	Break*				
3:30 - 5:00 pm	Concurrent Sessions G				
	G1	G2	G3	G4	
	Salon D	Salon E	Salon ABC	Salon FGH	
	Connecting Safety Culture to Safety and Health Management on Construction Jobsites	Occupational Injuries Among First Responders	Injuries in Commercial Fishing and Seafood Processing	Slips, Trips and Falls: Focus on the Footwear	
5:30 - 7:30 pm	Poster Session/Networking Event (MEC, Exhibit Hall B) Hors d'oeuvres served; cash bar Sponsored by American Society of Safety Professionals				

* Sponsored by WVU Safety & Health Extension and School of Public Health

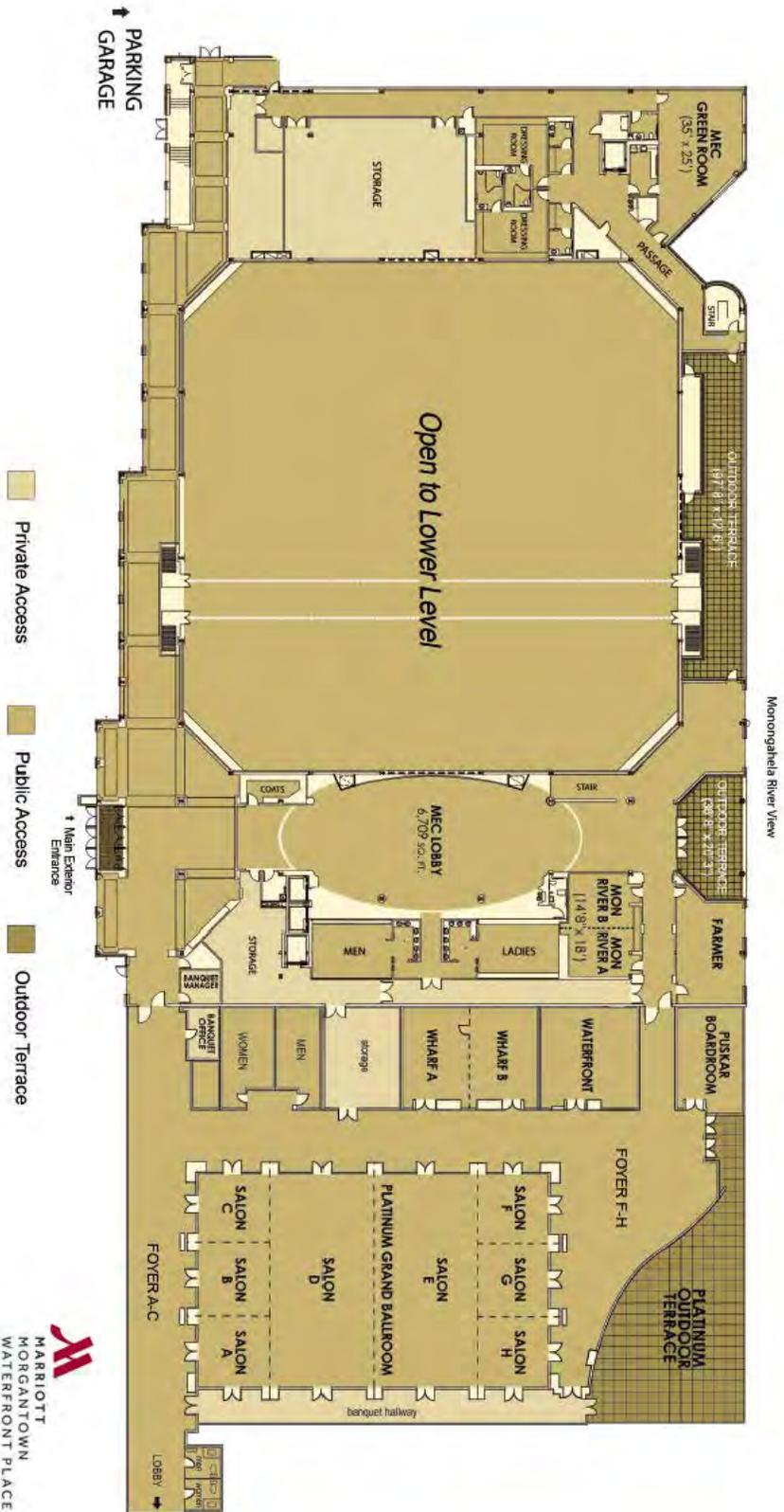
**NOIRS 2018
AT A GLANCE
DAY 3: THURSDAY, OCTOBER 18, 2018**

Time	Thursday			
8:30 – 10:00 am	Concurrent Sessions H			
	H1	H2	H3	H4
	Salon D	Salon E	Salon ABC	Salon FGH
	Integration of Safety Culture into the Incident Command System to Enhance Fire Fighter Safety	Reducing Occupational Safety and Health Risk Among Maritime Workers	Worker Safety in the Military	Musculoskeletal Symptoms and Disorders
10:00 – 10:30 am	Break*			
10:30 am – 12:00 pm	Closing Plenary (Salon D)			

* Sponsored by WVU Safety & Health Extension and School of Public Health

Waterfront Place Hotel Meeting Facilities

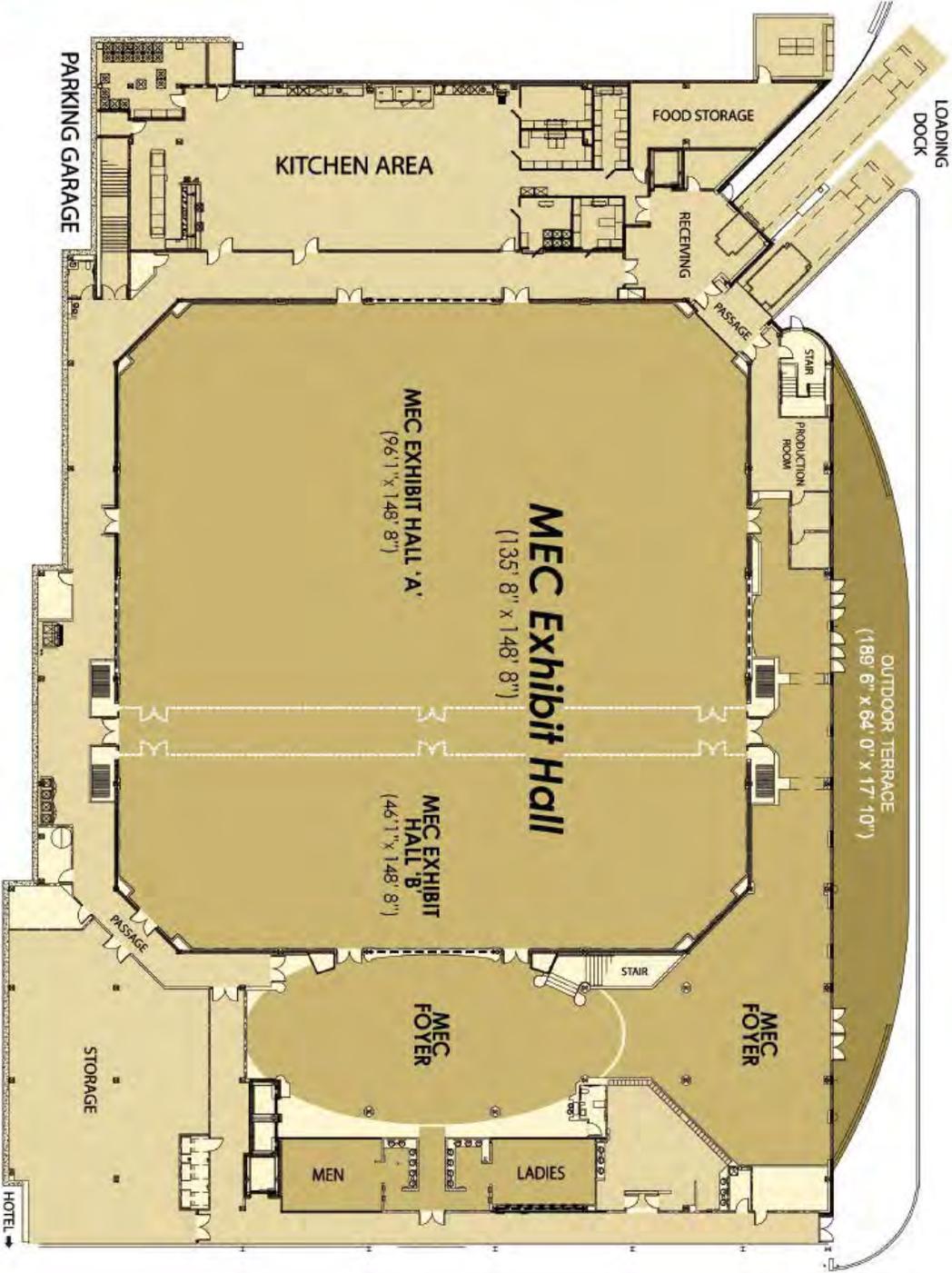
First Level



Waterfront Place Hotel Meeting Facilities Ground Level



- Private Access
- Public Access
- Outdoor Terrace



TUESDAY, OCTOBER 16, 2018

7:30 – 8:30 am

REGISTRATION

8:30 – 10:00 am

OPENING PLENARY SESSION (Salon DE)

Advancing Worker Safety in the 21st Century Through Research and Practice

Opening: Dawn N. Castillo, MPH
Director, Division of Safety Research
National Institute for Occupational Safety and Health

Welcome: Joyce McConnell, JD, LL.M.
Provost and Vice President for Academic Affairs
West Virginia University

Plenary Speakers

John M. Howard, MD
Director
National Institute for Occupational Safety and Health

Lorraine M. Conroy, ScD, CIH
Professor, Environmental and Occupational Health Sciences
Director of the UIC Center for Healthy Work
University of Illinois at Chicago

Joel M. Haight, PhD, PE, CSP, CIH
Professor of Industrial Engineering
Department of Industrial Engineering
University of Pittsburgh

Herb Linn, MS
Program Director for Collaboration and Communication
Health Research Center
West Virginia University School of Public Health

DISCUSSION

TUESDAY, OCTOBER 16, 2018

10:00 – 10:30 am BREAK*

10:30 am – 12:00 pm Concurrent Sessions A

A1	Implementation Science and Translation Research in Occupational Health and Safety Settings: Part 1 – Introduction and Process Models Moderator: Sarah Felknor Presenters: Paul Schulte, Thomas Cunningham and Pam Tinc	Salon D
A2	Surveillance of Work-Related Motor Vehicle Crashes Using Matched Census of Fatal Occupational Injury/Fatality Analysis Reporting System (CFOI/FARS) Data Moderator: Rosa Rodríguez-Acosta	Salon E
10:30 am	A2.1 CFOI/FARS Matching Methodology and Insights on Work-Related Motor Vehicle Crashes	Rosa Rodríguez-Acosta
10:50 am	A2.2 Motor Vehicle Crashes in the Oil and Gas Extraction Industry: An Analysis using Linked Data from CFOI/FARS	Kyla Retzer
11:10 am	A2.3 Fatal Occupational Road Transportation Injuries in the U.S. Construction Industry from 2011 Through 2016	David Fosbroke
11:30 am	A2.4 Seat Belt Use Among Fatally Injured U.S. Workers: Analysis of CFOI/FARS Matched Data	Rosa Rodríguez-Acosta
A3	Hot Topics in Worker Safety Moderator: Jeff Welsh	Salon ABC
10:30 am	A3.1 Wet Bulb Globe Temperature and Heat Index as Predictors of Occupational Heat-Related Illness: Review of Cases Reported to OSHA	Aaron Tustin
10:50 am	A3.2 Drug Overdose Deaths in U.S. Workplaces, 2011-2015	Hope Tiesman
11:10 am	A3.3 Use of Automation and Robotics in Construction	G. Scott Earnest
11:30 am	A3.4 Changing Perceptions of Robotics in Industry: Recent Accomplishment in Safety and Injury Risk Reduction	Mojtaba Yazdani

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A4	Workplace Violence Moderator: Carri Casteel	Salon FGH
10:30 am	A4.1 Understanding Differences in the Workplace Violence Experiences of Teens and Young Adults	Brandy Brown
10:50 am	A4.2 Factors Associated with Taxi Driver Verbal and Physical Assaults by Passengers: Results from a Taxi Driver Survey	Cammie Chaumont Menéndez
11:10 am	A4.3 Workplace Violence in Emergency Medical Services: The Development of a Systems-Level Intervention	Regan Murray
11:30 am	A4.4 Indicators of Workplace Violence	Daniel Hartley
A5	Agriculture: From Injury to Intervention Moderator: Risto Rautiainen	Wharf AB
10:30 am	A5.1 Agricultural Injuries in Central USA: Summary of 2011-2015 Data	Risto Rautiainen
10:50 am	A5.2 Occupational Side-by-Side Vehicle Exposure, Safety Behaviors, and Crash Experiences of Farm Progress Show Attendees	Charles Jennissen
11:10 am	A5.3 R2P: Adoption of Readers' Theatre as a Health and Safety Intervention by the Agricultural Community	Deborah Reed
11:30 am	A5.4 There's an App for That: Coupling Smartphone Technology with Behavioral Theory to Increase the Use of Hearing Protection in Agriculture	Josie Rudolphi
10:30 am – 12:00 pm	LUNCH (on your own) Documentary film "A Day's Work" (2015; Dave DeSario, Executive Producer; David M. Garcia, Director/Producer) will begin at about 12:15 in Salon D	
1:30 – 3:00 pm	Concurrent Sessions B	
B1	Implementation Science and Translation Research in Occupational Health and Safety Settings: Part 2 – Methods for Approaching and Evaluating Implementation Studies Moderator: Jennifer M. Lincoln Presenters: David Caruso, Eileen Betit, Theodore Teske and Pam Tinc	Salon D
B2	Collaborating with Industry Partners to Understand Work-Related Motor Vehicle Crashes Moderator: Stephanie Pratt	Salon E

1:30 pm	B2.1 Characteristics of Driving While Tired Among Taxi Drivers in Two Large Metropolitan Areas: Job Demands Consistently Matter	Cammie Chaumont Menéndez
1:50 pm	B2.2 Validating the Occupational Driver Behavior Questionnaire to Assess Self-Reported Road Safety Habits Among Taxicab Drivers in the U.S.	Cammie Chaumont Menéndez
2:10 pm	B2.3 Analysis of Motor Vehicle Crash and Claims Data for a Light-Vehicle Corporate Fleet	Jennifer Bell
2:30 pm	B2.4 Using Benchmarking Data to Identify Relationships Between Management Practices and Road Safety Performance	Stephanie Pratt
B3	Falls in Construction Moderator: Clint Wolfley	Salon ABC
1:30 pm	B3.1 Contributing Factors to Ladder Fall Severity for Perturbations During Ascent and Descent	Erika Pliner
1:50 pm	B3.2 Biomechanical Assessment of Using Production Tables on Mast Climbing Work Platforms	Christopher Pan
2:10 pm	B3.3 Strength of Temporary Wooden Guardrails Installed on Balconies and Prefabricated Walls Used in the Construction Industry	Bertrand Galy
2:30 pm	B3.4 Evaluation of the Implementation and Effectiveness of the Ontario Working at Heights Training Standard	Lynda Robson
B4	Fatality Incident Investigations Moderator: Michael Fiore	Salon FGH
1:30 pm	B4.1 Officer Struck by a Motorhome While Establishing Temporary Traffic Control on Interstate, A NIOSH Case Study	Melanie Moore
1:50 pm	B4.2 NIOSH Fire Fighter Fatality Investigation Leads to Improved Self-Contained Breathing Apparatus and Understanding of Breathing Air Events	Stephen Miles
2:10 pm	B4.3 FACE Investigation of a Wall Collapse in Construction	Jennifer E. Lincoln
2:30 pm	B4.4 Exposure, Crashes, and Deaths Related to the Use of All-Terrain Vehicles for Spraying	Charles Jennissen
B5	Topics in Surveillance Moderator: Kyla Retzer	Wharf AB
1:30 pm	B5.1 Advancing Worker Safety in Alaska Through the Prevention of Nonfatal Injuries	Devin Lucas

1:50 pm	B5.2 Quantifying the Workplace Safety of Contingent/Alternative Workers in the United States	Matthew Gunter
2:10 pm	B5.3 Creating Safer Workplaces: Learning from Work-Related Fatal Injury in New Zealand	Rebecca Lilley
2:30 pm	B5.4 Effect of Randomized OSHA Inspections on Employer Reporting of Amputations	Aaron Tustin
3:00 – 3:30 pm	BREAK*	
3:30 – 5:00 pm	Concurrent Sessions C	
C1	The Role of Safety Culture in Safety and Health Management in Mining, Oil and Gas Extraction Industries Moderator: Emily Haas	Salon D
3:30 pm	C1.1 Lagging or Leading?: Re-Conceptualizing our Notion of Occupational Injuries as Performance Indicators of Occupational Safety	Patrick Yorio
3:50 pm	C1.2 A Survey of Oil and Gas Extraction Workers: Safety Climate, Employer Health and Safety Policies, and Worker Behaviors	Kyla Retzer
4:10 pm	C1.3 Using Commodity-Specific Safety Climate Trends to Improve Health and Safety Management System Elements	Emily Haas
4:30 pm	C1.4 On-Site Assessment of Safety and Health Management System Effectiveness	Amy Richins
C2	NIOSH-Sponsored State-Based Fatality Assessment and Control Evaluation (FACE) Program Moderator: Nancy Romano Presenters: Robert Harrison, Michael Turner, Michael Fiore, Anthony Oliveri, Julia Zhu, Barb Epstien and Todd Schoonover	Salon E
C3	Special Topics in Workplace Vehicles Moderator: Kurt Beschorner	Salon ABC
3:30 pm	C3.1 Increasing Pedestrian Awareness of Forklifts in the Transportation, Warehousing, and Utilities Industry Sector to Reduce Traumatic Injuries	Thomas Bobick
3:50 pm	C3.2 Occupational and Recreational ROV Exposure, Safety Behaviors and Crash Experiences of Iowa FFA Members	Charles Jennissen

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4:10 pm	C3.3 The All-Terrain Vehicle Exposure and Crash Experiences of Iowa FFA Members	Charles Jennissen
4:30 pm	C3.4 Modeling an Advanced Curve Over-Speed Warning System for Firetrucks	Peter Simeonov
C4	Surveillance Methods Moderator: Audrey Reichard	Salon FGH
3:30 pm	C4.1 Prospects for Combining Survey and Non-Survey Data Sources to Improve SOII Estimates	Brooks Pierce
3:50 pm	C4.2 Efficiency of Autocoding Programs for Converting Job Descriptors into Standard Occupational Classification Codes	Bradley Evanoff
4:10 pm	C4.3 Enhancing Agriculture, Forestry, and Fishing Injury Surveillance Using Free Text Data	Erika Scott
4:30 pm	C4.4 BLS Household Survey of Occupational Injuries and Illnesses Pilot – Update and Discussion	Elizabeth Rogers
C5	Economics of Worker Safety Moderator: Tim Bushnell	Wharf AB
3:30 pm	C5.1 Using Evidence from NIOSH-Sponsored Research to Assess Unrecognized Economic Consequences of Non-Fatal Occupational Injuries on Workers and Their Families	Regina Pana-Cryan
3:50 pm	C5.2 Association Between Longest Held Occupation and Receiving Social Security Disability Benefit	Abay Asfaw
4:10 pm	C5.3 Economic Burden of Occupational Musculoskeletal Disorders (MSDs) in the Wholesale and Retail Trade (WRT) Sector	Anasua Bhattacharya
4:30 pm	C5.4 Work Precariousness and Mistreatment at Work	Tapas Ray
5:00 pm	Adjourn Day One	
5:30 – 7:30 pm	NETWORKING EVENT in MEC Exhibit Hall B Hors d'oeuvres served; cash bar available Sponsored by National Safety Council	

WEDNESDAY, OCTOBER 17, 2018

7:30 – 8:30 am REGISTRATION

8:30 – 10:00 am Concurrent Sessions D

D1	Collaborative Robotics – New Era of Human-Robot Cooperation in the Workplace Moderator: Carole Franklin Presenters: Carole Franklin, Mark Lewandowski, Jeff Fryman and Elena Dominguez	Salon D
D2	Safety Climate/Safety Culture Moderator: Lisa Steiner	Salon E
8:30 am	D2.1 Attitudes and Beliefs of Hourly Miners and Salaried Managers Regarding Safety and Health in U.S. Metal and Non-Metal Mines	Douglas Myers
8:50 am	D2.2 Influence of Work Organization and Environment on Health and Productivity Outcomes Among Construction Apprentices: A Total Worker Health Approach	Bradley Evanoff
9:10 am	D2.3 Testing the Associations Between Leading and Lagging Indicators in a Contractor Safety Pre-Qualification Database	Jack Dennerlein
9:30 am	D2.4 Preventable: Social Marketing to Reduce Preventable Injuries	Ian Pike
D3	Fatal Occupational Injuries Moderator: Keshia Pollack Porter	Salon ABC
8:30 am	D3.1 Traffic Incident Managers – An Under-Recognized Work Group at Risk for Fatal Occupational Injuries	Terry Bunn
8:50 am	D3.2 Cause-Specific Mortality Following Occupational Injury: An Exploratory Study	Abay Asfaw
9:10 am	D3.3 Analysis of Experimental Drug and Alcohol Data from the Census of Fatal Occupational Injuries, 2011-2016	Christen Byler
9:30 am	D3.4 Explaining State-Level Variations in Construction Fatality Rates	John Mendeloff
D4	Shift Work and Injury Moderator: John Violanti	Salon FGH
8:30 am	D4.1 Association Between Hour of Work and Injury Occurrence and Severity in the Oregon Construction Industry: Analysis of Workers' Compensation Disabling Claims, 2007-2013	Liu Yang

8:50 am	D4.2 Transportation-Related Fatalities Among Taxi Drivers from 2003 Through 2015: Older Drivers and Night Driving Can Benefit from Road Safety Programs	Cammie Chaumont Menéndez
9:10 am	D4.3 Adapting Sleep Hygiene and Vehicle Operator Fatigue Management for EMS Ambulance Crews	Gerald Krueger
9:30 am	D4.4 Red Light: A Novel, Nonpharmacological Intervention to Help Increase Alertness in Shift Workers	Marianna Figueiro
D5	Injury Prevention and Economics Moderator: Melvin Myers	Wharf AB
8:30 am	D5.1 Perceptions of Rural Residents' Off-Road Vehicle Insurance Coverage	Charles Jennissen
8:50 am	D5.2 Farm-Related Injuries: Cost and Risk Estimations by the Type of Injury Claims	Navneet Kaur Baidwan
9:10 am	D5.3 Cost-Effectiveness of the New York ROPS Rebate Program: An Update	Paul Jenkins
9:30 am	D5.4 Optimal Investment in Engineering Controls and Personal Protective Equipment	Brian Quay
10:00 – 10:30 am	BREAK*	
10:30 am – 12:00 pm	Concurrent Sessions E	
E1	Fatal Injuries in the U.S. Construction Industry Moderator: Christine Branche	Salon D
10:30 am	E1.1 Trends and Patterns of the Construction Focus Four 1992-2016	Xiuwen Sue Dong
10:50 am	E1.2 Fatal Occupational Injuries at Road Construction Sites from 2003 to 2016	Xuanwen Wang
11:10 am	E1.3 Mapping and Dissemination of Data on Fatal Construction Injuries in the United States, 2011-2018	Gavin West
11:30 am	E1.4 Recommendations for Construction Safety and Injury Prevention: Findings from the Construction FACE Database	Rebecca Katz
E2	Young Worker Injuries/Fatalities Moderator: Kimberly Rauscher	Salon E

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10:30 am	E2.1 An Overview of Young Worker Deaths in the U.S.	Kitty Hendricks
10:50 am	E2.2 Young Worker Reported Injuries in New Jersey for FY 2017 and Time Trends 1999-2017	Derek Shendell
11:10 am	E2.3 Hospitalization and Injury Fatality Rates Among New Jersey Youth Workers Ages 14 to 21	Derek Shendell
11:30 am	E2.4 Workplace Violence Against Youth: Results from a National Telephone Survey	Kimberly Rauscher
E3	Safety Climate: Application to High-Risk Work Moderator: Douglas Myers	Salon ABC
10:30 am	E3.1 Case Study: Two Fire Fighters Die and One Fire Fighter Injured When Struck at a Roadway Incident – NIOSH Fire Fighter Fatality Investigation and Prevention Program	Karis Kline
10:50 am	E3.2 An Assessment of Confined Space Entry and Rescue Training Effectiveness for Aircraft Rescue and Firefighter (ARFF) Members	Todd Smith
11:10 am	E3.3 The Validation of an Organizational Safety Culture Tool	Rebecca Green
11:30 am	E3.4 Moving FOCUS – The Fire Service Safety Climate Tool – From Research to Practice	Jennifer Taylor
E4	Know Your Target, Hit Your Target, Move Your Results into Safety Practice Moderator: David Fosbroke Presenters: Clayton Sinyai, Garrett Burnett, David Fosbroke, Theodore Teske, Sydney Webb and Rebecca Olsavsky	Salon FGH
12:00 – 1:30 pm	LUNCH (on your own) Lunchtime Topic Tables will begin at about 12:15 in MEC Lobby	
1:30 – 3:00 pm	Concurrent Sessions F	
F1	Lessons from Surveys of Construction Stakeholders Moderator: Christine Branche	Salon D
1:30 pm	F1.1 Safety Management and Safety Culture in the Construction Industry	Xiuwen Sue Dong
1:50 pm	F1.2 Characterizing Indicators of a Positive Safety Climate in the Construction Industry	Babak Memarian
2:10 pm	F1.3 A Social Network Analysis of the National Campaign to Prevent Falls in Construction	Eileen Betit

2:30 pm	F1.4 Using Stakeholder Feedback to Create an Online Network for Building Research to Practice (r2p) Capacity	Jessica Bunting
F2	Current Research on Truck Driver Safety Moderator: Stephanie Pratt	Salon E
1:30 pm	F2.1 Tight Delivery Schedules Linked to Job Satisfaction, Opinions on Maximum Speed Limits and Hour of Service Rules, and Noncompliance: NIOSH National Survey of U.S. Long-Haul Truck Driver Health and Injury	Guang Chen
1:50 pm	F2.2 Fatigue Among Long-Haul Truck Drivers	W. Karl Sieber
2:10 pm	F2.3 Identification of Factors Associated with Drug and Alcohol Screening of Fatally Injured Motor Vehicle Drivers Using Multiple Data Sources	Terry Bunn
2:30 pm	F2.4 Time-Varying Coefficient Model for Evaluating Commercial Truck Driver Performance	Feng Guo
F3	Safe Patient Handling Moderator: Jim Collins	Salon ABC
1:30 pm	F3.1 Safe Patient Handling and Mobility Injury to Staff in K-12 School Settings	Katherine Schofield
1:50 pm	F3.2 A Summary of Job Physical Exposure Measured Using the Revised NIOSH Lifting Equation in a Pooled Cohort	Andrew Merryweather
2:10 pm	F3.3 The Inequality Paradox: Hospital-Based Safe Patient Handling Intervention Decreases Overall Worker Injuries and Pain, but Widens Socioeconomic Disparities	Erika Sabbath
2:30 pm	F3.4 Uncovering a Hidden JEM: A General Population Job Exposure Matrix to Estimate Biomechanical Work Exposures	Marcus Yung
F4	Use of Claims Data to Advance Safety Moderator: Steve Wurzelbacher	Salon FGH
1:30 pm	F4.1 Targeting Industry Groups for Loss Prevention Services	Michael Lampl
1:50 pm	F4.2 Using Workers' Compensation Claims Data to Characterize Non-Fatal Injuries in Aviation Workers in Alaska	Kyle Moller
2:10 pm	F4.3 The Economic Effect of Chronic Comorbidities in Carpal Tunnel Syndrome Workers' Compensation Claimants, Washington State	Michael Foley
2:30 pm	F4.4 Measuring the Cost of Injuries with Workers' Compensation Data	Tim Bushnell

3:00 – 3:30 pm BREAK*

3:30 – 5:00 pm Concurrent Sessions G

G1	Connecting Safety Culture to Safety and Health Management on Construction Jobsites Moderator: Christine Branche	Salon D
3:30 pm	G1.1 Subcontractor Safety Management Programs and Worker Perceived Safety Climate in Commercial Construction Projects	Bradley Evanoff
3:50 pm	G1.2 Safety Climate and its Relationship with Construction Company Safety Management Systems and Programs	Luz Stella Marin and Jack Dennerlein
4:10 pm	G1.3 The Safety Climate Assessment Tool: Rubric-Based Approach to Measuring Construction Safety Climate	Linda Goldenhar
4:30 pm	G1.4 Evaluation of Safety Leadership Training to Enhance Construction Jobsite Safety Climate: The Foundations for Safety Leadership (FSL)	Natalie Schwatka
G2	Occupational Injuries Among First Responders Moderator: William Haskell	Salon E
3:30 pm	G2.1 Nonfatal Injuries to Emergency Medical Services Workers	Audrey Reichard
3:50 pm	G2.2 A Study of Nonfatal Injuries to Fire Fighters Treated in U.S. Emergency Departments	Suzanne Marsh
4:10 pm	G2.3 Injured On Duty: Non-Fatal Injuries to U.S. Law Enforcement Officers	Hope Tiesman
4:30 pm	G2.4 Occupational Injuries in the U.S. Motor Vehicle Towing Industry, 2011-2016	Srinivas Konda
G3	Injuries in Commercial Fishing and Seafood Processing Moderator: Devin Lucas	Salon ABC
3:30 pm	G3.1 Crew Position and Injuries in the Dungeness Crab Fleet	Viktor Bovbjerg
3:50 pm	G3.2 Traumatic Injuries in the Dungeness Crab Fleet: Engaging Fishermen to Prevent Injuries While Handling Crab Pots	Laurel Kincl
4:10 pm	G3.3 Perceived Causes of Injuries in U.S. West Coast Dungeness Crab Fishing	Sabrina Pillai

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4:30 pm	G3.4 Identifying Hazards at the Intersection of Manufacturing and Fishing: Traumatic Injuries Among Offshore Seafood Processors in Alaska, 2010-2015	Laura Syron
G4	Slips, Trips and Falls: Focus on the Footwear Moderator: Jennifer Bell	Salon FGH
3:30 pm	G4.1 Preventing Slip and Fall Accidents: Focus on the Footwear	Kurt Beschoner
3:50 pm	G4.2 Evaluation of Slip Resistance Testing of Work Boots on Ice Surfaces	Chantal Gauvin
4:10 pm	G4.3 Convolutional Neural Network with Wearable Inertial Sensors Can Recognize Surface Category and Turning Direction During Walking	Boyi Hu
4:30 pm	G4.4 Mapping the Traction Performance of Work Shoes During Natural Progressive Wear	Sarah Hemler
5:00 pm	Adjourn Day Two	
5:30 – 7:30 pm	Poster Session/Networking Event in MEC Exhibit Hall B Hors d'oeuvres served; cash bar available Sponsored by American Society of Safety Professionals	

LIST OF FEATURED POSTERS

P01	Anthropometry of Emergency Medical Technicians in the U.S.	Jinhua Guan
P02	Security Cameras in Three Row Seating Taxicab	Shengke Zeng
P03	Knee Tissue Deformation Measured In Vivo as a Result of Prolonged Standing	April Chambers
P04	Association Between Occupational Injury and Mental Health Among U.S. Workers: The National Health Interview Study, 2004-2016	Ja K. (Jack) Gu
P05	The Relationship of Occupational Injury and Use of Mental Health Care	María Andree López Gómez
P06	Shift Work and Sleep Quality Among Police Officers: Is Age a Factor?	John Violanti
P07	Injuries and Fatalities Among Meter Readers, 1995-2016	Megan Leonhard
P08	Difference in Occupational Injury Mortality Rate Among People Aged 15 to 69 Years in High-Income Versus Low- and Middle-Income Countries: 1990-2016	Yue Wu
P09	The NIOSH Fatality Assessment and Control Evaluation (FACE) Program	Melanie Moore
P10	Multi-Purpose Machinery Use – Using Excavators for Hoisting: A NIOSH Fatality Assessment and Control Evaluation Investigation	Melanie Moore
P11	Industrial Fire Accidents in Delhi and Prevention	Pranab Kumar Goswami
P12	Cognitive-Based Human Error Detection on Construction Sites	Sogand Hasanzadeh
P13	Implications for Risk Compensation in Construction Safety	Sogand Hasanzadeh
P14	Safety Culture/Safety Climate at Construction Sites: An Assessment of a Practical Model	Ahmed Al-Bayati
P15	Participatory Safety Training: Stimulating Worker Engagement	Ted Scharf
P16	Evaluation of the NIOSH Online Healthcare Workplace Violence Prevention Course	Marilyn Ridenour
P17	Steep Slope Machine Logging in Washington State: Hazard Assessment and Intervention	Randy Clark
P18	SW AgCrash: Leveraging Motor Vehicle Crash Data for Injury Surveillance and Research in AFF	Eva Shipp

P19	Occupational Immersion Deaths in Canada 1991-2014	Peter Barss
P20	Trends in Injuries and Fatalities for Electric Power Workers	Tiffani Ann Fordyce
P21	Surveillance of Acute Nonfatal Occupational Inhalation Injuries Treated in U.S. Hospital Emergency Departments, 2014-2016	Angela Javurek
P22	Have Work-Related Injuries Become More Severe?	Brooks Pierce
P23	Restaurant Inspection Reports as a Proxy Measure for Occupational Health and Safety: South Asian Restaurant Workers in New York City	Hasanat Alamgir
P24	Modernization of the National Occupational Mortality Surveillance Program and Future Opportunities	Andrea Steege

THURSDAY, OCTOBER 18, 2018

8:30 – 10:00 am	Concurrent Sessions H	
H1	Integration of Safety Culture into the Incident Command System to Enhance Fire Fighter Safety Moderator: Murrey Loflin	Salon D
8:30 am	H1.1 Developing and Assessing a Measure for Incident Command Operational Effectiveness in Firefighter Safety Research	Todd Smith
8:50 am	H1.2 Safety Culture and the Incident Command System	Murrey Loflin
9:10 am	H1.3 Beyond the Sixteen, How to Reduce Fire Fighter Fatalities on the Fireground	Dennis Rubin
9:30 am	H1.4 Finding FOCUS on a Safer Fire Service Climate	Jennifer Taylor
H2	Reducing Occupational Safety and Health Risk Among Maritime Workers Moderator: Jennifer M. Lincoln	Salon E
8:30 am	H2.1 Fatal Falls Overboard in Commercial Fishing: Using Surveillance Data to Identify Practical Solutions	Samantha Case
8:50 am	H2.2 Maritime Worker Safety Beyond the Horizon: Risks Associated with Vessel Casualties and Disasters	Alice Shumate
9:10 am	H2.3 Injury and Illness in Alaska's Onshore Seafood Processing Industry: An Analysis of Workers' Compensation Claims, 2014-2015	Laura Syron
9:30 am	H2.4 Occupational Safety in the Emerging Marine Aquaculture Sector: Assessing Current Knowledge and Regulations	Jillian Fry
H3	Worker Safety in the Military Moderator: Christina Socias-Morales	Salon ABC
8:30 am	H3.1 A Systematic Approach to Injury Prevention at Army Installations	Michelle Canham-Chervak
8:50 am	H3.2 Accuracy of Self-Reported Acute Traumatic and Cumulative Micro-Traumatic Injuries Compared to Medical Record Data	Anna Schuh-Renner
9:10 am	H3.3 The Impact of the United States Air Force Fall Injury Prevention Program	Christina Socias-Morales

9:30 am	H3.4 Measuring Effectiveness Without Good Denominators	Bruce Burnham
H4	Musculoskeletal Symptoms and Disorders Moderator: Bradley Evanoff	Salon FGH
8:30 am	H4.1 Findings from the NIOSH Upper Extremity Musculoskeletal Disorder Consortium and Implications for the Revised TLV for Hand Activity	Bradley Evanoff
8:50 am	H4.2 Musculoskeletal Symptoms Among Masonry Apprentices Indicate an Opportunity for Ergonomic Intervention	Laurel Kincl
9:10 am	H4.3 Comparison of Productivity, Vibration, Dust, and Noise Between Pneumatic Rock Drill and an Electric Rotary Drill	Eileen Betit
9:30 am	H4.4 Do Whole Body Vibration Exposure Thresholds Minimize for Acute Sensorimotor and Cognitive Effects?	Marcus Yung
10:00 – 10:30 am	BREAK*	
10:30 am – 12:00 pm	CLOSING PLENARY SESSION (Salon D)	

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Looking to Tomorrow: Worker Safety in the New Economy

Moderated by Dawn N. Castillo, MPH
Director, Division of Safety Research
National Institute for Occupational Safety and Health

Plenary Speakers

Michael Formaini, BS, MBA
Vice President HSE & Quality for Matrix North American Construction

Rebecca L. Reindel, MS, MPH
Senior Safety and Health Specialist
AFL-CIO

Andrew Levinson, MPH
Deputy Director
OSHA Directorate of Standards and Guidance

Mark Fullen, EdD, CSP
Professor and Director at
West Virginia University Safety and Health Extension

Robert Harrison, MD, MPH
Senior Scientist
California Department of Public Health

Kayla Faust, BS, BA
PhD Candidate
The University of Iowa
College of Public Health

NOIRS 2018 OPENING AND CLOSING PLENARY SPEAKERS



Dawn Castillo, MPH

Director, Division of Safety Research

National Institute for Occupational Safety and Health

Dawn Castillo is the Director of the Division of Safety Research at the National Institute for Occupational Safety and Health (NIOSH) in Morgantown, West Virginia. The Division serves as the focal point for traumatic occupational injury research and prevention programs at NIOSH. The Division also houses the NIOSH Centers for Motor Vehicle Safety and Occupational Robotics Research.

Ms. Castillo began her NIOSH career in 1991 as an epidemiologist. Between 1998 and 2011, she served as Chief of a Division Branch responsible for occupational injury data collection, analysis and interpretation. Ms. Castillo was the fourth recipient, in 2000, of the James. P. Keogh award, an annual NIOSH award recognizing a current or former NIOSH employee for exceptional service to the field of occupational safety and health. Ms. Castillo was appointed as Director of the Division of Safety Research in July 2011. She manages two NIOSH research programs, and co-chairs affiliated National Occupational Research Agenda (NORA) Councils: Traumatic Injury Prevention; and Transportation, Warehousing and Utilities. She also manages the new NIOSH Center for Occupational Robotics Research.

Ms. Castillo has authored numerous articles, book chapters, and technical documents on a variety of occupational injury topics, including occupational injuries among young workers, older workers, fire fighters, and workplace violence. Ms. Castillo received her B.S. in Biology from the University of California, Irvine and her Master's of Public Health in epidemiology from the University of California, Los Angeles.



Joyce McConnell, JD, LLM
Provost and Vice President for Academic Affairs
West Virginia University

As the Provost of West Virginia University, Joyce McConnell is the chief academic officer responsible for the administration of all academic policies, programs, facilities, and budgetary matters. She is committed to WVU's land-grant mission of ensuring access to exceptional education, supporting and facilitating innovative research, and serving the needs of the state and people of West Virginia.

Provost McConnell is also an academic who has dedicated her career to improving legal education. As a teacher, scholar, and higher education administrator, she has focused on two educational innovations: multidisciplinary learning and clinical legal education. Prior to her appointment as Provost, McConnell served as Dean of the WVU College of Law (2008-2014). At the College of Law, she expanded the College's multidisciplinary opportunities throughout the University and implemented state-of-the-art experiential and clinical programs and facilities that support curricular innovation. She made this possible by raising \$36 million in A State of Minds: The Campaign for West Virginia's University.

McConnell was named the 2014 Public Servant of the Year by the West Virginia Association for Justice. In 2010, she was awarded the Special Places Award by West Virginia Land Trust. She earned an undergraduate degree from Evergreen State College, a law degree from Antioch School of Law and a master of laws from Georgetown University Law Center.

In addition to being passionately committed to WVU, McConnell is an advocate for LGBTQ rights, for gender equity in the workplace, and for the preservation and protection of our environment. She is a past President of three sections of the Associations of American Law Schools: the sections on the Dean, on natural resources and energy law, and on women in legal education.

McConnell currently serves on the National Collegiate Athletic Association Division One Committee on Infractions, as Chair of the Board of Trustees of the Nature Conservancy in West Virginia, and as a member of the Board of Governors for Antero Resources.



John Howard, MD

Director

National Institute for Occupational Safety and Health

John Howard is the Director of the National Institute for Occupational Safety and Health, and the Administrator of the World Trade Center Health Program in the U.S. Department of Health and Human Services.

Dr. Howard was first appointed NIOSH Director in 2002 during the George W. Bush Administration and served in that position until 2008.

In 2009, Dr. Howard worked as a consultant with the US-Afghanistan Health Initiative. In September of 2009, Dr. Howard was again appointed NIOSH Director, and was reappointed for a third six-year term in 2015.

Prior to his appointments as NIOSH Director and WTC Health Program Administrator, Dr. Howard served as Chief of the Division of Occupational Safety and Health in the State of California's Labor and Workforce Development Agency from 1991 through 2002.

Dr. Howard earned a Doctor of Medicine from Loyola University of Chicago; a Master of Public Health from the Harvard University School of Public Health; a Doctor of Law from the University of California at Los Angeles; and a Master of Law in Administrative Law and Economic Regulation, and a Master of Business Administration in Health-care Management, both degrees from The George Washington University in Washington, D.C.

Dr. Howard is board-certified in internal medicine and occupational medicine. He is admitted to the practice of medicine and law in the State of California and in the District of Columbia, and he is a member U.S. Supreme Court bar. He has written numerous articles on occupational health, policy and law.



Lorraine M. Conroy, ScD, CIH

Professor

Environmental and Occupational Health Sciences and
Director of the UIC Center for Healthy Work
University of Illinois at Chicago

Dr. Lorraine M. Conroy is Professor of Environmental and Occupational Health Sciences in the School of Public Health at the University of Illinois at Chicago. She is an internationally recognized expert in occupational safety and health and has served as a member of a number of national review and advisory panels. She served as the Senior Associate Dean and Interim Dean of the School of Public Health where she led reaccreditation efforts and the introduction of an integrated MPH core curriculum.

From 1999 to 2015, Dr. Conroy successfully led the Occupational Health and Safety Education and Research Center (ERC). Under her leadership, the ERC added two new academic programs, initiated an innovative, interdisciplinary research training program that facilitates a problem-based team science approach to research; and expanded the outreach program to focus on underserved worker populations in partnership with local unions, workers' centers, and employers.

She has more than 25 years of experience in research, curriculum development, and teaching in occupational and environmental health. Her expertise is in the evaluation and control of hazards in the workplace and community, with a current focus on work as a determinant of health. She is the Director of the UIC Center for Healthy Work, a NIOSH-funded Center of Excellence in Total Worker Health and co-investigator on the Greater Lawndale Healthy Work project, within the Center, that is examining how precarious employment impacts the health of individuals and the health of communities in two high-hardship communities in Chicago.

Dr. Conroy received her undergraduate degree in chemical engineering and her master and doctoral degrees in environmental health and physiology with a concentration in industrial hygiene from Harvard University School of Public Health. She is certified in the comprehensive practice of industrial hygiene by the American Board of Industrial Hygiene.



Joel M. Haight, PhD, PE, CSP, CIH

Professor of Industrial Engineering
Department of Industrial Engineering
University of Pittsburgh

Dr. Joel Haight is a Professor of Industrial Engineering in the Swanson School of Engineering at the University of Pittsburgh where he teaches and does research in the areas of productivity, human factors engineering and safety engineering.

Prior to that, he served as Chief of the Human Factors Branch at the Centers for Disease Control and Prevention (CDC) – National Institute of Occupational Safety and Health (NIOSH) at their Pittsburgh Office of Mine Safety and Health Research, where he managed a research branch of 35-40 researchers in the areas of ergonomics, cognitive engineering, human behavior and training. Prior to this he served for four years on the NIOSH Board of Scientific Counselors.

Dr. Haight served for nearly 10 years as an Associate Professor of Energy and Mineral Engineering at the Pennsylvania State University. He also worked as a manager and engineer for the Chevron Corporation for 18 years prior to joining the faculty at Penn State. He has a Ph.D. and Master's degree in Industrial and System Engineering both from Auburn University. He is a professional member of ASSP, AIHA, IISE and the Human Factors and Ergonomics Society.

Dr. Haight served for six years as Trustee on the Board of the American Society of Safety Engineers Foundation and currently serves on the Board of Directors of the American Society of Safety Professionals. He is the 2017 recipient of the ASSE Presidents Award and the 2017 ASSE Council on Practices and Standards Safety Professional of the Year award and the 2004 ASSE Outstanding Educator Award. Dr. Haight has published 65 peer-reviewed scientific journal articles, book chapters and proceedings papers and has delivered invited and key note lectures at many domestic and international conferences including in; Australia, New Zealand, Peru, Poland, Equatorial Guinea, Angola, Democratic Republic of the Congo, United Kingdom, Mexico and Canada. He is the editor-in-chief of and contributing author to the J.W. Wiley and Sons' Handbook of Loss Prevention Engineering (2013) and the ASSE Safety Professionals Handbook 2nd ed. (2012).



Herb Linn, MS

Program Director for Collaboration and Communication
Health Research Center
West Virginia University (WVU) School of Public Health

Mr. Herb Linn has served in his current position with the Health Research Center (HRC) in the WVU School of Public Health since December 2017. The mission of the HRC is to improve the health status of West Virginia communities through policy analysis; research; collaboration with multiple partners at local, state and national levels; dissemination; and program evaluation. Mr. Linn previously served as Deputy Director and Associate Director for Outreach of the WVU Injury Control Research Center (2011-2017). From 1982 through 2005, Mr. Linn was with the NIOSH Division of Safety Research in Morgantown, serving his last few years there as the Associate Director for Communications.

Since joining WVU, Mr. Linn has been engaged in efforts to address the opioid use and overdose epidemic in West Virginia. His work has focused largely on harm reduction, particularly in increasing the availability of naloxone, the opioid overdose antidote, throughout WV. His collaborations with multiple local and state partners in efforts to acquire and distribute naloxone, have supplied the lifesaving drug to first responders and organizations that distribute naloxone to directly to patients and clients at high risk of overdose and associated adverse outcomes, as well as their family members, friends, caregivers and other close associates. Since 2015, Mr. Linn has had a hand in distributing over 11,000 naloxone rescue kits throughout the State of West Virginia. In December 2016, he started a small, community working group that conceived, planned, and ultimately implemented the WV PEERS initiative in Monongalia County WV. WV PEERS (West Virginia Peers: Enhancing Education, Recovery and Survival), a peer recovery services program that utilizes Certified Peer Recovery Coaches to engage overdose survivors in Emergency Departments and other individuals with substance use disorder across the community. The goal of WV PEERS is to aims to improve the health of Monongalia County residents who are struggling with OUD by 1) reducing the risk of overdose, and 2) reducing the risk of contracting infectious diseases and other adverse outcomes associated with injection drug use.

Mr. Linn received his Master of Science in Industrial and Mining Safety from Marshall University in 1986, and his Bachelor of Arts in English in 1979 from Fairmont State College



Michael Formaini, BS, MBA

Vice President HSE & Quality for
Matrix North American Construction

Michael Formaini is the Vice President, HSE & Quality for Matrix North American Construction (MNAC), based in Canonsburg PA. He has been with MNAC since 2014, and is an officer of Matrix Service Company, MNAC's parent. Mike is responsible for all aspects of employee safety, compliance assurance, HSE training, and QA/QC.

Mike is a Certified Safety Professional, and holds a Bachelor of Science degree in Safety Sciences from Indiana University of Pennsylvania (IUP), and an MBA from Penn State. He is a past President of the Northwestern PA chapter of the American Society of Safety Engineers, and has been an ASSE member for over 30 years. He has served as an Advisory Board member at IUP and Gannon University, and an Adjunct Faculty member in Gannon's Engineering Management master's degree program.

Mike previously held leadership roles with the General Electric Company, STERIS Corp, Lederle Labs, and Chevron.



Rebecca L. Reindel, MS, MPH

Senior Safety and Health Specialist

AFL-CIO

Rebecca Reindel is the Senior Safety and Health Specialist at the AFL-CIO, the umbrella federation of 55 labor unions representing 12.5 million working men and women. She provides safety and health support to unions and relies on research and workers' experiences to advocate for improved working conditions.

She covers many issues including retaliation against workers for reporting job-related injuries; improved reporting and collection of injury, illness and fatality data; and exposures to chemicals, infectious diseases, workplace violence and other safety hazards at work. Every year, her team publishes a major report, "Death on the Job: The Toll of Neglect," which is a national and state-by-state profile of workplace safety and health in the U.S.

Rebecca has worked on the ground conducting research and at the national level for EPA and OSHA using science in public policy. She serves as a board officer for the Association of Occupational and Environmental Clinics and for the Occupational Health Internship Program; and is active in the American Public Health Association. She is very active in recruiting and training the next generation of occupational safety and health professionals.

Rebecca received her Master's in Forensic Toxicology in 2007 and Master's in Public Health in 2012 from the George Washington University.



Andrew Levinson, MPH

Deputy Director

OSHA Directorate of Standards and Guidance

Mr. Andrew Levinson is Deputy Director for OSHA's Directorate of Standards and Guidance. Prior to that he was the Director of OSHA's Office of Biological Hazards. Mr. Levinson works on safety and health management systems, emergency response and preparedness, infectious disease, and protective clothing and equipment issues. Prior to joining the Agency, he worked on emergency responder health and safety matters at the International Association of Fire Fighters and on safety and environmental compliance at Anheuser-Busch's brewery in Cartersville, Georgia.

Mr. Levinson received his Master's in Public Health from the Emory University's Rollins School of Public Health and is a graduate of the University of Michigan – Ann Arbor.



Mark Fullen, EdD, CSP

Professor and Director at
West Virginia University Safety and Health Extension

Dr. Mark Fullen has a Doctorate in Technology Education from West Virginia University and a master's in occupational safety and Health and Industrial Hygiene from Murray State University. He has 25 years of practical field and academic occupational safety and health experience including working in the petro-chemical, industrial and bridge construction industries as a safety engineer and safety director.

Mark has conducted applied intervention and field research in the areas of traumatic injury reduction in construction, logging, development and use of mobile technology to collect hazard data and utilizing new training methods to educate to hard-to-reach workers and owners. His unit is the lead organization managing the National Resource Center OSHA Region III Education Center.

He teaches construction occupational safety and health courses as part of the OSHA Education Center and in the academic setting. His current research includes implementing an organizational intervention program in the area of logger hazard awareness and risk perception.



Robert Harrison, MD, MPH
Senior Scientist
California Department of Public Health

Robert Harrison has been on the faculty at the University of California, San Francisco in the Division of Occupational and Environmental Medicine since 1984, and is a senior scientist with the California Department of Public Health. He established the UCSF Occupational Health Services where he has diagnosed and treated thousands of work and environmental injuries and illnesses. He has designed and implemented numerous medical monitoring programs for workplace exposures, and has consulted widely with employers, health care professionals, and labor organizations on the prevention of work-related injuries and illnesses.

Dr. Harrison has led many work and environmental investigations of disease outbreaks, including over 250 acute traumatic fatalities. He has served as a technical and scientific consultant to Federal OSHA and CDC/NIOSH, and was a member of the California Occupational Safety and Health Standards Board. He is currently the Director of the NIOSH-funded Occupational Health Internship Program, and Associate Director of the UCSF Occupational and Environmental Medicine Residency Program.

His research interests include the collection and analyses of California and national data on the incidence of work-related injuries and illnesses. Dr. Harrison has authored or co-authored more than 50 peer-reviewed journal articles, and more than 40 book chapters/contributed articles/letters to the editor. He is the co-editor of the most recent edition of the textbook *Occupational and Environmental Medicine* (McGraw-Hill Education, New York, NY, 2014).



Kayla Faust, BS, BA

She/Her/Hers

PhD Candidate

The University of Iowa College of Public Health

Kayla Faust is a dissertating PhD candidate at the University of Iowa College of Public Health. Prior to beginning her graduate work, Kayla received bachelor's degrees in human physiology and psychology at the University of Iowa. During her time at Iowa, she was involved with various research and outreach activities in the areas of: driving simulation, farm safety and equipment crashes, autonomous vehicle technology, and older adult acceptance of in-vehicle safety systems.

Kayla is a two-time recipient of the Iowa-Illinois Safety Council's Bill Dickenson Scholarship. She has also received the Jack Beno Scholarship for Safety and Health awarded by the Iowa Governor's office. She has been featured on numerous news and media outlets for her innovative dissertation project involving the testing and use of a new pc-based tractor driving simulator which she will use to examine the impact of age and hypertension medication on selected driving performance measures.

In her "free-time," Kayla serves as the chair of the Student Advisory Committee on Sexual Misconduct and president of the LGBT Advocates for Public Health Equity, and works on her family's farm. She also serves on the SAVIR Advocacy and Policy committee, the Transportation Research Board's committee for the Safe Mobility of Older Persons, and is the student representative for several internal and external advisory committees for her department.

NOIRS 2018 ABSTRACTS

(Presenters underlined)

Although the abstracts in this publication were proofread to eliminate obvious errors in spelling, punctuation, and grammar, they were neither edited nor officially cleared by the National Institute for Occupational Safety and Health (NIOSH). Therefore, NIOSH is not responsible for the content, internal consistency, or editorial quality of the abstracts. That responsibility lies solely with the individual authors. Any use of company names and products throughout this publication does not imply endorsement by NIOSH, the Centers for Disease Control and Prevention, the Public Health Service, or the Department of Health and Human Services.

Day 1: Tuesday, October 16, 2018

Session A1

Title: Implementation Science and Translation Research in Occupational Health and Safety Settings: Part 1 – Introduction and Process Models

Moderator: Sarah Felknor

Within occupational health and safety research, much work has been done to develop valuable innovations that have the potential to save worker lives. In order to meaningfully decrease poor health and safety outcomes for workers, it is imperative that such innovations are widely adopted. Unfortunately, recent studies have demonstrated that relatively few occupational safety and health innovations have been fully integrated into practice. Only 17% of fishing research had made it to the implementation phase. Similar results were found in another study; however, taking into account the need for formative research in earlier stages and widespread worker adoption, the authors reported even fewer examples of published research documenting successful implementation within the agriculture, forestry, and fishing industries. While occupational safety and health researchers have increasingly used the term “research to practice,” few conversations have taken place to define what this phrase actually means, and how researchers can achieve success in this area. This session will begin the conversation surrounding implementation science and research to practice. Participants will be introduced to related terminology and process models for moving from basic science to adoption and improved health and safety outcomes.

Workshop Aims: The overarching goal of this workshop is to provide participants with the basic knowledge required to begin discussions about implementation science. Together with the session titled “Understanding Implementation Science in Occupational Health and Safety Settings: Part 2 – Methods for Approaching and Evaluating Implementation Studies,” participants will gain a better understanding of the implementation science field, including the need for implementation science research, challenges related to implementation efforts (overall, and for specific occupational groups), and examples from the field. Upon completing this workshop, participants will be able to: 1. Discuss and

apply key terminology used in implementation science research; 2. discuss and apply different types of process models used for guiding implementation science research; and 3. discuss the evolution of the T0-T4 model for occupational safety and health research and how it can be applied to measure and improve progress toward improved safety and health outcomes.

Workshop Overview: This workshop will focus on three main topics, which will provide participants with a basic knowledge of implementation science. First, participants will be introduced to the field of implementation science. With this knowledge, the workshop will continue on to discuss various process models available for use in implementation science research. Finally, the workshop will conclude with a discussion of the T0-T4 process model, which has recently been adapted for use in occupational settings. In the first part of the workshop, participants will be introduced to the field of implementation science and research to practice and how it relates to the mission and goals of the National Institute for Occupational Safety and Health (NIOSH), and thus, occupational safety and health research as a whole. The presenter will provide an overview of NIOSH’s expectations for and support of intra- and extra-mural efforts in regard to implementation science research. Key terminology and definitions relating to the field will be presented to foster a collective understanding of the implementation science field. In addition, the researcher’s role in conducting implementation science work will be presented. Due to the wide variation in researcher backgrounds and innovation types, this session will also discuss the value of partnerships, and how to go about identifying and strengthening the most appropriate ones. Once participants are familiar with implementation science overall, the discussion will move toward understanding the research to practice process and how the field of implementation science fits within this. Various process models, including both linear and cyclical models will be introduced and discussed. The history of these models, and how and why they have developed over the years will be shared. In addition, the pros and cons, as well as utilization of different types of models will be explored. The final section of this workshop will discuss, in greater specificity, the T0-T4 process model. Though the T0-T4 model was

initially developed for clinical research settings, it has been modified over time to reach further into the realm of public health. Recently, the session presenters published modified T0-T4 models, which are intended specifically for use among occupational safety and health researchers. In this session, the presenters will discuss the key components and considerations of the model step by step. Each phase of research will be explored in detail as presenters describe what is required in each phase. This section will close with an overview of how the T0-T4 model can be used to guide occupational health and safety researchers, and help them evaluate progress toward reducing injuries, illnesses, and fatalities in worker populations.

Session Moderator: Sarah Felknor, DrPH is the Associate Director for Research Integration and Extramural Performance in the NIOSH Office of the Director.

Session Presenters: Paul A. Schulte, PhD is the Director of the Education and Information Division, and Co-Manager of the Nanotechnology Research Center, National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention. [Dr. Thomas Cunningham](#) is a behavioral scientist and the Chief of the NIOSH Training Research and Evaluation Branch in the Education and Information Division. He also coordinates the NIOSH Small Business Assistance Program and Translation Research Program. [Pam Tinc](#) is a Research Investigator at the Northeast Center for Occupational Health and Safety: Agriculture, Forestry, Fishing and a PhD Candidate at Umeå University.

Session A2

Title: Surveillance of Work-Related Motor Vehicle Crashes Using Matched Census of Fatal Occupational Injury/Fatality Analysis Reporting System (CFOI/FARS) Data

Moderator: Rosa Rodríguez-Acosta

This session will discuss methods used to create a matched dataset using the Bureau of Labor Statistics (BLS) Census of Fatal Occupational Injury (CFOI) data and the National Highway Transportation Safety Administration (NHTSA) Fatality Analysis Reporting System (FARS) data. Overall results and analysis specific to the Oil and Gas Extraction and Construction Industries will be presented. A fourth presentation focusing on seat belt use will close this session.

A2.1

Title: CFOI/FARS Matching Methodology and Insights on Work-Related Motor Vehicle Crashes

Authors: Rosa Rodríguez-Acosta, Christen Byler, Stephanie Pratt

Background: Motor vehicle crashes (MVCs) are the leading cause of work-related fatalities in the US. In 2016, crashes on public roadways accounted for 24% of all work-related fatalities. Analysis of work-related MVCs has been limited by data sources that lack either data on potential risk factors or work-relatedness confirmation. The Bureau of Labor Statistics (BLS) Census of Fatal Occupational Injuries (CFOI) provides the most accurate counts of fatal work injuries based on confirmation of work relationship from multiple sources, while the National Highway Traffic Safety Administration (NHTSA) Fatality Analysis Reporting System (FARS) provides detailed data on fatal MVCs based on police reports, but ascertains work relationship solely on death certificates. To address these limitations, BLS, NHTSA, and the National Institute for Occupational Safety and Health (NIOSH) collaborated to match and analyze data from CFOI and FARS.

Methods: Case matching began with a subset of CFOI cases classified as roadway incidents – single- or multiple-vehicle crashes occurring on a public highway, street, or road normally used for travel, including the shoulder and surrounding areas, in which a worker in the vehicle was killed. BLS developed an algorithm to match CFOI and FARS data for 2011-2014. The algorithm used a series of iterative matches allowing for increasing levels of flexibility to accommodate potential coding differences or errors in the two datasets. We conducted a descriptive epidemiologic analysis to examine potential risk factors for MVCs, including occupational characteristics at crash, person, and vehicle level.

Results: All Fatalities: 4,060 work-related fatalities were matched, accounting for 90% of MVCs identified in CFOI; 92% of decedents were male and 60% aged 25-54. Workers employed in the Transportation, Warehousing and Utilities (TWU) industry accounted for the highest proportion (38%) of all fatalities, followed by Construction (11%). Wholesale Trade; Agriculture, Forestry, Fishing, and Hunting; Administrative and Support Services; and Waste Management and Remediation Services made up 6% each. By occupation, 57% of all fatalities

were in transportation and material moving occupations followed by construction and extraction occupations (10%). Drivers only: Drivers accounted for 3,581 of all fatalities (88%). Over 50% of drivers had a valid commercial driver's license. In the past 3 years, 19% had a speeding conviction, 14% had a recorded crash, and 9% a recorded license suspension/ revocation. Additionally, 36% were not using a seat belt, 5% had a blood alcohol level ≥ 0.08 g/dl and 9% were distracted. Crashes: 3,822 work-related crashes were identified in the dataset; the majority (83%) were classified as collisions in which the worker's vehicle struck another vehicle, a person, or an object. Over 50% of the crashes ($n=1,769$) involved a collision with a motor vehicle in transport. We examined manner of collision for these and observed that angle and front-to-rear collisions each accounted for a third of all crashes, 34% and 32% respectively. Vehicles: Of the 3,879 crash-involved vehicles, the majority were heavy trucks (45%), followed by pick-up trucks (14%), passenger cars (12%), vans (8%) and medium trucks (8%). In a small number of vehicles ($n=203$), more than one worker was fatally injured; multiple fatalities per vehicle were most common in TWU (36%) and Construction (15%) industries.

Discussion: This study shows the value of matched CFOI/ FARS data in increasing our knowledge and understanding of work-related MVCs. Results from this analysis allowed a more detailed characterization of fatally injured workers, as well as the circumstances surrounding MVC events. Further analysis of drivers' characteristics and risk factors linked to occupational characteristics will lead to more focused prevention recommendations.

A2.2

Title: Motor Vehicle Crashes in the Oil and Gas Extraction Industry: An Analysis Using Linked Data from CFOI/FARS

Author: [Kyla Retzer](#)

Background: Motor vehicle crashes (MVCs) are the leading cause of death for oil and gas extraction (OGE) workers. In 2016, MVCs caused 44% of all OGE work-related fatalities. There is a need for more data about these events. Previous analysis of MVC fatalities in this industry using the Bureau of Labor Statistics Census of Fatal Occupational Injuries (BLS CFOI) highlighted the need for more interventions related to seatbelt use, light

duty vehicle fleets, and small contractor employees. A data sharing agreement recently signed between the National Highway Traffic Safety Administration (NHTSA) and the BLS created the opportunity for the BLS CFOI to be linked to NHTSA's Fatal Accident Reporting System (FARS), comprehensive database of all roadway crashes involving a fatality in the U.S. This linkage, completed by BLS and National Institute for Occupational Safety and Health (NIOSH) researchers, allows for unprecedented detail in industry, occupation, demographic and accident details. This presentation will review the findings of an analysis of OGE fatal MVCs contained in this linked dataset (2011-2014) and provide recommendations for reducing future incidents in this industry sector.

Methods: To prepare the FARS file for linkage with CFOI, the person, vehicle, and accident level databases were merged by researchers to create a file with the maximum amount of information at the individual level. Then, an iterative process of matching was performed with the CFOI "highway" cases file, with increasing levels of flexibility for each step. Cases were merged using five variables: age, sex, state of incident, county of incident, and date of incident. There were 4,060 cases matched between the data sets. OGE worker cases were identified using the North American Industrial Classification System (NAICS) codes for oil and gas operators, drilling operations, and support activities for oil and gas operations (NAICS 211, 213111, 213112). Descriptive analyses were conducted using SAS version 9.4 for this subset of fatalities.

Results: There were 192 OGE occupational fatalities due to MVC that were successfully matched in the linked CFOI/ FARS dataset. More than half (98, 51%) were in Texas. The largest proportion of fatalities were occupants of pick-up trucks (42%). Fatigue or distraction were noted in the crash report as a factor in 1 out of 5 crashes. In terms of seatbelt use, a larger proportion of vehicle passengers were unbelted as compared to drivers (55% vs. 40%) The peak hours of crashes occurred during the early morning hours (6-9am).

Discussion: The linkage of these two datasets allows researchers to obtain a more complete picture of industry-specific details surrounding fatal work-related MVCs. Among OGE workers, researchers were previously aware of high incidence of non-seatbelt usage, but this data indicates certain types of vehicle occupants (i.e., passengers) and occupants of specific vehicle

types that should be a target of interventions. Current employer interventions that reduce driving at high risk times (i.e. journey management) can use this data to guide their programs. These findings also indicate a need to educate workers about the importance of sleep and to create policies and programs to manage fatigue. The implementation of cell phone policies to ban the use of phones while driving are also critical.

A2.3

Title: Fatal Occupational Road Transportation Injuries in the U.S. Construction Industry from 2011 Through 2016

Authors: [David Fosbroke](#), [Rosa Rodríguez-Acosta](#), [Christen Byler](#)

Background: In 2016, the construction industry had the highest number and third highest rate of fatal occupational injury in the United States. Road transportation incidents were the leading cause of fatal injury across all industries and the second highest in construction. Our research objective is to analyze injury surveillance data to identify opportunities for reducing road transportation related fatal injuries in construction.

Methods: A descriptive analysis of fatal work-related transportation incidents in the US using data from the Bureau of Labor Statistics (BLS) Census of Fatal Occupational Injuries (CFOI) was conducted. CFOI data for the 2011-2016 period were extracted from publicly available charts and tables posted on the BLS website (<https://www.bls.gov/iif/oshcfoi1.htm>) meeting the following case criteria: public and private sector construction industry; pedestrian vehicular incidents, roadway incidents involving motorized land vehicle, and non-roadway incidents involving motorized land vehicles. This temporal subset was selected due to a CFOI break in series (2010) for data utilizing event OIICS codes. A separate analysis of roadway incidents using CFOI data matched to National Highway Traffic Safety Administration (NHTSA) Fatality Analysis Reporting System (FARS) was conducted. This restricted access dataset contains data on roadway incidents - single- or multiple-vehicle crashes occurring on a public highway, street, or road normally used for travel, including the shoulder and surrounding areas, in which a worker in the vehicle was killed. We limited this file to fatalities in the construction industry.

Results: Over 1,500 workers employed in the construction industry died in a motor vehicle related transportation incidents from 2011-2016. The Specialty Trades Contractor and Heavy and Civil Engineering Construction subsectors each accounted for over 40% of these fatal injuries (n=690, 652 respectively), while the Building Construction subsector had the fewest (n=160). Events most frequently leading to fatal injury vary by construction industry subsector. For the industry as a whole, roadway incidents accounted over half of fatal events. In Building Construction and Specialty Trades Contractors, roadway incidents accounted for about 2/3 of fatalities, while in Heavy & Civil Engineering Construction fatalities were more evenly distributed between roadway and pedestrian events. Roadway collisions with other vehicles were primarily with vehicles traveling in the opposite direction (50%), followed by vehicles traveling perpendicular to (27%) the fatally injured workers' vehicle. Roadway collisions with an object or animal almost exclusively involved animals or objects on the side of the road (80%) while roadway non-collisions and non-roadway non-collisions were primarily jackknife/overturn events (86% and 65%, respectively). Roadway incidents from the CFOI/ FARS matched data from 2011 through 2014 provided additional insights. During the 4-year-period, the FARS/ CFOI data contains information on fatal crashes involving 394 vehicles leading to 435 fatalities. This industry had the second highest proportion of fatally injured workers (11%) with drivers accounting for 80% of all fatalities. Where known, 52% of fatally injured drivers did not wear a seat belt and no obvious distractions were reported for 85% of drivers in the CFOI/ FARS data.

Discussion: Results emphasize the need for more focused effort to improve road safety in Construction. In Heavy Civil Engineering Construction, continued efforts to reduce the number of workers on foot struck by vehicles need to be combined with renewed efforts to reduce fatal roadway collisions. In Building and Specialty Trades Construction, the primary focus should be on reducing fatal roadway collisions. Throughout the construction industry, improved seat belt usage is a step towards reducing fatal occupational road transportation injury.

A2.4

Title: **Seat Belt Use Among Fatally Injured U.S. Workers: Analysis of CFOI/FARS Matched Data**

Authors: [Rosa Rodríguez-Acosta](#), [Christen Byler](#)

Background: Motor vehicle crashes (MVCs) on public roadways are the leading cause of work-related fatalities in the U.S. accounting for over 25,000 deaths from 2003-2016. Adult seat belt use is the single most effective way to save lives and reduce injuries in the event of a crash. Research indicates that buckling-up in the front seat of a passenger car can reduce the risk of a fatal injury by 45% and of moderate-to-critical injury by 50%. Further, in light truck vehicles, seat belts reduce the risk of fatal injury by 60% and of moderate-to-severe injury by 65%. Even though seat belt use has shown an increasing trend since 2000, the U.S. has lower than average use compared to other countries. It has been documented that workers who drive as part of their job do not wear their seat belts all of the time. It is estimated that in the oil and gas extraction industry over a third of workers fatally injured from 2003-2009 were not using their seat belt. Survey results revealed that among long-haul truck drivers, 14% indicated they did not use a seat belt on every trip. Low seat belt use rates have also been observed among construction workers and occupants of commercial light vehicles, particularly pick-up trucks. In this study, we addressed seat belt use among fatally injured workers using Census of Fatal Occupational Injuries (CFOI)/ Fatality Analysis Reporting System (FARS) matched data.

Methods: Case matching began with a subset of CFOI cases classified as roadway incidents – crashes occurring on a public highway, street, or road normally used for travel, including the shoulder and surrounding areas. BLS developed an algorithm to match 2011-2014 CFOI data, which provides complete counts of fatal work injuries based on confirmation of work relationship from multiple sources, to FARS, which offers detailed data on fatal highway MVCs based on police reports. The algorithm used a series of iterative matches allowing for increasing levels of flexibility to accommodate potential coding differences or errors in the two datasets. We conducted a descriptive epidemiologic analysis of seat belt use among workers in the CFOI/ FARS matched dataset by examining seat belt use by demographic characteristics, vehicle type, seating position, and industry of employment. Analysis was restricted to events where seat belt use was known.

Results: There were 4,060 work-related fatalities in the matched dataset. Forty-three percent (43%) of workers were using a seat belt and 36% were unbelted. Seat belt use status was unknown for 15% and 7% were classified by FARS as not applicable. Among those with known seat belt use status (n=3,216), 54% were belted. By age group, fifty-seven percent (57%) of those aged 18-24 years were unbelted. No differences were observed by gender among cases where seatbelt use was known, with 54% of men and 55% of women using their seat belts. An overwhelming majority (95%) of those wearing seat belts remained inside the vehicle, while 55% of those unbelted were ejected. By seating position, 50% of those in the front seat were using their seatbelts but only 25% of those seated in the back were belted. About two thirds (65%) of passenger car occupants were belted, a similar proportion (60%) was observed among large truck occupants. The agriculture, forestry, fishing and hunting industry had the highest proportion of workers who were not wearing their seatbelt, while workers in the manufacturing industry had the highest observed rate of seatbelt use.

Discussion: This analysis shows differences in seat belt use among fatally injured workers. It highlights the importance of examining this motor vehicle safety behavior by demographic, as well as occupational characteristics in order to develop interventions aimed at workers showing lower seat belt use.

Session A3

Title: **Hot Topics in Worker Safety**

Moderator: [Jeff Welsh](#)

A3.1

Title: **Wet Bulb Globe Temperature and Heat Index as Predictors of Occupational Heat-Related Illness: Review of Cases Reported to OSHA**

Authors: [Aaron Tustin](#), [Courtney Morris](#), [Richard Gonzales](#), [Michael Hodgson](#)

Background: Heat stress occupational exposure limits (OELs) were developed by NIOSH and ACGIH in the 1970s to prevent heat-related illnesses (HRIs). The OELs define the maximum safe wet bulb globe temperature (WBGT) for a given physical activity level. These OELs were developed on the basis of laboratory research with human volunteers. The primary goal of this study was to

compute the sensitivity of heat stress OELs at real-world outdoor workplaces. Heat Index (HI) is a commonly used alternative heat metric. A second goal of this report was to determine an appropriate HI screening threshold that could trigger increased vigilance.

Methods: Retrospective analysis of outdoor work-related HRIs reported to the Occupational Safety and Health Administration (OSHA) in 2016. These employer reports included the industry, date, location, and a brief description of the work activities. We estimated the workload of each victim. We also downloaded weather data from the nearest National Oceanic and Atmospheric Administration (NOAA) observation station and computed each day's maximum WBGT and HI. We defined the OELs' sensitivity as the fraction of incidents with WBGT > OEL. We also computed the sensitivity of each possible HI discrimination threshold. In a separate analysis, we created simulated weather data, intended to mimic summer conditions at U.S. workplaces, to assess associations between WBGT and HI.

Results: The sample included 234 outdoor work-related HRIs (17 fatalities and 217 hospitalizations). Most (76%) HRIs occurred after heavy or very heavy workload. The two most common industry sectors were Construction (29%) and Transportation and Warehousing (24%). Sensitivity of the WBGT-based OELs was between 87.9% and 96.8%, depending upon our assumption about acclimatization status. In the subset of fatal cases, the OELs' sensitivity was 92.3% to 100%. The Heat Index was not always extremely high: heat-related hospitalizations occurred when HI was as low as 73°F (22.8°C) and fatalities occurred when HI was as low as 87°F (30.6°C). Simulated weather scenarios demonstrated that for a given HI, when radiant heat was included, WBGT was often higher than previously reported. The imperfect correlation between WBGT and HI precluded a direct translation of OELs from WBGT into HI.

Discussion: Our study confirmed that, in real-world settings, NIOSH's WBGT-based heat stress OELs are highly sensitive. The OELs should be considered the "gold standard" for occupational heat hazard assessment. When WBGT is unavailable, an HI screening threshold of approximately 80°F could identify potential workplace heat hazards with an adequate safety margin.

A3.2

Title: Drug Overdose Deaths in U.S. Workplaces, 2011-2015

Authors: [Hope Tiesman](#), [Srinivas Konda](#), [Lauren Cimineri](#), [Dawn Castillo](#)

Background: The U.S. drug overdose epidemic is ongoing. In 2016, the age-adjusted drug overdose death rate was more than three times the rate in 1999 (19.8 per 100,000 standard population versus 6.1). The pattern of drugs involved in these deaths has changed with opioids becoming the main driver of the epidemic. In 2016, 40% of drug overdose deaths involved a prescription opioid. It is unclear how this national epidemic is impacting workers and employers. If workers are under the influence of drugs while at work, they may be at an increased risk for injury and may also increase the risk for co-workers as well. The purpose of this study is to enumerate and describe drug overdose deaths that occurred in U.S. workplaces between 2011 and 2015.

Methods: Drug overdose deaths occurring in U.S. workplaces between 2011 and 2015 were obtained from the restricted access Bureau of Labor Statistics' (BLS) Census of Fatal Occupational Injury (CFOI) database. Denominator data for rate calculations were obtained from the BLS's Current Population Survey (CPS). Fatalities were identified using Occupational Injury and Illness Classification System (OIICS) codes. Drug overdose deaths were selected using the following primary and secondary injury source codes: '1840' (Drugs, alcohol, medicines, unspecified), '1842' (Drugs—nonmedicinal), '1843' (Medicines, except vaccines), '1848' (Multiple drugs, alcohol, medicines), and '1849' (Drugs, alcohol, medicines, n.e.c.). Narrative text fields were used to categorize the type of drug associated with the fatality. Socio-demographics of the decedent and workplace characteristics were compared with rate ratios (RRs) and 95% confidence intervals (CIs). Industry specific fatality rates were calculated. Negative binomial regression was used to assess annual drug overdose fatality rate changes.

Results: Between 2011 and 2015, 543 overdose deaths occurred in U.S. workplaces, resulting in an overall fatality rate of 0.8 per 1,000,000 FTEs. The annual workplace drug overdose fatality rate increased 23% (CI= 16%–31%) across the 5-year period ($p < 0.0001$). Men had significantly higher workplace drug overdose fatality rates than women (RR=4.4, 95% CI=3.4–5.5). Workers

between the ages of 25–34 had the highest workplace drug overdose fatality rates of all workers (0.94 per 1,000,000). Approximately one-third of workplace overdose deaths came from workplaces with less than 10 employees (n=174, 32%). Workplace drug overdose fatality rates were highest in the midwestern and western regions of the U.S (0.88 deaths per 1,000,000). The three industries with the highest number of workplace drug overdose deaths were construction, transportation & warehousing, and healthcare (n=83, n=77, n=73, respectively). The largest categories of drugs used in workplace overdose deaths were illicit drugs (n=320, 45%), opioids (n=159, 22%), ‘other’ which included prescription drugs, amphetamines, and benzodiazepines (n=130, 18%), multiple drug combinations (n=54, 8%), and unknown drugs (n=47, 7%).

Discussion: We found that while the number of workplace drug overdose deaths was low, this number doubled between 2011 and 2015. There were two important findings as it relates to prevention. First, nearly 50% of workplace drug overdose deaths occurred in only three industries – construction, transportation & warehousing, and healthcare – suggesting that prevention efforts be considered for these sectors. Second, 32% of workplace drug overdose deaths occurred in businesses with less than 10 employees. Therefore, programmatic efforts should keep in mind the needs and challenges of small businesses. More research is needed to understand the impact of the epidemic on workplaces and the most effective employer-based interventions.

A3.3

Title: Use of Automation and Robotics in Construction

Authors: [G. Scott Earnest](#), [Christine Branche](#)

The approximately ten million construction workers in the United States have elevated risks of fatal and non-fatal injuries as compared to workers in many other industries. Many of the fatal and nonfatal injuries to construction workers are the result of falls from elevation, struck by incidents, and musculoskeletal disorders. Construction work can lead to musculoskeletal disorders (MSDs) such as back injuries or upper arm disorders, and hand-arm vibration syndrome (HAVS). Back injuries

are the most prevalent work-related MSD in construction, and the rate of work-related MSDs in construction is 16% higher than in all industries combined. Construction work is demanding and labor intensive with significant manual material handling and awkward postures. Many of the building trades require skilled workers that are sometimes in short supply.

Technological advances such as robotics and automation are growing rapidly. These technologies are beginning to migrate from factories and manufacturing facilities to building and construction sites to perform complex tasks. Technologies such as collaborative robots, autonomous vehicles, drones, and powered or non-powered exoskeletons are beginning to reach the construction industry. Some of these advances have occurred more rapidly in other countries, such as Japan, but are now beginning to impact construction work in the U.S. These and other approaches (such as prefabrication and additive manufacturing) have the potential to improve quality, productivity, timeliness, and safety in the construction industry. These advanced automated and robotic technologies are well-suited for construction where significant material handling and challenging working conditions are common. Robots can take on the handling of heavy loads; performing dirty, dangerous, or repetitive work; working at elevation, in hard to reach places, and on tasks requiring difficult work postures. Robots are particularly well suited for work on civil infrastructure and home building activities such as bricklaying. Unanticipated hazards and consequences associated with the use of robots may be particularly significant because of the characteristics of traditional construction projects: ever-changing work environments, the need for multiple skilled craftsmen working on a project, multiple employers sharing a common worksite, and the interactions among many pieces of automated equipment.

Greater use of these technologies has the potential to reduce some of the many construction injuries and fatalities. Further safety research and development is needed for protocols, guidance, and best practices for the safe use of many new types of robots and automated systems that are starting to become commercially available for construction applications.

A3.4

Title: Changing Perceptions of Robotics in Industry: Recent Accomplishment in Safety and Injury Risk Reduction

Authors: [Mojtaba Yazdani](#), [Andrew Merryweather](#)

Advancements in automation and robotics have created a working environment where humans and robots labor alongside each other and together on collaborative tasks. Previously, there were few human interactions with robots during routine work, and most accidents with robots occurred during maintenance, setup and programming. Recently, humans and robots do more collaborative tasks, potentially increasing the risk of injury. This presentation reviews and summarizes research topics mainly in robotics, but emphasizes potential research opportunities to accomplish safety and protect workers through collaborations with ergonomists and safety professionals.

- Collision-free motion planning: We should carefully plan for the motions of industrial robots collaborating with humans to perform tasks quickly and efficiently while avoiding collisions with human workers. Several methods such as model predictive control, convex optimization, reactive planning and active reinforcement learning are being used to do develop such algorithms.
- Force and torque control: Low-level controllers that limit the amount of force and torque exerted by the robot during physical interactions with a human worker are needed. To reduce injury risk during unwanted collision and accidents. Impedance-based controllers are the most common algorithms in this area.
- Human intention prediction and recognition: Robots need to be able to learn, predict and recognize a human's intention to perform a task, often adapting their motion based on the human's movement. For example, a robot may want to pack a part so the human can provide the packaging, place the part inside the package, and finish the packaging process. Probabilistic modeling and learning algorithms are used in this area.
- Human motion prediction: In addition to knowledge of the worker's current location, robots need to have ability to predict human motion in future steps to avoid future collisions. Methods such as inverse optimal control and path-integral inverse reinforcement control have shown promise in this area.
- Safety and productivity-based motion planning:

Improvements in safety and productivity in semi-automated manufacturing is a major concern. Often these are considered competing interests. Roboticians are developing new algorithms to improve both simultaneously. In these algorithms, safety parameters and productivity are modeled as constraints and objective functions respectively. Planning for the robot maximizes productivity while maintaining worker safety.

- Task allocation between human and robot: The design of a collaborative workspace involves assigning tasks to human and robot workers. These decisions are not often based on human injury potential and physical limitations, but on robot features and capabilities. Safety and ergonomics guidelines should play an important role in deciding how to allocate tasks. Novel task allocation algorithms that maximize safety and ergonomics while maintaining performance and minimizing cost need to be developed in this area.

- Safety features for robots: Several researchers are adding safety features to robots in order to reduce injury severity. Robot airbags, brakes that stop the robot in case of collision, and using soft materials in robots to reduce contact forces have been implemented on collaborative robots.

To protect human workers in this rapidly changing industrial paradigm shift, roboticians, ergonomists and safety professionals need to work together. Combining expertise to address human safety and optimize task planning for human-robot work will help change the perception of the safety of human-robot interactions in industry. These efforts are needed to accelerate the adoption of this emerging technology in our workplaces.

Session A4

Title: Workplace Violence

Moderator: [Carri Casteel](#)

A4.1

Title: Understanding Differences in the Workplace Violence Experiences of Teens and Young Adults

Authors: [Brandy Brown](#), [Doug Myers](#), [Carri Casteel](#), [Kimberly Rauscher](#)

Background: Workplace violence is an important public health problem. While workers of all ages are affected, young workers under age 25 are at greater

risk. Despite this, little is known about the problem of workplace violence among this population of workers and whether the experiences of teens are different from those of young adults. The objectives of our analysis were to: 1) identify common themes in how young workers under age 25 experience workplace violence and the consequences they suffer as a result; and 2) identify differences between teens and young adults in the experiences and consequences they report.

Methods: We conducted a series of one-hour focus groups with 31 young people who had experienced any of the following forms of violence while at work: verbal abuse; threats; physical attacks; sexual harassment or assault; or bullying. Three focus groups were conducted with a total of 21 college students at West Virginia University (13) and the University of Iowa (8), and two were conducted with a total of 10 high school students in West Virginia (5) and Iowa (5). A focus group guide was used to ensure reliability and validity of the data collected across all focus groups. Sessions were audio recorded and later transcribed. Notes were also taken by several members of the study team and debriefing sessions with the study team were also conducted after each session. The transcribed recordings, focus group notes, and debriefing notes were analyzed by two separate members of the study team using independent theme analysis. The identified themes were considered by members of the study team and key issues of concern were identified.

Results: Our qualitative analysis identified the following major themes among all young workers: verbal abuse and sexual harassment common; social media used to bully and sexually harass; micro-aggressions; differential treatment by supervisors; negative impacts on work, school and relationships; negative mental health impacts; maladaptive coping strategies; tolerating or ignoring the behavior or removing oneself from the situation versus reporting (fears). Themes particular to college students included: sees workplace violence as a problem; use of power by supervisors; management focus on customer not employee during violent event; and cliques among co-workers. Themes particular to high school students were: worries about being left alone at work; bullying episodes; supervisor mistreatment; generational issues as cause; and reports to parents not supervisors.

Discussion: Working teens and young adults are often

categorized and viewed as a homogeneous group of “young workers.” Results from this study indicate that when it comes to workplace violence, experiences between high school students and those only a few years older are similar yet some clear differences exist that warrant further study. By understanding the differences between young workers of different ages, and therefore, stages of development, we are able to create more effective age-appropriate workplace violence prevention and response programs and training.

A4.2

Title: Factors Associated with Taxi Driver Verbal and Physical Assaults by Passengers: Results from a Taxi Driver Survey

Authors: [Cammie Chaumont Menéndez](#), [Christina Socias-Morales](#), [Srinivas Konda](#), [Marilyn Ridenour](#)

Background: Workplace violence remains the leading cause of work-related fatalities among taxi drivers, a workforce that drives for a living. There is a lack of literature exploring the range of factors associated with passenger violence in an industry whose regulation varies tremendously from city to city and currently is challenged with enforcing safety measures with the advent of transportation network companies (TNCs) such as Uber and Lyft. The study objective was to explore current safety measures, work environment, business-related factors and personal factors related to verbal and physical assaults by passengers.

Methods: Licensed drivers in two metropolitan cities were invited to participate in a 30-minute survey administered by trained interviewers. Passenger violence was measured using two separate outcomes: responding yes to having been verbally assaulted, including yelled at, threatened or insulted by a passenger in the last 12 months and responding yes to having been physically assaulted, including being hit, pushed or grabbed by passenger in the last 12 months. Safety measures included safety equipment and training. Work environment included a short safety climate scale and job demands. Business-related factors are work scheduling, years driving a cab, and ownership of cab and medallion. Personal factors included gender, age, race/ethnicity, nativity and educational attainment. Passenger violence was modeled on safety measures, work environment, business-related and personal factors

using logistic regression analyses performed separately by city.

Results: In Houston, 40% (n=199) of drivers reported having a security camera, bullet-resistant partitions, 20% (n=101), GPS dispatch, 47% (n=231), silent alarms, 11% (n=53), cashless payment systems, 80% (n=392) and 58% (n=287) took a safety training. In Houston, verbal assault (29%) was associated with fewer weekly hours driving a cab ($p<0.001$) and experiencing a motor vehicle crash while driving a cab ($p=0.029$), while drivers who were physically assaulted were more likely to have taken a safety training ($p=0.042$) and more likely to experience a motor vehicle crash while driving a cab ($p=0.002$). In Los Angeles, 98% (n=490) of drivers have a camera and no partition, 99% (n=496) have a GPS dispatch, 96% (n=480) have a silent alarm, all but 1 have a cashless payment system and 84% (n=418) took a safety training. In Los Angeles, verbal assault (43%) was associated with scoring higher on perceived job demands ($p<0.001$), ranking safety training as not useful ($p=0.001$), driving longer during the day ($p=0.002$), and being foreign-born ($p=0.027$), while physical assault (5%) was associated with driving longer during the day ($p=0.012$). Safety equipment was either not associated with the outcomes to continue the model selection process (Houston) or were so prevalent the bivariate regression models would not converge (Los Angeles).

Discussion: In Los Angeles, almost all taxis were equipped with recommended safety measures, whereas in Houston most taxis had a cashless payment system and less than half had additional safety measures. For both cities, verbal assaults were more prevalent than physical assaults. Safety equipment use was not associated with either type of violence in Houston, and almost every taxi in Los Angeles had all of the safety equipment surveyed. In Houston, experiencing a motor vehicle crash while driving was associated with both types of assault. The association of safety training was likely a factor of the study design where assaulted drivers retake the safety training. In Los Angeles, driving longer during the day was associated with both types of assault. Due to the cross-sectional study design temporality cannot be established, but other safety outcomes (road safety) and driving scheduling times are important considerations for preventing passenger violence. Furthermore, every driver should be taking a high-quality safety training that is perceived as useful.

A4.3

Title: Workplace Violence in Emergency Medical Services: The Development of a Systems-Level Intervention

Authors: [Regan Murray](#), [Jennifer Taylor](#), [Andrea Davis](#), [Lauren Shepler](#), [Kevin Mitchell](#), [Joseph Allen](#)

Background: In the United States, calls for emergency medical services (EMS) have increased approximately 20% each year. In at least one study, paramedics had 14-fold higher odds for violent injuries than firefighters. In a study of safety climate with over 100 firefighters from fire departments across the United States, firefighters reported that the 911 system is strained. Firefighters highlighted the high volume of low acuity calls that occupy much of their workload, divert resources from emergencies, and lead to unwarranted occupational hazards like speeding to non-serious calls. As a result, firefighters reported high occupational stress, low morale, and desensitization to community needs. Firefighters called for improvements to the 911 system including better triage, more targeted use of EMS resources, continuing education to align with job demands, and a strengthened social safety net to address the persistent needs of poor and elderly populations. A major challenge confronting fire-based EMS is understanding the organizational, mental health, and safety burden that providers experience as they respond to increasing community demand. An understudied aspect of this demanding work is the impact of violence from patients against EMS responders. A multitude of best practices to address violence can be gleaned from industry trade journals and some academic sources, but none are organized in a way that first responders and leadership can readily implement. Objective: To develop a multi-level industry-specific systems-level checklist of policies and procedures for preventing and mitigating violence against fire-based EMS responders.

Methods: Initial content and format of draft checklist items were informed by a previously published systematic literature review. Fire and EMS leaders, academic researchers, front line workers, and labor representatives were convened for a two-day consensus conference to establish agreement on checklist items. ThinkTank and ThinkLets technology facilitated brainstorming, convergence, organization, evaluation, and consensus building activities. A brief processing period

followed, and a final review of the checklist then proceeded amid a large-group facilitated session.

Results: We will present the resultant systems checklist, a comprehensive inventory of best practices, policies, and procedures for all levels of the fire department including dispatch, EMS responders, leadership, and union officials. Strategies and barriers to consensus building will be discussed as well as a timeline for checklist implementation and mixed methods evaluation.

Discussion: To date, no evidence-based intervention exists to prepare EMS responders for violence on the job. A multi-disciplinary consensus building process led to a systems checklist that speaks to each phase of emergency response: 1) traveling to the event, 2) scene arrival/ prior to entry, 3) patient care, 4) transport to the hospital, 5) transfer to ED staff, and 6) assessing readiness to return to service), in addition to pre-event conditions and post-event follow-up. The checklist has the potential to reduce injury exposures from violence, impact self-reported mental health metrics, and improve organizational outcomes (e.g., burnout, job satisfaction, engagement). These improvements- intended to benefit the worker- may also lead to improved patient outcomes and quality of care.

A4.4

Title: Indicators of Workplace Violence

Authors: [Daniel Hartley](#), [Audrey Reichard](#), [Susan Derk](#), [Erika Harrell](#), [Lynn Langton](#), [Stephen Pegula](#), [Mark Zak](#)

Background: Workplace violence can affect employees physically and psychologically. It can lower worker morale and productivity and impact interpersonal relationships. Employers can also be affected by higher rates of turnover and damaged goodwill for the organization. To understand the occurrence, nature, and effects of workplace violence, an interagency effort was undertaken to compile a comprehensive report using all available national surveillance data sources known to effectively measure these crimes.

Methods: The National Institute for Occupational Safety and Health (NIOSH) partnered with the Bureau of Justice Statistics (BJS) and the Bureau of Labor Statistics (BLS) to create a statistical report that will summarize the nature, extent, and patterns of fatal and nonfatal

workplace violence in the United States. The data are from the Census of Fatal Occupational Injuries and the Survey of Occupational Injuries and Illnesses conducted by BLS, the National Crime Victimization Survey sponsored by BJS, and the National Electronic Injury Surveillance System-Occupational Supplement sponsored by NIOSH. The databases each present a piece of the entire picture of workplace violence-related incidents. The report taken as a whole presents a broad perspective on aspects of workplace violence that could not be accomplished by looking at any of the data sources alone. It is important to note that each database uses its own distinct methodology and addresses a different population. The authoring agencies have alerted readers to these differences in the report.

Results: There were 1,756 workplace homicides from 2011 to 2014. Over two-thirds of these were the result of shootings. On average over one-million workers were assaulted at work or on duty annually from 2010 to 2014. The vast majority, over three-fourths of these assaults, were committed by unarmed perpetrators. On average, over 100,000 workers were treated annually in emergency departments for injuries resulting from assaults in the workplace (2011 to 2014), and more than three-fourths of these worker injuries were from hitting, kicking, and beating. In 2014, there were approximately 25,500 nonfatal workplace violence-related injuries that required days away from work. Of these, two-thirds of the injuries that resulted from hitting, kicking, beating, or shoving were experienced by female victims.

Discussion: The final co-branded report is expected to be published by the end of calendar year 2018, and will be released on BJS, BLS, and NIOSH websites simultaneously. Each organization will issue an announcement of the new resource. Social media will also serve as an avenue for announcing the report. The long-term plan is to provide data updates to the report every five years. It is expected that this report will provide information to better focus resources and prevention efforts related to workplace violence.

Session A5

Title: Agriculture: From Injury to Intervention

Moderator: [Risto Rautiainen](#)

A5.1

Title: Agricultural Injuries in Central USA: Summary of 2011–2015 Data

Author: [Risto Rautiainen](#)

Background: The US Bureau of Labor Statistics injury surveillance covers hired workers on large farms, but there are no current national surveillance systems covering non-fatal injuries to farmers and ranchers in the US. To fill this gap, the Central States Center for Agricultural Safety and Health (CS-CASH) initiated annual injury surveys in 2011 covering the center's region of Iowa, Kansas, Missouri, Minnesota, Nebraska, North Dakota, and South Dakota.

Methods: The National Agricultural Statistics Service (NASS) selected 1000 operations from each of the seven states in the CS-CASH region each year and mailed out injury surveys to the selected farms and ranches (n=7000*5 years). NASS entered data from returned surveys (n= 10,897, total for 5 years) and added selected farm production variables for each operation from recent Census of Agriculture data. The CS-CASH research team analyzed the datasets, including descriptive statistics in this report.

Results: The data consisted of 1069 injuries and 15,074 person-years. The average annual injury rate (injuries per 100 person-years) was 7.09 for all operators, 7.69 for primary operators, 5.68 for second operators and 4.71 for third operators. The major sources of injury were livestock (26%), machinery (11%), hand tool (10%), working surfaces (9%), tractor (8%), power tool (5%), ATV (5%), and trucks/ automobiles (4%). The lost time from injuries was 0 days in 33% of the cases, up to 2 days in 27% of the cases, 2-29 days in 26% of the cases and one month or longer in 12% of the cases. The direct medical expenses were \$9707 on average; \$2475 were paid out-of-pocket and \$7232 were paid by insurance.

Discussion: This surveillance study provides information on the magnitude of the injury problem on farms and ranches in the Central US, including medical expenses and lost work time resulting from the injury. Information on the frequency, severity, sources and other characteristics of injuries can be used for designing targeted prevention programs and following if the injury rates improve from year to year.

A5.2

Title: Occupational Side-by-Side Vehicle Exposure, Safety Behaviors, and Crash Experiences of Farm Progress Show Attendees

Authors: [Charles Jennissen](#), [Karisa Harland](#),
[Kristel Wetjen](#), [Pam Hoogerwerf](#), [Lauren O'Donnell](#),
[Gerene Denning](#)

Background: Side-by-sides (SxSs), including both utility-task vehicles (UTVs) and recreational off-highway vehicles (ROVs), have become increasingly popular for performing work-related tasks and for recreation in rural areas. No studies have examined the safety issues and experiences of agricultural workers and their families while driving SxSs. The study objective was to better understand the epidemiology, safety behaviors, and crash experiences of SxS riders.

Methods: Visitors to the Farm Progress Show, the nation's largest outdoor farm show, were surveyed on their SxS use at the Iowa ATV Safety Task Force tent in Boone, Iowa, in 2014 and in Decatur, Illinois, in 2015. Descriptive and comparative analyses were performed.

Results: 446 surveys were completed. Respondents were 75% male, over half (53%) were ages 30-59 years old, 74% were involved in agricultural work, and 61% were owners/ renters of the farming operation. Over one-third currently owned a SxS in their family. About four-fifths had driven or ridden a SxS in the past with 70% of these individuals having used one for occupational purposes in the past year. Participants whose family owned a SxS were significantly more likely to have driven or ridden one in the past year ($p<0.0001$). A higher proportion of respondents reported more frequent riding (at least once a week) for occupational (60%) versus recreational (42%) use. Occupational SxS uses included transportation (83%), checking fields (77%), hauling loads (71%) and spraying (50%). Nearly all occupational users had driven on roadways (>90%), with 28% and 40% reporting driving at least once a week on paved and unpaved roads, respectively. Forty-six percent stated they never wear a helmet and 29% said they never use the safety belt/ harness when using a SxS for work. During their lifetime, an occupational crash was reported by 17% of occupational SxS users. Of these, 44% occurred in the past year. These values were higher than for recreational crashes, where 11% reported having crashed in their lifetime, and 32% of those having occurred in the past year. Occupational

crashes most commonly involved rollovers (68%), and half of occupational crashes in the past year resulted in victims seeking medical attention.

Discussion: Farmers frequently own and use SxSs for occupational purposes. Transportation is a frequent occupational use, and driving on roadways is exceedingly common. Many SxS users are not wearing the restraint device which is critical to stay within the rollover protective structure if in a crash. Deaths and injuries related to SxSs is an emerging issue in agriculture, and our study indicates interventions to educate farmers and increase safe riding behaviors when using SxSs are critically needed.

A5.3

Title: R2P: Adoption of Readers' Theatre as a Health and Safety Intervention by the Agricultural Community

Authors: [Deborah Reed](#), [Deborah Claunch](#), [Debra McCallum](#), [Will Stallard](#), [Eileen LeGault](#)

Background: Senior farmers accounted for over half of all farming deaths between 1992 and 2004. This project trialed readers' theatre with farm couples ages 45 and over to test theatres' effectiveness in changing work and health behaviors. This community partnership model focused on how to best approach the continued injury challenge. The intervention has proven to be an effective means of changing the work behavior of aging farmers with swift uptake by the agricultural community.

Methods: The theatre involved partnerships between three institutions and local agricultural communities. Community participatory methods guided the study. The research team worked closely with the local communities to develop scripts that were realistic and applicable to farm production in their area. Community farmers performed the scripts and the researcher led a focused discussion between each play. The discussion allowed the audience to reflect on the content and incorporate the information within their own experiences and the social norms of the group. Comparison groups received a mailed packet of educational materials, covering the same topics. Two weeks and again two months' post-intervention, telephone interviews were conducted with each group to assess the extent to which participants had thought, talked, or done something about the safety and health issues addressed. A toolkit was developed to

describe the process involved in hosting/ presenting a farm theatre.

Results: Eight theatre (N=573) and eight comparison (N=320) sites were included in the analysis. The mean and median age of participants was 63. Overall, each group (theatre or comparison) increased their actions on health and safety matters with the theatre group doing more than the comparison group. The percentages of respondents who said they made specific changes are as follows: 2-week: Theatre-57%; Comparison-40% ($p < .001$); 2-month: Theatre-60%; Comparison-52% ($p = .012$). The popularity of the intervention was phenomenal with 96% of the enrollees completing the study. After the intervention the research team remained in contact with the local leaders, providing them the results of the study for their site and engaging them in further refinement of the process. Theatre site leaders requested repeat theatres upon completion of the research project. The toolkit, originally planned as the product of the study, is now being further developed jointly by the research team and the UK College of Agriculture. Trainings for Cooperative Extension Agents in leading theatres have been done in Kentucky and Tennessee with more planned. The PI of the study has been hired by the UK College of Agriculture as the College's agriculture nurse and partnerships extend beyond agriculture to other programs. The theatre format is currently being used for other groups in addition to older farmers. Participants rate the theatre as realistic, helpful, and enjoyable. The format is easily adapted to local issues, and can be delivered using existing infrastructure.

Discussion: Interventions grounded in local ownership have great potential for success and uptake if research personnel remain engaged with the communities. This novel program resulted in surprising and swift health and safety behavior changes. The toolkit guidance empowers local communities to host a theatre to disseminate health and safety information on any topic.

A5.4

Title: There's an App for That: Coupling Smartphone Technology with Behavioral Theory to Increase the Use of Hearing Protection in Agriculture

Authors: [Josie Rudolphi](#), [Diane Rohlman](#), [Shelly Campo](#)

Background: Farming ranks among the top occupations for noise-induced hearing loss (NIHL). NIHL is permanent, irreversible, yet preventable. Farms with fewer than 11 employees are exempt from OSHA inspections, and hearing conservation programs are often not implemented. Hearing Protection Devices (HPDs) (i.e., ear muffs and ear plugs) are effective at preventing exposure to noise; however, few farmers report consistent use. Interventions to increase the use of HPDs have historically targeted experienced, older farmers, and lack a theoretical foundation. We developed and tested an intervention to increase the use of HPDs among young adult swine facility workers that coupled constructs from the Social Cognitive Theory with smartphone technology. The intervention tested the three major constructs from the Social Cognitive Theory among three study groups to determine the effect of each construct on HPD use. The Social Cognitive Theory (SCT) has been used as the foundation of many interventions that have successfully modified health behaviors among young adults. Three major constructs of the SCT are 1) environmental conditions; physical and social factors that serve as barriers or facilitators that permit or discourage a particular behavior, 2) personal cognitive factors; the ability to self-regulate behavior, develop self-regulatory skills, and reflect on experiences and 3) behavioral factors; actions that enhance the adoption of a behavior and include personal intention or goal-setting. We utilized smartphone technology to assist in the development of self-regulatory skills and behavioral factors – two constructs of the SCT. Smartphone apps allow behavioral tracking to be an efficient, interactive process and are an appealing intervention platform among young adults.

Methods: A pilot, randomized controlled trial was implemented with 74 participants recruited from the Midwest. Participants were randomized into three groups based on the three constructs of the Social Cognitive Theory. Group 1 received a mailed box of HPDs. Group 2 received the box of HPDs and were instructed to track their daily use of HPD when in swine buildings for 60 days using a smartphone app. Group 3 received a box of HPDs, were instructed to track their daily use of HPDs when in swine buildings for 60 days with the app, and set a daily goal for HPD use within the app. Reported HPD use was compared between study groups at three time points; baseline (before the 60-day behavioral tracking period), immediate post-intervention (after the 60-day behavioral tracking period) and 3-month follow-

up (3 months after immediate post-intervention).

Results: We observed an increase in reported HPD use among all three groups at immediate post-intervention. The greatest increase in reported hearing protection use was among Group 3 who reported a mean increase of 47.1%. Group 2 increased reported use by 42.3% and group 1 increased use by 32.0%. At 3-month follow-up, Groups 3 and 2 had decreased reported HPD use and group 1 reported a 4.0% increase in HPD use. Even with the reported decreases, all three groups maintained a statistically significant increase in HPD use from baseline. Differences between groups at follow-up were not significant.

Discussion: The interactive, behavioral theory-based intervention increased the reported use of HPD among swine facility workers from baseline to 3-month follow-up. Results among group 1 indicated modifying the environment by supplying HPDs was effective in increasing HPD use among swine facility workers. This suggests improving access to hearing protection alone may be enough to encourage sustained changes in behavior, and more realistic than encouraging the download and consistent use of a smartphone app. Research examining barriers to acquiring HPDs among agricultural population should be conducted and intervention to increase access developed and tested.

Session B1

Title: Implementation Science and Translation Research in Occupational Health and Safety Settings: Part 2 – Methods for Approaching and Evaluating Implementation Studies

Moderator: Jennifer M. Lincoln

Within occupational health and safety research, much work has been done to develop innovations that have the potential to prevent injuries and save worker lives. In order to meaningfully decrease poor health and safety outcomes for workers, it is imperative that such innovations are widely adopted. Unfortunately, recent studies have demonstrated that relatively few occupational safety and health innovations have been fully integrated into practice. Recent research indicates only 17% of fishing research had made it to the implementation phase. Similar results were found in a study conducted by fellow implementation science researchers; however, taking into account the need for formative research in earlier stages and widespread worker adoption, even

fewer examples of published research documenting successful implementation within the agriculture, forestry, and fishing industries were reported. As described, a major gap exists in moving evidence-based innovations into widespread use. Despite this, there are numerous frameworks and theories supporting such efforts that have primarily been applied in clinical settings. This session will provide an overview of these methods in order to enhance participant's understanding of how to progress toward closing the research to practice gap.

Workshop Aims: The overarching goal of this workshop is to provide participants with a general understanding of implementation science frameworks and theories so that they may begin to assess how they can move their own research into widespread practice. Together with the session titled "Understanding Implementation Science and Translation Research in Occupational Health and Safety Settings: Part 1 – Introduction and Process Models," participants will gain a better understanding of the implementation science field, including the need for implementation science research, challenges related to implementation efforts and examples from the field. Upon completing this workshop, participants will be able to: 1. Give examples of implementation science methods used across various occupational safety and health settings; 2. discuss key factors that impact implementation science efforts in occupational safety and health settings; and 3. discuss frameworks and theories used for evaluating implementation science efforts.

Overview: This workshop will focus on methods used for implementing innovations among target populations and evaluating efforts. Implementation will be examined first based on standard development and regulation. As not all issues can be solved through regulation, the conversation will then focus on how to encourage end users to adopt safer work practices through social marketing. Presenters will also discuss the development and use of partnerships to enhance implementation activities. Finally, an overview of implementation frameworks and models for evaluating progress will be discussed. Raising Awareness and Removing Barriers to Address Occupational Safety Concerns Between 2010 and 2014, nine workers died while working around open tank hatches at oil and gas wellsites. Exposure to hydrocarbon gases and vapors and oxygen deficiency are believed to be factors. In response to the identification of this hazard by NIOSH and its partners, the American

Petroleum Institute (API) developed and published a new safety standard (API 18.2) promoted safer, alternative methods for crude oil measurement. API 18.2 was adopted by the Department of the Interior's Bureau of Land Management (BLM) to allow companies to protect workers while maintaining compliance with BLM regulations. Measurement methods that do not require a worker to open a tank hatch will improve safety and health at wellsites. This session of the workshop will explore how standards were changed to provide a safer method for oil and gas workers to perform necessary tasks without the hazards associated with exposure to hydrocarbon gas and vapor exposures. The presenter will discuss the process which included: using NIOSH data to identify the problem; developing and disseminating communication products to make workers and employers aware of the hazard; and ultimately the change to an industry standard and adoption of that new standard by the Bureau of Land Management. When Regulation Doesn't Work: Social Marketing to Increase Worker Adoption Marketing strategies are often used by large corporations to encourage populations to participate in a number of activities. Using similar methods, social marketing aims to encourage behavior changes that will benefit the wellbeing of populations. Using the example of overexertion injuries from the construction sector, the presenter will discuss the basics of social marketing, and how these campaigns are developed and implemented to correct occupational safety and health issues. Formative research is a key component of developing successful social marketing interventions. Thus, the stages of formative research, including both data collection and analysis to identify current practices, barriers to behavior change, and strategies for overcoming barriers will be discussed. In addition, the presenter will discuss how the results of formative research can be used to develop the complete social marketing package. Finally, considerations for developing and implementing social marketing interventions will be discussed. Mobilizing Stakeholders to Facilitate Research to Practice Whether focusing on standard development or behavior change, researchers, alone, often lack the wide variety of knowledge and resources necessary to take innovations across the full spectrum of identifying research priorities, developing and testing innovations, widely implementing those innovations, and improving health and safety outcomes. As such, partnerships are often necessary components of implementing effective innovations. This portion of the workshop will focus

on understanding the process and benefits of developing and maintaining collaborative relationships. Using examples from the agriculture, forestry, and fishing settings, the presenter will discuss when, how, and why partnerships form. In addition, the presenter will discuss challenges related to starting or maintaining these relationships, and the benefits to each involved organization or individual. Methods for Evaluating Implementation Efforts Before diving into implementation studies, it is important to understand the frameworks and theories available for guiding and evaluating the implementation process. The Consolidated Framework for Implementation Research and the Theoretical Domains Framework will be explored. These two frameworks have been comprehensively developed and evaluated with other implementation frameworks in mind. Though both have primarily been used in clinical settings, they show promise for application in occupational safety and health research. Methods for adapting the frameworks to the specific issue will also be addressed. Finally, this session will help participants understand how to choose and adapt a framework or theory for their own implementation studies.

Moderator: [Jennifer M. Lincoln, PhD](#) is an injury epidemiologist at NIOSH, where she serves as both the director of the Center for Maritime Safety and Health Studies and Associate Director for Science for the NIOSH Western States Division.

Presenters: [David Caruso](#) is a senior health communication specialist and the coordinator for the NIOSH Oil and Gas Safety and Health Program. [Eileen Betit](#) is the Research to Practice Director at CPWR-The Center for Construction Research and Training. [Theodore Teske](#) is a health communication specialist for the NIOSH Western States Division. [Pam Tinc](#) is a Junior Research Investigator at the Northeast Center for Occupational Health and Safety: Agriculture, Forestry, Fishing and a PhD candidate at Umeå University.

Session B2

Title: Collaborating with Industry Partners to Understand Work-Related Motor Vehicle Crashes

Moderator: Stephanie Pratt

The four papers in this session will demonstrate the value of collaborating with organizations and individual companies to better understand: worker attitudes and driving behaviors, demographic and employment fac-

tors associated with collisions and injuries, and the relationship between safety program elements and road safety performance. The research included in this session used a range of methods: surveying workers directly; confirming validity of a driving-behavior instrument for use in a new worker population; using linked data on drivers, vehicles, and events to examine collisions and injuries and calculate exposure-based rates; and combining data on road safety performance and a survey of program elements from almost 70 companies to determine which program elements are associated with the lowest collision rates.

B2.1

Title: Characteristics of Driving While Tired Among Taxi Drivers in Two Large Metropolitan Areas: Job Demands Consistently Matter

Authors: [Cammie Chaumont Menéndez](#), [Christina Socias-Morales](#), [Srinivas Konda](#), [Marilyn Ridenour](#)

Background: Fatigue is increasingly recognized as a crucial and realistically modifiable component of road safety. Workers who drive for a living and transport passengers on-demand in heavily trafficked road networks are a particularly high risk workforce where fatigue is both a health outcome resulting from typical job duties and a risk factor for work-related injuries and fatalities. Fatigue is estimated to be a causal factor in at least 1 in 5 fatal U.S. crashes. Naturalistic studies evaluate sleep patterns and driving times in great detail but generally do not survey drivers for work environment or individual factors which may play a role in fatigued driving. We analyzed individual factors, work environment, and business-related aspects of driving a taxi to assess associations of these variables with driving while tired among taxi drivers in two large metropolitan areas.

Methods: Licensed taxi drivers in Houston and Los Angeles were invited to participate in a 30-minute survey designed to measure business-related aspects to driving a taxi such as scheduling and driving times, job demands and company safety climate, passenger violence, motor vehicle crashes, installed safety equipment, safety training, safe driving habits and individual factors. The Occupational Driver Behavior Questionnaire provided the driving while tired subscale where drivers supplied Likert responses to frequency of (1) driving while tired, (2) having difficulty driving because of tiredness or fatigue, and (3) nodding off while driving.

Driving while tired was modeled on individual factors, work environment, and business-related aspects of driving. Multivariable logistic regression analyses were performed separately for each city using SAS v9.4. The NIOSH IRB approved the study protocol.

Results: 496 Houston drivers and 500 Los Angeles drivers completed the survey. The proportional odds assumption was violated for the categorical distribution of the driving while tired subscale. It was dichotomized to an averaged Likert response of > 1 compared to 1 to indicate any frequency of driving while tired versus not driving while tired. In Los Angeles, 68% of drivers reported driving while tired, in comparison Houston was 54%. In Houston, higher educational attainment ($p=0.0002$), longer workweeks (in hours) ($p<0.0001$), and greater number of miles driven weekly ($p=0.001$) were associated with lower frequency of driving while tired. Experiencing passenger violence ($p=0.036$), decreased company safety climate ($p=0.005$), higher job demand scores ($p=0.0315$), longer daytime driving hours ($p=0.0075$) and greater number of years driving for current company ($p=0.0041$) were associated with greater frequency of driving while tired. In Los Angeles, greater number of miles driven weekly ($p=0.0087$) and ranking safety training as useful for minimizing motor vehicle collisions ($p=0.0007$) was associated with lower frequency of driving while tired while increased job demands ($p<0.0001$) was associated with greater frequency of driving while tired.

Discussion: A majority of drivers reported at least some frequency of driving while tired, with the proportion greater in Los Angeles. Individual, work environment, and business-related aspects of driving a taxi in Houston were associated with driving while tired. In both cities, increased job demands were significantly associated with reporting driving while. Increased job demands associated with driving while tired presents an impetus to industry regulators and company owners to provide road safety training that addresses fatigue mitigation strategies, especially at a time of increased perceived job demands with more drivers from Uber and Lyft sharing the market. Taxi and for-hire vehicle regulation varies by city. It is important that fatigue-related research in less regulated transportation workers include individual factors, work environment and business-related aspects of driving to better understand factors associated with driving outcomes or intervention effectiveness.

B2.2

Title: Validating the Occupational Driver Behavior Questionnaire to Assess Self-Reported Road Safety Habits Among Taxicab Drivers in the U.S.

Authors: Richard Munoz, [Cammie Chaumont Menéndez](#), Timothy Walker, Benjamin Amick III

Background: Naturalistic driving studies, especially those supplemented with actigraphs and in-vehicle monitoring systems, provide objective measures of road safety behaviors such as distracted driving, drowsy driving, and obeying traffic laws. However, road safety management programs that can employ these measures to promote safe driving in the occupational setting are the exception to the norm, with the majority of such programs available through large companies or well-funded government entities. There is a need for practical survey instruments that can validly measure road safety behaviors for use in monitoring typical workweeks among occupational drivers. Self-reported road safety behaviors for occupational drivers were typically measured using scales designed for the general driving population. In Australia a road safety behavior scale (Newman's Occupational Driver Behavior Questionnaire (OBDQ) was designed for occupational driving and recruited nurses who regularly drove to communities to perform their duties.

Methods: Newman's Occupational Driver Behavior Questionnaire (OBDQ) was administered among taxi drivers in two metropolitan areas in the U.S. They were invited to participate in a field study to assess work environment, individual, and business-related risk factors for passenger violence and motor vehicle crashes. The OBDQ has four subscales: speeding, rule violations, inattention, and driving while tired. In meeting the study objectives a psychometric analysis was completed to assess the validity of the OBDQ in a different industry and country than was originally developed. Confirmatory factor analysis was used to assess the validity of a 4-factor model using the Analysis of Moment Structures (AMOS) supplement to SPSS software. The following indicators were examined to assess model fit: overall Chi square, comparative fit index (CFI), Tucker-Lewis index (TLI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR). Bootstrapping techniques were used to account

for the non-normal distribution of the data.

Results: Survey data from 496 Houston drivers and 500 Los Angeles drivers were pooled for analysis. The 4-factor model demonstrated good model fit ($\chi^2(45) = 223.055, p < .001; CFI = 0.987; TLI = 0.981; RMSEA = 0.064; \text{ and } SRMR = 0.024$). A second order model was also estimated with the ODBQ as a single scale, but this model did not fit the data as well as the 4-factor model.

Discussion: These results replicate the work done in Australia. They support the use of the ODBQ to assess road safety behaviors among taxicab drivers in two large metropolitan areas of the U.S. The scale has reasonable structural validity and should be used in other driving populations to see its utility.

B2.3

Title: Analysis of Motor Vehicle Crash and Claims Data for a Light-Vehicle Corporate Fleet

Authors: [Jennifer Bell](#), [Stephanie Pratt](#)

Background: Motor vehicle crashes (MVCs) are a significant cause of lost-workday injuries, and the leading cause of work-related fatalities in the US for all industries combined. Prevention research has focused mainly on collisions fatal to drivers of large trucks. This study addresses gaps in the literature by: conducting a descriptive analysis of nonfatal motor vehicle events involving light-vehicle drivers in a large healthcare-industry fleet; identifying risk factors for work-related MVCs and injuries based on vehicle miles traveled; and providing details on circumstances of these events.

Methods: Data sources were auto claims for Jan 2010–Jun 2014 for a healthcare company's light-vehicle sales and service fleet, merged with driver demographic characteristics, vehicle type, and miles driven data. The claims data included events resulting in vehicle or property damage, a vehicle-related workers' compensation claim, or injury. Over the 4.5 year study period, 8,068 motor vehicle events were reported by 6,680 U.S.-based drivers. The outcome measures of interest were injuries and collisions (an event on or off a public road where the company vehicle came in contact with another motor vehicle in transport, pedestrian, animal, or a fixed or non-fixed object). Collisions were classified as recoverable or non-recoverable (that is, the company's ability to recover costs from another party). Driver-month was the unit of analysis. Mileage-based collision and injury rates were calculated by gender, age, and tenure. Dif-

ferences in rates within categories of these variables were assessed with Poisson regression techniques, adjusted using generalized estimating equations (GEE) for repeated observations on the same employee over time. $P < .05$ was chosen for statistical significance. Gender (male vs female), age (<25 years, 25–54.9 years, 55+ years), and tenure (<2 years, 2+ years) were examined together as collision risk factors in a multivariate Poisson regression model.

Results: The data set contained 2,660 collisions. For 57%, costs were non-recoverable. The total collision rate was 5.04 per million miles (CPMM). In univariate tests, age, gender, and tenure were all significantly related to CPMMs. When these variables were entered in a multivariate model, rates were significantly higher for females than for males (6.3 vs 4.1 CPMM, $p < .001$) and for drivers employed less than 2 years compared to drivers employed for 2 or more years (6.2 vs 4.8 CPMM, $p < .0001$). Rates for drivers ages 25 through 54 were significantly lower than rates for drivers less than age 25 (4.9 vs 9.5 CPMM, $p = .018$), but rates for drivers age 55 or older were not significantly different from rates for drivers less than age 25 (5.7 vs 9.5 CPMM, $p = 0.178$). Although statistical tests were not performed by recoverability status, patterns in demographic risk factors were similar for recoverable and non-recoverable collisions. Among collision types with 10 or more injuries, collisions where the front of one vehicle hit another vehicle at an angle were the most likely to injure the employee driver or another party (41.9%). Of all collision types, rear-end collisions led to the greatest number of injuries ($n = 294$), but were less likely to result in injury than were angle collisions (31.6%).

Discussion: The findings suggest that employers should address collision prevention for less-tenured employees, for both non-recoverable collisions where the employee driver's actions contributed, and recoverable collisions due to other drivers' actions. To prevent angle and rear-end collisions, which were the most likely to result in injury, employers could consider offering training to help drivers recognize precursors to these crash scenarios and apply preventive strategies, and also consider selecting vehicles with safety features such as forward collision warning with automatic emergency braking and lane-departure warning to help further prevent rear-end and angle crash occurrence.

B2.4

Title: Using Benchmarking Data to Identify Relationships Between Management Practices and Road Safety Performance

Authors: [Stephanie Pratt](#), [Jonathon Vivoda](#), [Susan Gillies](#)

Background: Motor vehicle crashes (MVCs) are consistently the leading cause of work-related fatalities in the U.S. for all industries combined. Nonfatal MVCs at work also have substantial injury and economic consequences for workers and employers. Most of the literature focuses on fatal crashes, large trucks, and/or specific industries or companies. No studies in the peer-reviewed literature have assessed the relationships between road safety program elements and outcomes across multiple companies. This study addresses these gaps by reporting benchmarking results for companies from diverse industries that operate all types of vehicles, calculating mileage-based collision rates, and linking program elements to safety outcomes.

Methods: Data were obtained from the annual benchmark program of the Network of Employers for Traffic Safety (NETS) through which member companies compare their road safety performance against other companies and learn which program elements distinguish the best-performing companies. The analysis included 2016 data for 70 U.S. fleets, covering 333,000 vehicles and over 5.4 billion miles driven. The primary outcome of interest was collisions per million miles (CPMM), excluding 2- and 3-wheeled vehicles. NETS defines a collision as a vehicle-related event on or off a public road that leads to death or injury to any person and/or material property damage. It may involve contact between vehicles in motion, or contact with a pedestrian, cyclist, or stationary object. The NETS definition also includes non-collision events such as rollovers. Collision data were supplemented with results from a questionnaire about members' road safety programs and practices. Depending on the variable type, relationships between CPMM and individual or composite variables were assessed using t-tests, ANOVA, or correlation analysis, with alpha set at .05. Multivariable regression used an iterative process: entering all the significant variables from the bivariate analyses as predictors; removing variables that were multicollinear or some linear combination of another; removing items asked only of a subset of companies; and removing the variables with the highest p-values to arrive at a final model.

Results: The mean CPMM for all fleets was 4.94.

Significant bivariate relationships were seen between CPMM and 21 practices related to training, collision review, fatigue management, use of in-vehicle monitoring, reporting of results on a road safety scorecard, mobile phone policies, and vehicle selection. For seven practices, differences were not in the expected direction, that is, having the practice in place was associated with higher CPMM. In the multivariable analysis, the final model yielded four variables with independent significant relationships to CPMM. Online or DVD training as a response to identifying a driver as high-risk was associated with higher CPMM ($p=.0043$). Other practices were independently associated with lower CPMMs: having a larger number of fatigue management practices for light-vehicle drivers ($p=.0321$); publishing an internal road safety scorecard ($p=.0413$); and checking mobile phone records after all collisions (compared to not checking records, $p<.001$; serious collisions only, $p=.0015$).

Discussion: Overall, the results suggest that the use of fleet management practices related to fatigue management, mobile phones, training, collision review, in-vehicle monitoring, and a road safety scorecard are related to lower CPMMs. A small number of practices were related to higher CPMMs; additional analysis will be needed to clarify these counterintuitive results. For fatigue management and mobile phone policies, more intense implementation was associated with lower CPMMs. The results of this study will help fleet safety professionals select and emphasize the management practices that are most likely to improve CPMMs, thereby reducing injuries and costs.

Session B3

Title: Falls in Construction

Moderator: [Clint Wolfley](#)

B3.1

Title: Contributing Factors to Ladder Fall Severity for Perturbations During Ascent and Descent

Authors: [Erika Pliner](#), [Na Jin Seo](#), [Kurt Beschorner](#)

Background: Ladder falls accounted for 18,532 (32.5%) of non-fatal and 128 (21.5%) of fatal falls to lower levels among workers in 2013. This is surprising given only a fraction of workers use a ladder for work and for only a

fraction of the work day. There is a prominent need to improve ladder safety. We hypothesized that a person's ability to avoid a fall after experiencing a ladder climbing perturbation is dependent on their response (using both the upper and lower body) and their strength. Thus, this study quantified the contribution of upper body strength, hand placement, and foot placement on fall severity by investigating this relationship by climbing direction.

Methods: Data was collected from 28 participants who completed 30 ladder climbs. Prior to data collection, participants were equipped with athletic wear, work shoes with a raised heel, and a safety harness. A load cell (1kHz) was connected to the safety harness to measure the weight supported by the harness (i.e., fall severity) after a climbing perturbation. Thirteen infrared cameras tracked 47 reflective markers placed on the participant to capture their climbing motion (100 Hz). Participants experienced 6 ladder climbing perturbations (3 ascent, 3 descent) with 3-6 unperturbed climbing trials between perturbations to reduce perturbation anticipation. Perturbations simulated a misstep by releasing the fourth rung from the ladder at a time when a climber's foot is most likely to slip. Participant upper body strength was assessed from a dynamometer that measured grip strength. Harness force and grip strength were normalized to body weight. Three hand placement and two-foot placement responses were observed after a ladder climbing perturbation. The hand either moved two (HP2), one (HP1) or no rungs (HP0) from the starting position. At least one-foot reestablished foot placement or neither foot reestablished foot placement. Hand and foot placements were determined from the velocity and acceleration of the hand and foot, respectively. An ANOVA was run separately for each climbing direction with normalized harness force (square root transform) as the dependent variable. Independent variables assessed were hand placement, foot placement, grip strength and first order interactions. Subject number was included in the models as a random variable. A Tukey's post hoc was performed on any significant effects that contained hand placement.

Results: For ascent, hand placement ($p=0.001$; $F_{2,49}=7.785$), foot placement ($p=0.005$; $F_{1,50}=8.473$) and grip strength ($p<0.001$; $F_{1,50}=17.003$) affected normalized harness force. HP1 after ascending perturbations led to higher harness forces than the other two hand placement responses. For descent, hand placement ($p=0.007$; $F_{2,41}=5.394$) and grip strength ($p=0.020$;

$F_{1,42}=5.901$) affected normalized harness force. HP2 after descending perturbations led to higher harness forces than HP0.

Discussion: Factors that influenced harness force varied by climbing direction. After an ascending perturbation, reaching to a higher rung (HP2), reestablishing at least one foot back onto the ladder rung and individuals with greater grip strength had lower fall severities. After a descending perturbation, maintaining a high hand placement (HP0) and individuals with greater grip strength had lower fall severities. Understanding the factors that influence ladder fall severity by climbing direction can help tailor interventions to optimize recovery with the ladder after a perturbation. Such interventions may be training climbers to grasp higher rungs and reestablish their foot placement after an ascending perturbations and training climbers to lead with their feet during ladder descent to maintain higher hand positions relative to the body.

B3.2

Title: Biomechanical Assessment of Using Production Tables on Mast Climbing Work Platforms

Authors: [Christopher Pan](#), [Xiaopeng Ning](#), [Bryan Wimer](#), [Joyce Zwiener](#), [Tsui-Ying Kau](#), [Mat Hause](#), [Richard Whisler](#), [Darlene Weaver](#), [Mahmood Ronaghi](#)

Background: Mast climbing work platforms (MCWPs) are rapidly replacing existing elevating devices at construction sites throughout the United States. Seventy percent of the 22,000 MCWPs in the U.S. are used on a daily basis by approximately 50,000 construction workers. Since MCWPs are an emerging elevating technology in the United States, systematically analyzed injury trend associated with MCWP is not available. Nevertheless, Census of Fatal Occupational Injuries (CFOI) data showed that there were seventeen mason-worker fatality cases between 1992 and 2009 and seven of them involved a fall from height, including a case of which a masonry worker stepped from the main working platform to the planked working deck two feet below. Another hazard that masonry workers have faced is back injuries associated with various manual material handling tasks. The prevalence rate for back disorders is 45-50% higher than that of other body parts for masonry workers. At present, workers store their

bricks and other materials directly on the MCWP's main platform while they work from the lower planked level next to the relevant workspace. To reduce fall and back disorder exposures and increase worker productivities, MCWP manufacturers have designed a "production table," which is a stand that can be placed on top of a MCWP to hold bricks and other materials, creating a level working deck. To further enhance the safety function of the stand, our NIOSH research team has modified the table to allow bricks and materials to be placed closer to a worker. The objective of this study is to evaluate masonry workers' posture and stability while performing brick laying tasks under three conditions: (1) no production table, (2) use of manufacturer's production table; and (3) use of the NIOSH-refined production table.

Methods: Nine masonry workers participated in the study. They stood on a simulated MCWP and laid bricks on an adjacent wall. Their trunk angles, gait/ step characteristics, and stepping stability while performing brick laying tasks were recorded, using an 8-camera VICON motion analysis system and two Bertec force platforms. Data were analyzed using repeated measures analyses of variance (ANOVA) with a SAS mixed procedure to evaluate the effect of different experimental conditions on trunk angles, gait characteristics, and postural stability.

Results: Study results indicated that the use of manufacturer and NIOSH refined production tables significantly reduced trunk angles of the workers in the sagittal, frontal, and transverse planes (F-values are 73.16, 55.37, and 14.79 respectively; p-values are all less than 0.01). In addition, the use of production tables significantly reduced vertical reaction forces, and anterior-posterior and medial-lateral sway forces, when workers step from the main platform to a plank (2-ft below).

Discussion: The use of a production table on MCWPs improved workers' postures and overall stability by reducing their trunk bending and twisting angles as well as various postural sway forces induced by workers. These findings indicate that use of production tables is a viable intervention to reduce fall- and back-injury-related incidents for MCWPs.

B3.3

Title: Strength of Temporary Wooden Guardrails Installed on Balconies and Prefabricated Walls Used in the Construction Industry

Authors: [Bertrand Galy](#), [Andre Lan](#)

Background: Among the many occupational risks construction workers are exposed to, falls from height is the most dangerous. In order to prevent falls from height, the best solution is to avoid working at height whenever possible. If this is not possible, then collective fall protection equipment such as guardrails should be used. As a last resource, personal protective equipment must be used if no other method is suitable to protect the workers. For residential construction, job-built wooden guardrails are quite common. Most of the time, the problem encountered is not the strength of the 2x4 posts or rails themselves, but rather the strength of the attachment of the vertical posts to the structure being built. The objective of this paper is to investigate the strength of temporary wooden guardrails made of common 2x4 and assembled either to open joists (commonly used for small balconies) or prefabricated walls.

Methods: Typical structures, to which temporary wooden guardrails are attached, have been reconstituted in our laboratory. The temporary wooden guardrails studied comply with Quebec's safety code for the construction industry requirements, which are: rails of not less than 40-mm thick by 90-mm wide (2x4 nominal), supported on posts of the same dimension spaced at intervals of not more than 1.8 m (6 ft), top rails stand at 1–1.2 m (3.3–4 ft) above the surface on which the worker is working. Quebec's strength requirements are quite similar to those of OSHA which are: "A guardrail shall be designed to: (a) resist a concentrated horizontal force of 900 N applied to any point of the top plate; and (b) resist a concentrated vertical force of 450 N applied to any point of the top plate". Strength tests are performed for temporary wooden guardrails attached to open joists ranging from 9 ½" to 16" in height, and to a 2x4 prefabricated wall, using different types of fastening hardware, such as: • 3 ½" twisted nails (16D penny, 8 gauge); • 3 ¼" straight nails, nailed with a pneumatic nail gun (12D penny, 9 gauge); • 3 ¼" ring shank nails, nailed with a pneumatic nail gun (12D penny, 9 gauge); • 3" #10 wooden screws (3/16" diameter); • 3" lag screws (3/8" diameter). The strength tests are performed on single span and three spans systems (both on

the central span and on the edge span). Besides the type of fastening hardware used, the influence of the position and number of nails/ screws are also taken into consideration. The vertical force of 450 N is constant and applied at mid-span by means of a dead weight connected to the top rail using a webbing lanyard. The horizontal force is applied by a hand winch with a webbing strap and recorded in real time (10Hz) using a load cell. The strength tests are conducted until failure of the guardrail system or until the horizontal force reaches 1350N (150% of minimum strength), whichever occurs first. In the case where the strength is significantly higher than 900N for the horizontal force on a single span, the tests on the three spans system are not carried out. Each test is repeated three times to account for wood properties variation.

Results: The laboratory testing is currently ongoing. Preliminary results indicate that for smaller open joists, nailing may not be sufficient to achieve the required strength. More results will be available soon and will help safety professionals to:

- identify safe fastening configuration depending on the open joist height available to assemble the wooden posts;
- identify safe fastening configuration for prefabricated walls made of 2x4 or higher;
- identify unsafe guardrail configurations.

Discussion: Even though the study is on-going, the method, based on the strength and performance requirements of the Quebec Safety Code for the construction industry to verify job built guardrails, is reproducible and can be applied to any international regulations to test the strength of guardrails.

B3.4

Title: Evaluation of the Implementation and Effectiveness of the Ontario Working at Heights Training Standard

Authors: [Lynda Robson](#), [Cameron Mustard](#), [Peter Smith](#), [Benjamin Amick III](#)

Background: The Province of Ontario, Canada introduced regulatory changes in 2015 which affect construction workers who use fall protection equipment. They are now required to undergo a specified one-day Working at Heights training given by an accredited training provider. The Institute for Work & Health is evaluating the implementation and effectiveness of these regulatory changes.

Methods: The evaluation design uses mixed methods

and incorporates the perspectives of multiple stakeholders. It includes interviews with labour inspectors; cross-sectional surveys of employers, trade workers, and training providers; a longitudinal survey of learners; and analysis of administrative data, including training activity and workers' compensation injury claims.

Results: Results from the inspector interviews, employer survey and learner surveys are available in February 2018. Results from the inspector interviews and the employer survey show that awareness of the regulatory changes is widespread (93% of surveyed employers were "definitely aware" of the changes). Of surveyed employers affected by the regulatory change (i.e. employers with workers working on construction projects and using fall protection equipment), 93% were found to be compliant with the new training requirement. The surveys of employers and employees document statistically significant positive changes at the worksite. For example, 40% of employers reported purchasing new fall protection equipment as a result of the training. Employee practices showed statistically significant improvement from before to after the training. Curiously, the markedly dominant opinion among labour inspectors was that there was no impact at the worksite.

Discussion: The interim findings show that the authorities achieved a widespread reach with their regulatory intervention, and impacts at the worksite. Final results of the evaluation will be available in November 2018.

Session B4

Title: Fatality Incident Investigations

Moderator: [Michael Fiore](#)

B4.1

Title: Officer Struck by a Motorhome While Establishing Temporary Traffic Control on Interstate, A NIOSH Case Study

Author: [Melanie Moore](#)

Background: In 2014, the Bureau of Labor Statistics reported the fatality rate for the more than 900,000 U.S. law enforcement officers (LEO) is nearly four times more than the average worker. In 2015, 123 LEOs died as a result of a traumatic injury on the job; 36% of those line of duty deaths (LODD) were motor vehicle-related incidents. Although LEO's motor vehicle-related fatality rates are significant, information pertaining to these incidents is not routinely used for prevention purposes.

Methods: The National Institute for Occupational Safety and Health's (NIOSH) Law Enforcement Officer (LEO) Motor Vehicle Crash and Struck-by Fatality Investigations Pilot Program investigates LEO line-of-duty deaths due to motor vehicle events. Following the public health model, the NIOSH Fatality Investigations Team cooperates with the fallen officer's department and other agencies at the municipal, state, and federal level to investigate motor-vehicle LODDs. Information is collected on the incident circumstances using a standardized procedure, including interviews with witnesses and department officials as well as review of medical examiner, police, and crash reconstruction reports. Agent, victim, and environmental information is evaluated to identify contributing factors and develop prevention recommendations. A report describing the event, contributing factors, and 'lessons learned' is published on the NIOSH Law Enforcement Officer Motor Vehicle Safety web page for access by police departments and agencies, officer organizations, manufacturers, and safety and health researchers.

Results: In 2014, a police officer died when he was struck by a motorhome and drug under the trailer it was pulling on an interstate highway. The officer had responded to a jackknifed and overturned pickup/trailer combination that was blocking an entrance ramp to the interstate. To assist with traffic control, the officer positioned his patrol unit south of the entrance ramp in lane three, and a Tennessee Department of Transportation help truck operator positioned his vehicle next to the patrol unit to block the shoulder and lane four. The officer and help truck operator were standing between their vehicles in lane three, when a motorhome pulling a trailer approached the scene. The driver of the motorhome believed the traffic speed and volume in lanes one and two prevented him from moving to the left; as a result, he attempted to drive between the police car and the help truck. The help truck operator saw the oncoming motorhome, yelled to the officer, and ran out of the way; the officer was unable to do so. The motorhome and trailer sideswiped the help truck and struck the officer dragging him underneath the trailer for 116 feet before the motor home came to a stop. He died at the scene. Contributing factors identified included motorhome driver did not slow down and merge left, positioning of patrol unit, law enforcement officer standing in partially open lane, law enforcement officer looking away from oncoming traffic; discussing traffic

control with help truck operator and a delay in updating an upstream dynamic message sign.

Discussion: This investigation identified several prevention recommendations for this situation: 1) public awareness campaigns to inform motorists of the risks that law enforcement officers face while operating along the roadside and of the need to follow "Move Over" laws, 2) Law enforcement officers and emergency responders should move to a safe area within an established temporary traffic control zone and should maintain situational awareness, 3) developing a standard operating procedure that includes guidance on how to properly establish a temporary traffic control plan, including advance warning and transition areas for highway/ roadway emergency incidents, and 4) positioning patrol units and other emergency vehicles as they arrive on-scene to maximize the protected work zone for the emergency responders.

B4.2

Title: NIOSH Fire Fighter Fatality Investigation Leads to Improved Self-Contained Breathing Apparatus and Understanding of Breathing Air Events

Authors: Paul Moore, Stephen Miles

Background: In 2010, a fire fighter died while searching for an elderly occupant and pet in a large residential structure. The fire fighter along with his captain had entered the structure with an un-charged 1 ¾ inch hose line. After successfully locating and extricating the dog, they continued searching for the occupant. Shortly thereafter, the fire fighter became separated from the captain and yelled for help. The captain radioed a Mayday to command. Two rapid intervention teams (RIT) were sent into the structure to search for the fire fighter. He was found 11 minutes after the Mayday. His gloves, helmet and self-contained breathing apparatus (SCBA) face piece had been removed. The fire fighter's death was due to exposure to gases of combustion although 3000 psi of breathing air remained in the SCBA cylinder.

Methods: The incident was investigated by the NIOSH Fire Fighter Fatality Investigation and Prevention Program. Upon investigation NIOSH learned that the SCBA involved in the incident was equipped with a pneumatic data logger, a technology not widely used at the time that recorded breathing air pressure and the fire fighter's breathing rate along with time stamps. Matching this

data with radio logs and witness interviews along with medical findings NIOSH investigators established a likely sequence of events that contributed to the death. Review of the fire fighter's training and the SCBA user manual further supported the scenario. SCBA manufacturers and fire service subject matter experts were consulted to identify procedures that could be used to prevent similar events. In addition to disseminating the results through publication of an investigation report, NIOSH brought the information to the attention of the National Fire Protection Association (NFPA).

Results: NIOSH determined that the fire fighter had experienced an SCBA emergency, a clogged nose cup, a not uncommon occurrence. NIOSH also learned that the nose cup can be cleared without removing the face piece using the purge button. However, this procedure had not been formalized in fire service training material or SCBA user manuals. The investigation also illustrated the benefit of recorded SCBA pneumatic operating parameters in helping investigators understand the circumstances of SCBA emergency events.

Discussion: NIOSH recommended that the fire service develop protocols addressing corrective actions fire fighters can use to overcome SCBA emergencies when face pieces are rendered inoperable. The NFPA Respiratory Protection Committee formed a task group chaired by a NIOSH investigator to develop minimum pneumatic data logging requirements for SCBA. These new minimum requirements will become mandatory for all fire service SCBA in the 2018 edition of NFPA 1981 Standard on Open-Circuit Self-Contained Breathing Apparatus.

B4.3

Title: A FACE Investigation of a Wall Collapse in Construction

Author: [Jennifer E. Lincoln](#)

Background: Between 2011 and 2015 the BLS reported there were 701 fatalities in construction due to worker contact with objects or equipment, 60% (420) were struck by objects or equipment. CPWR found that of those 420 fatalities due to struck by objects or equipment, more than half (51% or 216) of fatalities were caused by falling objects or falling equipment. In April 2013, a 24-year-old Hispanic laborer and a 37-year-old Hispanic pipefitter were crushed by a falling block wall when it failed; they died immediately of their injuries.

A 46-year-old utility foreman was also injured in the incident. The laborer had been caulking the expansion joints of the wall, and the pipefitter and the utility foreman were installing piping for the building's sprinkler system in a trench next to the block wall. A wind gust caused the wall to fall onto the laborer, pipefitter, and utility foreman. On September 9, 2014, a NIOSH health scientist investigated the fatality and reviewed incident circumstances with the investigating Tennessee Occupational Safety and Health Administration compliance officer.

Methods: Investigations conducted through the Fatality Assessment and Control Evaluation (FACE) Program identify factors that contribute to these fatalities. Investigators travel to the location where a death occurred, examine the worksite, and collect facts about what happened before, during, and after the incident from OSHA compliance officers, company officials, witnesses, and workers. The following investigation details a struck by falling object event and provides prevention recommendations for employers.

Results: The FACE investigation identified the following unrecognized hazards as key contributing factors in this incident; deviation from engineering drawings; inadequate inspection of rebar placement; inadequate bracing for the block wall; wall height extending too far above the bracing; worker proximity to unbraced block wall; lack of competent person to monitor wind speed; and inadequate training related to masonry wall safety.

Discussion: NIOSH concluded that, to help prevent similar occurrences, employers should: ensure that employees follow the engineering/ architectural drawings during building construction and obtain engineering approval before plan changes are made; develop and follow a masonry wall bracing plan, train employees on proper masonry wall bracing, and ensure masonry walls are properly braced throughout the project; develop and implement a restricted/ limited access zone; train workers on the hazards of working around unsupported masonry walls; assign a competent person trained to monitor wind speeds; and schedule work tasks to limit exposure of nonessential workers to hazards posed by masonry walls under construction.

B4.4

Title: Exposure, Crashes, and Deaths Related to the Use of All-Terrain Vehicles for Spraying

Authors: [Charles Jennissen](#), [Kristine Schaefer](#), [Gerene Denning](#), [Sean Hendren](#), [Stephanie Leonard](#)

Background: Off-road vehicles such as all-terrain vehicles (ATVs) have become valuable assets in many work settings, but especially on farms and ranches. ATVs are associated with a significant and growing percentage of U.S. agricultural work-related deaths and injuries. Some of the dangers associated with ATV use may not be easily recognized by agricultural workers and families. The objectives of this study was to investigate the experiences of private pesticide applicators in using ATVs for spraying, and determine the mechanisms of injury and contributing factors associated with occupational deaths while spraying with ATVs.

Methods: All participants of the 2015-2016 Private Pesticide Applicator Continuing Instruction Course performed by Iowa State Extension and Outreach were questioned about their use of ATVs for spraying and their crash experiences on the evaluation form for the course. Courses were given in each county in Iowa from December 1, 2015, through April 15, 2016. In addition, the Iowa Fatality Assessment & Control Evaluation (FACE) program database was utilized to identify occupational ATV sprayer-related deaths from 1996-2014. Descriptive analyses were performed.

Results: A total of 6,344 private pesticide applicators completed the course and evaluation form. Nearly two-thirds (65%) reported having used an ATV for spraying herbicides. Of these, 8% had been in a crash while spraying with an ATV. All of the occupational ATV-related deaths in the FACE database from 1996-2014 (N=29) were in agriculture. Over two-fifths of the fatalities involved a sprayer, with ten occurring while spraying with an ATV. Of these 10 deaths, eight were male and one-half were 70 years of age and older. All of the crashes occurred during the day (one was at dusk), but many of the victims were found hours after the event. All fatalities involved a rollover with the individual being pinned under the ATV resulting in compression asphyxia. Eight of the crashes involved sloped terrain or a ditch, and in the other two the slope of the terrain was not known/recorded. None of the crashes were witnessed or known to involve alcohol. Additional sprayer-related rollover

deaths occurred when a 55 year old farmer was pulling a sprayer with an ATV on a public road, and when a 78 year old farmer was driving uphill with a sprayer tank on the rear rack of his ATV.

Discussion: Most private pesticide applicators in Iowa use ATVs for spraying and 8% of those that do reported having been in a crash. Spraying with ATVs appears to be major risk factor for ATV-related occupational death. Older applicators may be at greater risk, and spraying on sloped terrain is a major contributing factor. Tanks mounted on the rear rack and the shifting of tank fluid likely cause changes in the center of mass which are conducive to ATV rollover. Agricultural workers who utilize ATVs for spraying should be targeted for safety education. Courses required for pesticide application may be an important venue to impart this instruction.

Session B5

Title: Topics in Surveillance

Moderator: [Kyla Retzer](#)

B5.1

Title: Advancing Worker Safety in Alaska Through the Prevention of Nonfatal Injuries

Authors: [Devin Lucas](#), [Samantha Case](#), [Jennifer Lee](#), [Kyle Moller](#), [Mary O'Connor](#), [Laura Syron](#), [Joanna Watson](#)

Background: During the 1980s, Alaska was the deadliest place for workers in the US, with a fatality rate of 35 deaths per 100,000 workers, seven times higher than the rate for all US workers (5 per 100,000). In 1991, the National Institute for Occupational Safety and Health created a field station in Anchorage and dispatched a small group of scientists to study workplace hazards in the state and to promote solutions. By using a collaborative Research to Practice approach, major improvements in worker safety were realized during the 1990s and early 2000s. During 1990-2016, fatalities at work in Alaska declined 65%, and the fatality rate in 2016 was 10.6 deaths per 100,000 workers, compared to 3.6 for all US workers. While the gains in workplace safety in Alaska are remarkable, major hazards remain. The intense focus by NIOSH on studying and preventing deaths in Alaska was necessary, but did not address the substantial need for research on nonfatal injuries. A

new initiative has been launched by the NIOSH Western States Division to advance worker safety in Alaska by concentrating on the study and prevention of nonfatal injuries.

Methods: In 2016, NIOSH scientists at the Western States Division collaborated with the NIOSH Center for Workers' Compensation Studies to form a partnership with the State of Alaska Division of Workers' Compensation to gain access to claims data for the purpose of epidemiologic studies of nonfatal injuries. Claims data for 2015 were transmitted to NIOSH in 2017. Preparing the data for analysis required labor-intensive manual cleaning and additional coding, including coding of claims with the Occupational Injury and Illness Classification System (OIICS), Abbreviated Injury Severity (AIS), and Functional Capacity Index (FCI). The NIOSH Industry and Occupation Computerized Coding System (NIOCCS) was used to code industry and occupation of claims.

Results: Preliminary analysis of the workers' compensation claims data revealed that in 2015, there were 18,521 accepted claims for nonfatal injuries, a rate of 44 per 1,000 workers. Workers were mostly male (61%) and an average age of 40 years (14 – 95 years). The industry sectors with the highest numbers of injuries were public administration (2,682 injuries) and healthcare (2,643). Elevated risk of injury was observed in several sub-sectors, including grocery wholesalers (206 per 1,000 workers), management, scientific, technical consulting (124 per 1,000 workers), and electric power utilities (108 per 1,000 workers). The most frequent causes of injuries were overexertion involving outside sources (2,831; 16%), struck by object or equipment (2,602; 15%), and falls on same level (2,126; 12%). The most frequent injuries were sprains, strains, tears (6,638; 36%), contusions (2,461; 13%), and lacerations (2,175; 12%).

Discussion: Although workers' compensation data require a great deal of manual effort to prepare for epidemiologic analysis, there is abundant potential for detailed analyses that can identify hazards in specific industries and occupations. Forthcoming studies using Alaska workers' compensation claims data will pinpoint safety problems, promote partnerships with industry, and drive the development and testing of injury prevention interventions. In addition, future claims data can be used for evaluation studies to assess the impact of interventions. This new concentration on nonfatal

injuries using the successful Research to Practice model will be a positive force for advancing worker safety in Alaska.

B5.2

Title: Quantifying the Workplace Safety of Contingent/Alternative Workers in the United States

Authors: [Matthew Gunter](#), [Stephen Pegula](#)

Background: The trend of employing workers only when there is an immediate and direct demand for their services has changed the nature of work for many Americans. These contingent/ alternative workers face short-term jobs where payment is often tied to performing a specific task, have no guarantee of future work beyond their current job, and have no assurances that work will be available when it's desired. While the Bureau of Labor Statistics (BLS) has collected data on contingent/ alternative workers previously, no data on the workplace safety experience of these workers has been available from BLS until now.

Methods: The Census of Fatal Occupational Injuries (CFOI) has conducted a complete annual count of workplace fatal injuries in the U.S. since 1992. With its 2016 data, CFOI pilot-tested procedures to identify fatal injuries to contingent/ alternative workers. CFOI included Independent contractors, on-call workers, day laborers, and workers contracted out through a temporary help agency as contingent/ alternative workers in this pilot.

Results: CFOI identified 662 fatal injuries to contingent/ alternative workers in 2016 – 13 percent of all fatal work injuries. Independent contractors accounted for 87 percent of fatal injuries to contingent/ alternative workers in 2016.

Discussion: While there are important limitations associated with identifying contingent/ alternative workers, this is the first attempt at quantifying fatal occupational injuries to these workers using CFOI data. CFOI will continue to solicit feedback and refine its procedures for identifying these workers as needed.

B5.3

Title: **Creating Safer Workplaces: Learning from Work-Related Fatal Injury in New Zealand**

Authors: **Rebecca Lilley, Bronwen McNoe, Gabrielle Davie, Simon Horsburgh, David McBride, Tim Driscoll**

Background: As in many countries around the world workplace fatal injuries are an important and under-researched Public Health problem in New Zealand (NZ). NZ's workplace fatality record has been shown to be very poor compared to similar countries, with a rate twice that of Australia, four times that of the UK and 17% higher than the US. The reasons for NZ's substandard performance are highly debated, and in-depth analysis to inform this debate is limited by a dearth of detailed fatality data. Addressing NZ's poor workplace fatality record has become a high priority for the NZ Government following a high-profile catastrophic mine explosion in 2010 that killed 29 workers and three subsequent high level workplace safety performance reviews. Occupational safety legislation reforms were enacted in 2016 and the NZ Government has set the goal of a 25% reduction in workplace fatalities by 2020. Currently in NZ it is not possible to use routinely collected official data to reliably report: i) who is fatally injured due to work activities, ii) what groups should be prioritized for preventive action, and iii) to what extent occupational safety regulations have prevented work-related fatalities, largely due to incompleteness and potentially inaccuracy. The previous Work-Related Fatal Injury Studies in NZ (WRFIS-1 and -2), used Coronial case files for the period 1974-1994 overcoming the limitations of existing routine data collections. This has provided stakeholders with the most complete and detailed evidence platform for workplace safety policy and action in NZ. However, this information is now 20 years out of date. The current WRFIS-3 project updates this time series to include fatalities occurring from 1995-2014, creating a continuous work-related fatal injury dataset covering 40 years. This will help address the existing knowledge gap, enabling current and long-term trends in work-related fatalities to be established and the impact of previous workplace safety legislative reform to be assessed. This research will provide the contemporary evidence urgently sought in NZ to directly inform workplace injury prevention. The study aims to accurately inform work-related injury prevention efforts for NZ for the period 1995-2014 (WRFIS-3) by:

i) comprehensively documenting and enumerating the work-related fatal injury burden; and ii) identifying high risk groups and circumstances to prioritize and target preventive action.

Methods: This research project is establishing a complete and comprehensive work-related fatal injury dataset from 1975-2014 by collecting data for the period 1995-2014 using Coronial case files and appending this to existing data for 1975-1994. Data collection involved the use of valid and feasible methods to: 1) identify possible cases aged 0-85 years from the NZ Mortality Collection using selected external cause of injury codes, 2) link these to Coronial case files, which were retrieved and reviewed for work-relatedness, and 3) code work-related cases. Work-related cases are classified as workers, bystanders, commuters or students.

Results: Data collection will be completed by July 2018. Of 9971 fatal injury cases reviewed to 1 March 2018, 2309 (23%) are work-related fatalities. 1078 of these fatalities are workers. Annual work-related injury frequencies and rates per 100,000 workers for the most recent 20 year period will be presented, with rates compared by age, sex, employment status, occupation and industry. The circumstances of the 1995-2014 injury events will be analysed in-depth. Comparisons with WRFIS-1 & -2 will be made. Future analyses using these data will also be discussed.

Discussion: This research demonstrates an innovative use of coronial data, and will provide a rare example of a continuous and comprehensive long-term coronial dataset, to generate knowledge for informing workplace preventive strategies in NZ.

B5.4

Title: **Effect of Randomized OSHA Inspections on Employer Reporting of Amputations**

Authors: **Aaron Tustin, Jon Bernt, Richard Gonzales, Michael Hodgson**

Background: OSHA conducts workplace inspections to enforce U.S. occupational safety and health regulations. OSHA's National Emphasis Program (NEP) on Amputations is intended to reduce amputation injuries. Certain high-hazard industries are targeted for more frequent random inspections. The targeted industries, all of which are in the manufacturing sector, are known to have workplaces with machinery and equipment that can cause amputations. An updated recordkeeping

standard, effective as of January 1, 2015, requires employers to report all work-related amputations to OSHA's Severe Injury Reports (SIR) system. The SIR outcomes data provide an opportunity to evaluate the effectiveness of the amputations NEP.

Methods: The study was a retrospective analysis of a randomized field trial. We consulted a commercial database of U.S. employers to identify all establishments that were eligible for inspection under the amputations NEP and that were in continuous operation from 2008 through 2016. We cross-referenced this list with OSHA's internal inspections database to determine which establishments had been randomly inspected under the amputations NEP between 2008 and 2014. These inspected establishments comprised the "treatment" group. The remaining establishments, which were not chosen for random inspection under the amputations NEP, comprised the control group. We then analyzed the first two years of SIR data, from 2015-2016, to assess which establishments had reported amputations (the "outcome") to OSHA. Log-binomial regression was used to calculate the relative risk of the outcome in the treatment group, compared to the control group.

Results: The study population included 31,144 establishments with a median size of 30 employees (interquartile range, 18 to 68 employees). There were 5596 (18%) establishments in the treatment group and 25,548 (82%) establishments in the control group. During the two-year follow-up period, 910 (2.9%) of the employers in the study reported an amputation to OSHA. The relative risk of the amputation outcome was 1.74 (95% confidence interval: 1.51 to 2.00) in the treatment group, compared to the control group.

Discussion: In the largest study to date of randomized OSHA safety inspections, we observed that establishments inspected as part of the amputations NEP were 74% more likely to report an amputation during the first two years of OSHA's revised reporting requirements. We believe that this unanticipated result is likely due to under-reporting, a known limitation of the SIR database. For example, a study in Massachusetts documented that employers failed to report roughly half of all amputations to OSHA. Our result could be explained if employers who have been inspected by OSHA are more likely to comply with reporting requirements. We intend to test this hypothesis by cross-referencing our data with state workers' compensation injury records.

Session C1

Title: The Role of Safety Culture in Safety and Health Management in Mining, Oil and Gas Extraction Industries

Moderator: Emily Haas

Emily Haas, Cassandra Hoebbel, Murrey Loflin, and Ted Scharf, representing the NIOSH Safety Culture Working Group: An occupational safety and health management system (OSHMS) is a set of interacting strategic practices used to achieve occupational safety and health (S&H) goals (e.g., ANSI/AIHA Z-10; BS OHSAS 18001) and reduce inadequacies in risk management. The Department of Labor (DOL), through its respective agencies, are making efforts to integrate a risk assessment-based OSHMS into its oversight of and assistance to U.S. industries. Even though organizations are expected to employ a risk-analysis process, integrating an OSHMS into U.S. mining, oil and gas extraction organizations has been challenging. To date, difficulties in implementing interventions and evaluations has created a lack of understanding about the implementation of these systems and its ties to safety culture. Although recent research has made connections between safety climate and the participation in safety practices, additional empirical evidence is needed to understand how the safety culture in which management fosters intersects with workers' perceptions and performance as a part of the SHMS. Characteristics of an organization's safety culture can impact workers' own safety values and decisions. Aspects of safety culture that influence worker performance include organizational support, supervisor support and communication, and employee participation. Safety culture has not only been identified as a valid leading indicator of incident occurrence, but there is also evidence that the culture might strengthen workers' proactive behavior. Specifically, research has linked a positive safety culture to fewer errors, near misses, and incidents. However, these outcomes are dependent upon the organization's SHMS. Despite recommendations to improve SHMSs by way of enhancing safety culture, ways to engage workers and demonstrate processes that positively contribute to a SHMS remain unclear. To begin answering these critical questions, this session explores research and interventions in safety management that demonstrate the interdependence of safety culture/ climate with safe work policies and practices in mining and oil and gas extraction industries. Of particular importance and what makes

this session unique, is the involvement and presentation of research from a variety of disciplines including the social sciences, surveillance and statistics, public health, and engineering. The multidisciplinary involvement within this session allows gaps in safety culture and SHMSs to be addressed from different angles as well as see intersections across these research fields. Following the presentations, a discussion will be facilitated by the NIOSH Safety Culture/ Safety Climate Working Group to help tie in the presentations and ensure any additional audience questions are answered by the presenters.

C1.1

Title: Lagging or Leading?: Re-Conceptualizing our Notion of Occupational Injuries as Performance Indicators of Occupational Safety

Authors: Patrick Yorio, Susan Moore, Emily Haas, Lee Greenawald

Background: Decades of research support the notion that an establishment's safety climate temporally precedes safety performance, as measured by the number and severity of incidents. Theoretical work, however, has challenged the notion that the relationship between traditional leading indicators (e.g., safety climate) and lagging indicators (i.e., occupational injuries) are that simple. It has been argued that, just as safety climate can precede injuries, the frequency and severity of injuries can shape an organization's safety climate—this suggests a cyclic relationship between safety climate and incidents. Although occupational safety incidents have been traditionally considered to be lagging indicators, for this argument to hold, they must also function as leading indicators. While theoretical work suggests that lower severity injuries may precede higher severity injuries, the empirical work to support this theory is limited. Additionally, the empirical work that has been completed has been hampered by a lack of establishment-specific data over long periods of time. The purpose of this presentation is two-fold: 1) to provide an overview of the theoretical work that posit occupational injuries and near misses as a leading indicator; and 2) to present establishment-specific empirical evidence derived from mathematical models that statistically examined the efficacy of using occupational injuries and near misses as leading indicators that can predict occupational safety.

Methods: Publically available injury data from 25,000+ mining sector establishments over a 13 year period (2000-2012) was used to explore the research inquiry. Within the models, high severity occupational injuries (i.e., fatalities) were conceptualized as the lagging indicator and less severe injuries and near misses were positioned as leading indicators. Numerous statistical models were examined in order to fully explore the efficacy of positing an establishment's injuries as a leading indicator of subsequent year high severity occupational injuries.

Results: The results suggest that occurrences of each of the injury categories considered (permanently disabling, lost time injuries, recordable injuries, and near misses) significantly increased the probability of a subsequent year fatal event in the unconditional models: 6.63 times for permanently disabling injuries and 1.08 times for near misses. When controlling for mine size, permanently disabling injuries (1.37 times) and near misses (1.02 times) significantly increased the probability of future fatalities. The results further suggest that as the average and total number of lost days associated with the injuries increased so did the probability of a subsequent year fatal event. For example, between the conditional and unconditional models mining establishments with >100 total days lost were 2.69 to 17.34 times more likely to experience a future fatality compared to establishments with 0 lost days. Also for example, establishments with an average lost days per injury of >10 were 1.64 to 3.20 times more likely to experience a future fatality compared to establishments with an average of 0 lost days per injury.

Discussion: Strong evidence was found to support the view that less severe occupational injuries and near misses can be used as a leading indicator of more severe safety incidents. Thus, the data from this study supports the need for further research that investigates the argument that safety climate and incidents are be cyclically related. Additionally, the relative influence that each may have on the other remains unknown. Accordingly, and consistent with recent empirical efforts, an important next step for researchers would be to conduct longitudinal studies that characterize the interdependence of these two parameters.

C1.2

Title: A Survey of Oil and Gas Extraction Workers: Safety Climate, Employer Health and Safety Policies, and Worker Behaviors

Author: [Kyla Retzer](#)

Background: Research regarding the safety climate of the oil and gas extraction workforce has been focused primarily on workers of offshore platforms in other parts of the world, a highly-regulated working environment. Limited or no research on the safety climate of U.S. onshore oil and gas extraction operations has been completed despite the fact that almost all U.S. oil and gas extraction worker fatalities occur on onshore operations. There is also limited knowledge about the extent to which occupational safety and health management systems (OSHMS) have been adopted by U.S. onshore oil and gas producers and the contracted companies who drill and complete oil and gas wells. Additionally, oil and gas well sites are exempt from OSHA's OSHMS standard for process industries (i.e., Process Safety Management Standard). The purpose of this session is to describe preliminary findings of a survey of factors affecting the health and safety of workers in the U.S. land-based oil and gas extraction industry.

Methods: The National Institute for Occupational Safety and Health, Western States Division researchers conducted a survey and brief interview of 500 oil and gas extraction workers at their worksites. Employers included drilling contractors, servicing companies, and oil and gas producers. Surveys were completed in various field locations: oil and gas well sites, drilling rigs, completions sites, and regional field offices. The purpose of the survey was to conduct preliminary research of on-duty and off-duty factors that may affect risk for crashes, injuries, and illnesses and to generate hypotheses for future health and safety research in the industry. The survey was composed of previously validated national survey questions as well as questions that were designed specifically to address health and safety concerns for this industry. New questions were pilot-tested by using cognitive interviews. Surveys were completed during 2017 and 2018. Some of the topics in the survey included demographic information, employers' health and safety policies, training, personal protective equipment, history of injuries and illness, and driving behaviors. Four statements about safety climate were included and rated by participants on a 5-point

Likert scale. Descriptive and chi-square analyses were conducted using Qualtrics and SAS.

Results: Preliminary data analysis shows that almost all respondents reported that their company had some type of worker health and safety program in place. A majority of workers also reported that their employer had a mentoring program for workers who are new to the oilfield. A strong sense of safety culture appears to be prevalent among the companies who participated, but differences exist among company types (e.g. drilling contractors, service companies, and operators).

Discussion: A strong safety climate exists among companies who participated in this survey, despite the lack of formal regulatory standards for this industry. However, preliminary results suggest that there is a lack of knowledge among participants about the existence of certain health and safety policies, such as fatigue management, journey management, and policies regarding the maximum number of hours employees can work per day or per week. Employers should reinforce the existence and purpose of health and safety policies to workers through front line management, and provide training on effective communication and culture to these managers. Attendees of this session will learn about the preliminary findings of this study and potential future research questions pertaining to safety climate and OSHMS for this relatively unstudied yet high-hazard workforce.

C1.3

Title: Using Commodity-Specific Safety Climate Trends to Improve Health and Safety Management System Elements

Authors: [Emily Haas](#), [Cassandra Hoebbel](#)

Background: Health and safety management systems (HSMS) have received extensive attention in recent research, especially in consideration with safety climate as a key product of the system's implementation. However, with an absence in mining-specific research, the interrelatedness of organizational and individual safety practices remains unknown, and more specifically, how the management system and workers jointly influence incident prevention. In response, empirical research that addresses how the implementation of an HSMS by an organizational entity fosters a safety climate that positively influences worker perceptions and actions is needed. This research advises on ways to tailor elements

of an HSMS and evaluate its effectiveness, using safety climate as one key indicator.

Methods: Researchers developed a psychometrically supported survey based on theoretical and empirical reviews and revalidated each identified factor using a 6-point Likert scale (strongly disagree to strongly agree). Six organizational factors (supervisor H&S support, supervisor H&S communication, organizational H&S support, H&S training, worker engagement, and coworker communication) and four distal, personal factors (adaptability, locus of control, risk avoidance, and thoroughness) that are important in fostering H&S behaviors and outcomes were identified. The performance outcomes measured within the survey were proactivity and compliance (derived from Zacharatos et al). Researchers traveled to various mine sites and administered this 59-question survey to approximately 2,521 workers at 35 mines between February 2016 and February 2018. Several mined commodities were represented in the study (n = 1,255 sand, (lime) stone, and gravel miners; n = 358 coal miners; n = 424 industrial mineral/aggregate miners; and n = 484 kaolin miners). Survey scales revealed internal consistency values (coefficient a) between .7 and .9, which is acceptable to high.

Results: Results revealed several key concepts that mine companies can and should address by way of their strategic HSMS to improve work processes, safety climate/ culture, and worker performance. This presentation discusses common themes that trended as having a large influence on the safety climate but were not perceived well among workers. In other words, gaps are illustrated in current H&S processes including site-wide communication and engagement methods and possible ways that leadership can organize their workforce to reduce workers' risk tolerance and increase their sense of control on the job. Specific risk management methods are presented as well as their impact on worker perceptions and performance which, over time, can help reduce lost time injuries, fatalities, and illnesses.

Discussion: Based on the results discussed, the next question becomes how organizations can use the results to their advantage. A multiple regression analysis showed which organizational and personal factors have the biggest impact on workers' perceptions of safety climate/ culture. In response, after this presentation session participants will walk away with a new, more manageable way to interpret their safety climate and make tailored improvements to their risk management

processes. Additionally, they will learn some generalizable aspects of safety climate that have an impact on near miss incidents, as well as how some industry practitioners have used the results to improve their own health and safety management programming.

C1.4

Title: On-Site Assessment of Safety and Health Management System Effectiveness

Authors: [Amy Richins](#), [Michael Nelson](#), [W. Pratt Rogers](#), [Ashley Hodgson](#)

Background: The University of Utah is conducting a study of the implementation effectiveness of safety and health management systems (SHMSs) in the mining industry. The effectiveness of management systems has been thoroughly studied in the healthcare field, but no similar studies have been done in the mining industry. This study examines 10 mines with different SHMSs, to understand how well those systems and their implementation correlate with improvements in safety performance. The study is longitudinal, and each mine will be visited three times.

Methods: Employee perceptions are assessed using a standard survey, which includes 57 statements to which subjects respond using a five-level Likert scale. Each company's approach to safety management is assessed during and after site visits. Project personnel meet with managers and supervisors to discuss safety management practices and procedures at the site. Then, in follow-up discussions, project personnel make a consensus ranking of the site's system using a 19-point SHMS matrix based on the CORESafety system. The data are imported into EXCEL and SPSS. Seven mines were visited in 2016 and 2017. Each survey data set was analyzed using factor analysis, Cronbach's alpha test, Bartlett's Test of Sphericity, and the Kaiser-Meyer-Olkin test. The data sets were then analyzed for single- and multi-variable correlation, comparing employee perception and MSHA incidence and fatality rates, employee perceptions and SHMS implementation, and SHMS implementation and MSHA incidence and fatality rates.

Results: The Cronbach's alpha coefficient for the project's standard perception survey was 0.953, indicating that the reliability of the survey as a measuring tool is high, and that the administered surveys can be trusted to measure what is intended. Bartlett's Test of Sphericity showed an approximate chi-squared value of 8,850 with

1,540 degrees of freedom, indicating that the variables measured in the survey are suitable for correlation analysis. The Kaiser-Meyer-Olkin measure for the data collected in the study was 0.931, which showed that factor analysis is acceptable for this data set. Single-factor analyses were performed to find the correlations of employee perceptions with four variables, Leadership, Risk Management, Culture, MSHA Compliance, with each of three MSHA statistics for 2916, Employee Injuries, Contractor Injuries, and MSHA Citations. Spearman's rho coefficients showed correlations of employee perceptions of Leadership and Culture with both Employee Injuries and MSHA Citations. The highest correlations were around 0.3, which is considered low. This is not surprising in analyses in which tens of thousands of survey data points to just twenty-four data points from the MSHA database. Multivariate correlation analysis showed similar results.

Discussion: The project has already built a large database, and new data are being added almost monthly as site visits continue. Detailed study of the data is expected to continue for some time, as the longitudinal analysis develops. The site visits have been very informative, not only for the data they have yielded, but also for the insights gained by talking to and observing site employees—managers, supervisors, and hourly. The presentation will include first results of the data analysis, along with a brief discussion of the more qualitative observations from the 11 site visits to date.

Session C2

Title: NIOSH-Sponsored State-Based Fatality Assessment and Control Evaluation (FACE) Program

Moderator: Nancy Romano

The National Institute for Occupational Safety and Health (NIOSH) Fatality Assessment and Control Evaluation (FACE) program is a research program designed to identify and study fatal occupational injuries. The goal of the FACE program is to prevent occupational fatalities across the nation by identifying and investigating work situations at high risk for injury and then formulating and disseminating prevention strategies to those who can intervene in the workplace. The FACE Program allows researchers to gain knowledge about the specific circumstances that surround worker deaths and to formulate prevention strategies. FACE products provide employers and workers with recommendations

to address safety policies, work practices and worker training. FACE also often makes recommendations to manufacturers for changes to equipment and tools.

The FACE program has two components. 'NIOSH FACE' consists of participating states that voluntarily notify NIOSH of fatalities occurring in targeted categories. These categories have included: falls in construction, foreign-born workers, dual use machinery, temporary workers, and robot-related fatalities. 'State FACE' currently comprises seven State health or labor departments (CA, KY, MA, MI, NY, OR and WA) that conduct State level surveillance, targeted investigations, and prevention activities through cooperative agreement with NIOSH.

This NIOSH-sponsored State-based FACE session will provide overviews and examples of various work (i.e., fatality investigations, and safety-related products) that has been completed by the State FACE programs. This session is composed of seven State FACE presentations:

1. [Robert Harrison, MD, MPH](#) – California FACE, California Department of Public Health. California FACE Program: Prevention of Workplace Fatalities. This presentation will discuss the findings, investigations, and digital video from oil and gas fatalities due to inhalation of hydrocarbon vapors, and (2) an investigation of a fatality with a stump grinder that highlights the risk among landscapers and groundskeepers.
2. [Michael Turner, MS, ASP, CSHS](#) – Kentucky FACE, Kentucky Injury Prevention and Research Center. Dump Truck Driver Loses Control and Flips Truck Resulting in Fire. This presentation will highlight the findings from an investigation that involved a dump truck driver that lost control and flipped the truck onto a culvert. As the incident occurred, an exposed piece of rebar protruding from the culvert's concrete base, punctured the fuel tank of the truck, causing it to catch fire, and resulted in the driver's death.
3. [Michael Fiore, MS](#) – Massachusetts FACE, Occupational Health Surveillance Program, Massachusetts Department of Public Health. Laborer Injured in a Fall When a Portable Platform Ladder Overturned. This presentation will provide details of a fatality investigation and the important safety recommendations for preventing falls from platform ladders.
4. [Anthony Oliveri, PhD, MPH](#) – Michigan FACE, Michigan State University, Department of Medicine, Occupational and Environmental Medicine. 23-Year-Old Laborer Was

Overcome and Drowned When He Entered a 10,500-gallon Molasses Tank to Reposition a Drain Pipe. This presentation will provide details of a fatality investigation and will discuss the prevention recommendations to prevent incidents occurring in permit-required confined spaces.

5. [Julia Zhu](#) – New York FACE, New York State Department of Health Bureau of Occupational Health and Injury Prevention. Causes and Risk Factors of Fatal Injuries Associated With Mobile Hand-fed Wood Chippers. This presentation will highlight that operating wood chippers can be dangerous. NY FACE identified 113 chipper-related worker deaths. The victims were killed in struck-by (57), caught-in (41), motor vehicle (7), electrical (4), fall (2), and heat stroke (2) incidents while transporting, setting up, feeding, troubleshooting, maintaining, and repairing wood chippers.

6. [Barb Epstien, MPH, CIH, FAIHA](#) – Oregon FACE, Oregon Institute of Occupational Health Sciences, Oregon Health & Science University. Oregon Partnership to Prevent Fatalities in Agriculture. This presentation will provide information on how Oregon FACE partnered with SAIF Corporation, Oregon's leading workers' compensation insurer, to develop effective safety outreach resources help expand our reach to farmers and ranchers across the state. A collaborative hazard alert containing real stories and prevention tips was developed and distributed to more than 2,000 attendees at SAIF's agricultural safety seminars in 2017-2018.

7. [Todd Schoonover, PhD](#) – Washington FACE, Washington State Department of Labor & Industries, SHARP Program. Coffee Stand Owner Dies in a Propane Caused Fire: Investigation, Collaboration, Media Attention, and Safety Interventions. The presentation will highlight the collaboration and assistance from multiple agencies. In addition, recommendations from the report were disseminated and addressed through publications, media reports, and physical changes to coffee stands.

Session C3

Title: Special Topics in Workplace Vehicles

Moderator: Kurt Beschorner

C3.1

Title: Increasing Pedestrian Awareness of Forklifts in the Transportation, Warehousing, and Utilities Industry Sector to Reduce Traumatic Injuries

Authors: [Thomas Bobick](#), [Christina Socias-Morales](#), [Mat Hause](#), [Melody Gwilliam](#)

Background: Forklifts are important pieces of equipment in the Warehousing segment of the Transportation, Warehousing & Utilities (TWU) Sector. They move supplies and products throughout facilities, as well as unload and load tractor-trailer vehicles. Research conducted by NIOSH in the 1990s indicated that forklift injuries and fatalities were mainly due to vehicle overturns, struck-by events to pedestrian workers, and crushed-by-forklift incidents to both operators and pedestrians. In 2017, the Division of Safety Research (DSR) of the National Institute for Occupational Safety and Health (NIOSH), Morgantown, WV initiated a two-part pilot study to improve the visibility of forklift vehicles during operation. The purpose of the study is to (a) understand the national burden of injuries related to forklifts, and (b) evaluate the functionality of retrofit safety equipment to improve the conspicuity of forklift vehicles to help improve the safety of pedestrian workers.

Methods: First, we examined data from two national occupational injury surveillance systems to understand the current burden of work-related forklift injuries – the Census of Fatal Occupational Injuries (CFOI) and the Survey of Occupational Injuries and Illnesses (SOII), both maintained by the Bureau of Labor Statistics. CFOI is an accurate count of fatalities occurring each year in U.S. workplaces, and the SOII is an annual survey estimate of lost-workday injuries and illnesses from a nationally representative sample of employer-collected records. The Occupational Injury and Illness Classification System (code 8621) was used to identify the primary source of forklift fatalities in the CFOI data. Second, the research team established a partnership with a local forklift distributor to assist with the study. Discussions focused on locating a company that would cooperate with DSR to use and maintain retrofit safety equipment during normal work activities. During May 2017, a Pittsburgh-area company that supplies parts and components for rail transportation agreed to collaborate with DSR. Observational studies were conducted in July, August, and September 2017. Researchers conducted

multiple plant visits to establish a baseline of operation for three stand-up forklifts.

Results: From 2011-2016 there were 412 fatal injuries in all U.S. industries where the forklift was the primary source of fatality. This is an average of 69 forklift fatalities per year. During the same period, there were approximately 42,000 lost-workday injuries involving forklifts—an average of 7,000 annually. Safety equipment has been added to the forklifts to increase their conspicuousness. Retrofit interventions consist of blue lights mounted on the front and rear of the forklift canopies to indicate forward and reverse movement. Blue lights project an oval that measures 24-in wide by 45-in long. Red lights are mounted on both sides of the three forklifts to project a rectangle onto the floor on both sides (5-in wide by 15-ft long) to indicate the perimeter and rear-end turning radius. Feedback from warehouse workers has indicated that the addition of safety lights on the three forklifts has definitely assisted pedestrian workers to be more aware of the presence and movement of the forklifts for vehicle avoidance.

Discussion: Previous NIOSH research using an earlier national fatality surveillance system indicated that there was an average of 68 deaths of U.S. workers related to forklifts each year from 1980 to 1994. The results from CFOI show that 69 forklift deaths occurred annually from 2011 to 2016. While these two datasets are not directly comparable, they do suggest that forklifts represent a persistent occupational hazard over this 37-year period. This study to evaluate retrofit safety lights indicates that the blue and red lights are effective in providing a warning to pedestrian workers of forklift movement and contribute to vehicle avoidance.

C3.2

Title: Occupational and Recreational ROV Exposure, Safety Behaviors and Crash Experiences of Iowa FFA Members

Authors: [Charles Jennissen](#), [Kristel Wetjen](#), [Pam Hoogerwerf](#), [Lauren O'Donnell](#), [Karisa Harland](#), [Gerene Denning](#)

Background: Recreational off-highway vehicles (ROVs) have become increasingly popular, but no studies have examined the safety issues and experiences of adolescents while operating ROVs for both recreational and occupational purposes. The objective of this study was

to better understand the epidemiology, safety behaviors, and crash experiences of youth ROV riders.

Methods: Attendees of the 2015 and 2016 Iowa FFA Leadership Conference were surveyed. Data related to the frequency of ROV occupational and recreational use, the safety behaviors practiced, and the crashes and injuries experienced were collected. Descriptive and comparative analyses were performed.

Results: 1939 surveys by conference attendees 12-18 years of age were included in the analysis. Half of respondents were 15-16 years of age, and 55% were female. The residence of participants included on a farm (51%), in the country but not a farm (20%), and in town (29%). Over three-quarters of FFA members surveyed (82%) had been on an ROV, and 66% and 82% reported riding an ROV in the past year for occupational and recreational purposes, respectively. Many were frequent riders, with 50% and 36% of those who rode for occupational and recreation purposes, respectively, being at least weekly riders. The most frequent work tasks performed by youth with ROVs included transportation (84%), checking fields (72%) and livestock (69%), and working on fences (71%). An ROV was owned by over a third of subjects' families, and these individuals were significantly more likely to have ridden an ROV than those whose families did not own a vehicle (97% vs. 59%, $p < 0.001$). Those reporting that their families owned an ROV varied by place of residence (Farm 50% > Country Not Farm 25% > Town 16%, $p < 0.001$). Over 95% and over 70% of those riding for both occupational and recreational purposes reported riding on unpaved public roads and on paved public roads, respectively, in the past year. Many were at least weekly riders on public roads. About 80% stated they never or almost never wore a helmet, and nearly half stated they never or almost never wore the seat belt/ safety harness when riding an ROV. In the year prior to taking the survey, 14% of those riding for occupational purposes and 9% of those riding for recreational purposes were involved in at least one ROV crash. Collision with an object was the most common crash mechanism (~42%), followed by a rollover (~38%). About 10% of those having a crash in the past year sought medical attention for injuries.

Discussion: Iowa FFA members have high exposure to ROV riding, and both unsafe riding behaviors and crashes are extremely common. Interventions to increase ROV safety awareness and safe riding behaviors

are urgently needed, especially in rural areas and for adolescents using ROVs for work purposes.

C3.3

Title: The All-Terrain Vehicle Exposure and Crash Experiences of Iowa FFA Members

Authors: [Charles Jennissen](#), [Kristel Wetjen](#), [Pam Hoogerwerf](#), [Lauren O'Donnell](#), [Gerene Denning](#)

Background: All-terrain vehicles (ATVs) continue to be popular vehicles for occupational and recreational purposes, especially on farms. About 30% of all serious injuries due to ATVs in the state of Iowa are suffered by children <16 years of age. In fact, more children <16 years old die from ATV-related events than from bicycle crashes in the United States. Children that work and play on farms are at particular risk. The objective of this study was to better understand the ATV-related exposure and crash experiences of adolescents in rural areas.

Methods: Attendees of the 2017 Iowa Future Farmers of America (FFA) Leadership Conference were surveyed at the Iowa ATV Safety Task Force booth. Data was collected with regards to when FFA members first rode an ATV as a passenger and as a driver, when they had their first ATV crash as a passenger and as a driver, the total number of ATV-related crashes they had been in, and whether they ever had to seek medical attention due to an ATV-related crash and, if so, at what age. Descriptive and comparative analyses were performed. ATV exposure and crash-related variables were compared in relationship to age, sex, where the FFA member lived, and family ATV ownership. A total of 603 FFA members 12-19 years old completed the survey.

Results: The vast majority of participants (95.5%) had ridden an ATV. Nearly all reported having ridden as a passenger. Mean age at which respondents first rode as a passenger was 6.1 years, and as an operator was 8.9 years. Nearly 20% and about 30% reported having crashed on an ATV when riding as a passenger and as a driver, respectively. The mean age at which they first crashed as a passenger was 10.5 years and as a driver was 11.0 years. On average, males drove ATVs about a year earlier than females. Both those that lived on farms or whose families owned an ATV were significantly younger when they first rode an ATV than those that lived elsewhere or did not own an ATV, respectively. Overall, one-third had been in an ATV crash. Males and

those who lived in the country had higher percentages that had been in a crash. Over one-fifth of those in an ATV crash required getting medical attention and the mean age at the time of their first crash that required medical attention was 11.5 years.

Discussion: Iowa FFA members reported nearly universal exposure to ATVs and commonly practice unsafe behaviors such as riding as or with a passenger. Those who lived on farms started riding on ATVs much younger on average than those who lived elsewhere, and higher percentages of those who lived in the country reported having had an ATV-related crash. Farm families are routinely not enforcing safe ATV practices and are allowing children to ride and drive ATVs at ages which are not developmentally appropriate and against manufacturer recommendations. Widespread efforts are needed to educate rural families regarding ATV safety and change present practices.

C3.4

Title: Modeling an Advanced Curve Over-Speed Warning System for Firetrucks

Authors: [Peter Simeonov](#), [Hongwei Hsiao](#), [Ashish Nimbarte](#), [Douglas Ammons](#), [Richard Current](#), [Shengke Zeng](#), [HeeSun Choi](#)

Background: Excessive speed has been identified as one of the major contributing factors for fire apparatus crashes and overturns. A typical example of the adverse impact of excessive speed is when the speeding vehicle is unable to negotiate a curve in the road. A system that can proactively warn firetruck drivers when they are approaching a curve with unsafe speed may have the potential to reduce these fatal crashes. Adapting and using advanced driver assistant systems to assist the driver in controlling the speed of a fire apparatus in emergency response situations is a promising novel approach to reduce the risk of firetruck crashes and overturns.

Methods: The Division of Safety Research, NIOSH is conducting a study to test the performance, acceptability, and safety outcomes of an advanced curve over-speed warning (COSW) system for firetrucks. For the study, NIOSH researchers are using a high-fidelity motion-base driving simulator in our newly established Vehicle Safety lab. The experimental conditions involve emergency response and normal return driving with and without a COSW system. The experimental setup

includes two firetruck models – a pumper and a tanker, a simulated two-lane rural road environment with challenging curves, and a model of a COSW system.

Results: The model of the COSW system, developed for the study by the NIOSH researchers, calculates and uses a safety speed profile based on the road geometry (from a digital road map) and the dynamic characteristics of each firetruck. The safety speed profile is calculated and selected with the goal to prevent road departure crashes and can factor-in weather effects including dry, wet, and icy road conditions. For a specific road condition, the safety speed profile uses the minimum required safety speed based on calculations for risks of overturn, slide-out, and lateral acceleration levels. The COSW system algorithm uses the safety speed profiles and vehicle position location (from a Global Positioning System), to calculate the deceleration required to reduce the vehicle speed to the safety speed limit for an upcoming curve. The system can be adjusted to target achieving the curve safety speed anywhere from the curve start to curve apex. Also, the algorithm accounts for different driving styles by using pre-assessed driver-specific settings for preferred deceleration and reaction time. The COSW system issues a warning ahead of the curve, if the required deceleration becomes higher than a critical deceleration value.

Discussion: The COSW system model is designed to issue a multimodal warning, including visual, auditory, and tactile signals. The visual display of a mounted computer provides information for the actual vehicle speed, the posted road speed, and the required safety speed. A color-coded graph provides a cautionary warning in yellow and imminent warning in red with a sign for the curve direction. The auditory warning provides a looming signal with increasing beeping frequency as a function of the required deceleration level. Tactile warning signals are delivered with the imminent warning from a set of four factors in the driver's seat. The COSW system model has been extensively pretested and optimized to improve its accuracy and reduce the risk of annoyance to drivers.

Session C4

Title: Surveillance Methods

Moderator: Audrey Reichard

C4.1

Title: Prospects for Combining Survey and Non-Survey Data Sources to Improve SOII Estimates

Author: [Brooks Pierce](#)

Background: The Survey of Occupational Injuries and Illnesses (SOII) is the primary survey of nonfatal work-related injuries and illnesses in the U.S. The SOII surveys employers about information they maintain on Occupational Safety and Health Administration (OSHA) forms. Recently OSHA instituted a requirement that certain employers electronically report to OSHA some of this information. The new reporting requirement raises the possibility that OSHA administrative data could be combined with SOII survey data to improve estimates of injury risks in the workplace. This work describes BLS attempts to understand the practical significance of OSHA administrative records collection for SOII processes. It also compares data collected through the SOII survey to employer reports made to OSHA under the new reporting requirements, for calendar year 2016 injuries and illnesses.

Methods: We analyzed nonresponse in the OSHA administrative records. That analysis motivated a weights-adjustment approach: OSHA reporters are treated as representing themselves and others (non-reporters), within groups corresponding to SOII survey strata. This treatment is roughly analogous to SOII survey nonresponse adjustments. We then constructed and compared SOII and OSHA estimates, based on the weighted data from each source, and investigated strategies for combining such estimates. Finally, we probabilistically linked reports by the same establishment to SOII and OSHA, in order to compare responses under the two different systems.

Results: Some establishments failed to report via the OSHA administrative records capture system. In addition, some establishments apparently not required to electronically report to OSHA did so. There were clear patterns of nonresponse along industry and establishment size lines. Establishments with higher rates of workplace injuries and illnesses were more likely to follow the reporting requirement. The patterns of selection into reporting status are consistent with the hypothesis that more knowledgeable employers were more likely to follow the new electronic reporting requirement. The nonrandom selection into OSHA reporting status

complicates attempts at combining data from the OSHA and SOII sources. Finally, we found that establishments identified in both sources tended to report similar information to each source.

Discussion: OSHA's electronic reporting requirement may continue to evolve. Employers' understanding of the new rules will presumably evolve as well. The nonrandom selection of employers into OSHA reporting status and other practical considerations could affect any BLS attempt to combine OSHA and SOII records, or substitute OSHA records for SOII survey information.

C4.2

Title: Efficiency of Autocoding Programs for Converting Job Descriptors into Standard Occupational Classification Codes

Authors: [Bradley Evanoff](#), [Skye Buckner-Petty](#), [Ann Marie Dale](#)

Background: Existing datasets often lack job exposure data. Standard Occupational Classification (SOC) codes, based on job information, can link publicly available work exposure data to individual health outcomes via a Job Exposure Matrix. However, job code assignment is a laborious process if done manually. Two recently developed automatic coding programs provide an efficient resource for job code assignment but the number of job titles that can be automatically assigned codes, and agreement with assignment from manual coding have not been tested other than during development of the tool.

Methods: Two publicly available programs, NIOSH Industry and Occupation Computerized Coding System (NIOCCS) version 2 and Standardized Occupation Coding for Computer-assisted Epidemiological Research (SOCcer) version 1, convert text based job descriptors into SOC codes and compute confidence scores based on the strength of those assignments. We entered industry and occupation descriptions from two existing cohorts into both autocoding programs. Independent manual SOC coding was also completed for each worker. Agreement between manual codes and autocodes was assessed at varying confidence scores. We also assessed agreement of several exposure values (from the Occupational Information Network, O*NET) linked by manual SOC codes versus those linked by autocodes, in order to examine how differences in coding might affect exposure assignments in general population cohort studies.

Results: NIOCCS produced SOC codes for the majority of subjects (Cohort A: 71%; Cohort B: 62%). The level of detail for these codes varied; detailed occupations (6-digit SOC codes) were available for 44% and 43% of cohorts A and B respectively. Comparison to manual codes showed strong agreement at the major group 2-digit level ($\kappa \geq 0.8$ and 0.6) and weaker agreement at the 6-digit level ($\kappa \geq 0.6$ and 0.3). SOCcer produced 6-digit SOC codes for all subjects with good agreement at the 2-digit level ($\kappa \geq 0.7$ and 0.6) and slightly lower at the 6-digit level ($\kappa \geq 0.4$ and 0.3). Agreement for O*NET exposures was very high for most comparisons within both cohorts for both programs (many ICCs > 0.8). Both programs produced better agreement as confidence scores increased.

Discussion: Both autocoding programs can be reliable tools to aid in assigning SOC codes that represent broad industry levels, with less agreement at finer levels of job codes. Given the availability of large public datasets with job information but no other work exposure data, autocoding of jobs provides exciting opportunities for analyzing work-related health outcomes in future studies. We are currently assessing the performance of NIOCCS version 3, which will be introduced later this year.

C4.3

Title: Enhancing Agriculture, Forestry, and Fishing Injury Surveillance Using Free Text Data

Authors: [Erika Scott](#), [Liane Hirabayashi](#)

Background: Access to free text in existing administrative databases has proved useful in identifying and characterizing agricultural, forestry, and fishing (AFF) related injuries. Particularly, narratives from pre-hospital care reports (PCRs) provide specific details of the injury event directly from the scene and from interviewing the patient. These narratives, which are retained by a number of states, are systematically searched for AFF specific keywords and verified for AFF relatedness. The Occupational Injury and Illness Classification System (OIICS) is then applied to the dataset by a team of coders. To enhance this process, researchers are applying Bayesian methodologies to speed up text review and ultimately, reduce the cost of the surveillance system.

Methods: The process described above has been applied to PCRs from Maine and New Hampshire for a three-year period to create a confirmed injury dataset.

Agriculture, forestry and fishing records were identified by industry, and by the certainty of the injury report (e.g. true case, suspected case) This dataset was then split, along with non AFF records, into a training and validation datasets to build and test Bayesian algorithms for the determination of AFF records.

Results: Maine and New Hampshire had 767,060 pre-hospital care report records for 2008-2010. Of these, 28,341 contained one or more of 161 AFF keywords (searched either by character string or exact word). Of the keyword containing records, 1,203 were determined to be AFF related. Results of the Bayesian methodology are currently being testing and will be presented at the conference.

Discussion: Pre-hospital care reports are a rich source of occupational injury data, especially for agriculture, forestry and fishing. These injuries are able to be identified and coded using the OIICS classification scheme, making them comparable to other industries. Pre-hospital care reports have the potential to be a useful source of research data, beyond AFF, but for other industries and for public health in general. Conclusions on the success of using Bayesian methods to enhance coding of AFF cases will be discussed at the conference.

C4.4

Title: Household Survey of Occupational Injuries and Illnesses Pilot – Update and Discussion

Author: [Elizabeth Rogers](#)

Background: Research conducted by the Bureau of Labor Statistics (BLS) and others has identified under-reporting in the Survey of Occupational Injuries and Illnesses (SOII). In 2009 Congress charged BLS to develop a research program to examine the issue of under-reporting of occupational injuries and illnesses. OSHA and NIOSH were also asked to create similar research programs. In addition to internal research, BLS has also partnered with outside researchers on a variety of projects, including matching SOII and Workers' Compensation data, evaluating the use of multiple sources to identify nonfatal cases, and assessing the recordkeeping practices and knowledge of SOII respondents. While the scope of under-reporting to the SOII is not currently known, research points to filters that may reduce injury and illness reporting by employees or employers. These filters include employees not reporting injuries to their employers in the first place, insufficient employer

understanding of recordkeeping definitions and requirements, and disputes over the work-relatedness of an injury or illness. This may prevent employers from being aware of some occupational injuries and illnesses or from reporting known injuries and illnesses to the SOII. In light of this, BLS has examined various approaches to capturing a more complete count of workplace injuries and illnesses. One possible approach is the collection of occupational injury and illness data from workers directly. While a key strength of the SOII is the richness of the data published from it, comparing injury and illness data collected from households to SOII data may yield a greater understanding of the magnitude of workplace injuries and illnesses.

Findings/Discussion: To test this approach, in 2017 and 2018 BLS developed and piloted a Household Survey of Occupational Injuries and Illnesses (HSOII). The HSOII is a large-scale, nationally-representative telephone survey designed to yield responses from 3,520 workers in the United States. Responses are collected using random digit dial. Individuals are asked about occupational injuries and illnesses that they experienced in the past year, the effect those incidences have had on their work and pay, and their demographic characteristics. One goal of this pilot is to evaluate the feasibility of collecting occupational injury and illness data from workers directly. A second goal is to produce nationally representative top line estimates that can be compared to similar estimates from the SOII to better understand the magnitude of underreporting to the SOII. Data collection for the pilot HSOII will conclude in July, 2018.

BLS plans to present a summary of the research into SOII underreporting, a description of the HSOII pilot study, and the preliminary results of the HSOII pilot, including estimates from the pilot for available industries, occupations, case circumstances, and worker demographics and an assessment of data quality. The results will provide insight about the feasibility of collection of occupational injuries and illnesses from workers directly, a greater understanding of the potential magnitude of these cases, and challenges for any future collection of these data from households.

Session C5

Title: Economics of Worker Safety

Moderator: [Tim Bushnell](#)

C5.1

Title: Using Evidence from NIOSH-Sponsored Research to Assess Unrecognized Economic Consequences of Non-Fatal Occupational Injuries on Workers and Their Families

Author: [Regina Pana-Cryan](#)

Background: A seminal NIOSH-sponsored study estimated the economic burden of worker injury and illness at \$250 billion in 2007, based on medical costs and productivity losses (Leigh 2011). In this analysis, we aimed to synthesize findings from four other NIOSH-sponsored studies that assessed economic consequences of additional burden on injured workers and their families. Together, these studies estimated excess mortality and depression suffered by injured workers, and hospitalizations and musculoskeletal disorders (MSDs) suffered by family members of injured workers. Assessing this additional burden in the context of the estimates by Leigh (2011) provides a more accurate understanding of the true burden of worker injury and illness.

Methods: The first study by Boden et al (2016) assessed the relationship between non-fatal occupational injuries and long-term mortality by linking non-fatal injuries from the New Mexico workers' compensation system for 1994-2000 with mortality data from the Social Security Administration through 2014. Asfaw and Souza (2012) assessed the incidence and medical cost of depression suffered by workers with non-fatal occupational injuries, using 2005 MarketScan data on workers' compensation and outpatient medical costs. Asfaw et al (2012) used MarketScan data for 2002-2005, which included workers' compensation and inpatient medical care claims data for injured workers' families. They used a before-after analysis to compare the odds and costs of hospitalization of at least one family member 3 months before and after the index occupational injury. Asfaw et al (2015) used MarketScan data for 2005-2006, which contained information on workers' compensation and outpatient family healthcare claims to assess occupational injury and MSDs among family members of injured workers. Severe injuries were defined by receipt of indemnity payments and at least 7 days of lost work. We used these findings along with additional sources that allowed us to adjust findings to 2007, using estimates of non-fatal occupational injuries by Leigh, annual numbers of workers' compensation claims, and values for the medical care component of the Consumer

Price Index for multiple years (<https://fred.stlouisfed.org/series/CPIMEDSL#0>). We made several additional assumptions to accommodate the synthesis of the information. Our intention was not to provide precise estimates but a rough and partial assessment of the economic burden of worker injury and illness that is usually not considered.

Results: We present preliminary results that consider medical costs only and do not yet include findings from Boden et al. (2016). They found that over 20 years after injury, women with lost-time occupational injuries were 24% more likely to die than women with medical only injuries, while for men, the likelihood of increased mortality was 21%. Asfaw and Souza (2012) estimated that in terms of outpatient medical costs alone, after-injury depression cost at least an extra \$8.2 million within a 3-month study period in 2005. Adjusting their numbers resulted in \$18 million in 2007. Asfaw et al (2012) estimated a \$48 family inpatient cost per injured worker in the U.S. during 2002-2005, resulting in a total additional cost of \$301 million. Our adjusted number was \$167 million in 2007. Finally, Asfaw et al (2015) concluded that severe occupational injury would be associated with between \$29 and \$33 million additional cost of family member outpatient MSD claims. Based on their lower bound, our adjusted number was \$50 million in 2007.

Discussion: Based on only three select studies, non-fatal occupational injuries resulted in additional medical costs of approximately \$235 million in 2007. To put this in context, the medical costs of fatal occupational injuries were estimated at \$310 million in 2007 (Leigh 2011). Our analysis illustrated an approach to improve our understanding of the true cost of worker injury and illness.

C5.2

Title: Association Between Longest Held Occupation and Receiving Social Security Disability Benefit

Authors: [Abay Asfaw](#), [Regina Pana-Cryan](#), [Brian Quay](#)

Background: The Social Security Administration houses the Social Security Disability Insurance (SSDI) program, one of the largest federal disability programs in the United States. SSDI benefits are paid to workers or their family members if they are unable to work because of a medically determinable physical or mental

condition that is expected to last at least one year or result in death. The cost of SSDI has been increasing overtime and may outweigh the SSDI trust fund if the current trend continues. There is evidence that economic, policy, demographic, and health factors might affect the rapid growth in the SSDI rolls. However, very few studies have examined the impact of workplace factors on the rising costs of the SSDI program. Improving our understanding of the potential long-term effects of occupation on government-run safety net programs can help us develop occupation-specific prevention strategies. Objective: This study explored whether occupation was one of the risk factors for the rising number of disabled workers who received SSDI benefits between 1992 and 2014. As to our knowledge, no other studies have examined the association between occupation and the risk of receiving SSDI benefits. Hypothesis: Workers with high risk longest held occupations are more likely to receive SSDI benefit at an earlier age compared with workers with lower risk longest health occupations. Data and measurement of variables: We used the Health and Retirement Study (HRS), a longitudinal panel survey of a representative sample of Americans aged 50 and older in specific years or waves. We used a cohort of 16,196 HRS respondents (with 63,290 observations) between the age of 51 and 64 years who were followed from the date of entry (at age 51 or older) and until they received SSDI benefits, died, reached full retirement age by turning 65, or until the end of the follow-up period (2014), whichever came first. The outcome variable was receiving SSDI benefit, occurring on and after the first interview year but before or on the last interview year, 2014. Longest-held occupation was our main explanatory variable. We considered sixteen different occupations, and included sex, race and ethnicity, marital status, smoking, alcohol consumption, and obesity as covariates.

Methods: We used the extended Cox proportional hazard survival model to estimate the association between longest-held occupation and the likelihood of receiving SSDI benefits, controlling for covariates. Because one third of the respondents in our cohort did not report their longest held occupation, we used a multiple imputation method to address the problem of missing observations.

Results: Controlling for covariates, there was no statistically significant difference in the likelihood of receiving SSDI benefits between workers in longest held mana-

gerial (reference) occupations and workers in private household service, professional and technical support, clerical and administrative support, sales, and farming, forestry, and fishing occupations. However, compared with workers in managerial occupations, the likelihood of receiving SSDI benefits was more than 2 times higher for handlers and helpers, machine operators, and workers in transportation, food preparation, construction and extractives, personal services, and health services occupations. Workers in mechanics and repair and precision production occupations were 1.9 and 1.7 times, respectively, more likely to receive SSDI benefits than workers in the reference occupation.

Discussion: Targeted interventions to improve the safety and health of workers in longest held occupations associated with a high risk of receiving SSDI benefits would help reduce the societal burden of occupational injury and illness overall and the burden on the social security system specifically. Further research is needed to understand what the specific preventable risks are for workers in these occupations.

C5.3

Title: Economic Burden of Occupational Musculoskeletal Disorders (MSDs) in the Wholesale and Retail Trade (WRT) Sector

Author: [Anasua Bhattacharya](#)

Background: The incidence rate of nonfatal occupational injuries and illnesses requiring days away from work was 109.4 cases per 10,000 workers in 2013 in the US. MSDs accounted for 33 percent of these cases. The total number of reported MSDs in the WRT sector was 131,060 in 2013. Workers sustaining MSDs took a median of 11 days away from work, above the median of 8 days for all cases. In wholesale trade, the rate of MSDs was 37 cases per 10,000 workers with median of 12 days away from work and, in retail trade, it was 42 cases per 10,000 workers with a median of 11 days away from work. Objective: This study estimated the economic burden of occupational MSDs in WRT subsectors in 2013 and ranked these subsectors by costs, cases, and rates. Data: Data from a special query conducted by the Bureau of Labor Statistics (BLS) at the request of the author were used to estimate MSD cases and rates for the WRT sector and by WRT subsector, age group, and gender. Data from the Health and Productivity Management component of Truven Health MarketScan database

were used to estimate workers' compensation costs for MSDs by age group and gender.

Methods: MSD cases obtained from BLS were classified as non-disabling and disabling (resulting in indemnity or wage replacement payment), following Leigh (2011). Non-disabling cases were multiplied by the average medical cost of MSDs and disabling cases by the average medical and indemnity cost of MSDs derived from MarketScan to estimate total medical costs and lost earnings in 2013. Other cost components, including fringe benefits and home production losses, were estimated using related information from Leigh (2011).

Results: Preliminary results suggested that the costs of MSDs in WRT was \$ 2.7 billion in 2013. Among subsectors, grocery stores (\$462 million) in retail trade and grocery and related product wholesalers (\$198 million) in wholesale trade had the highest costs. Cases of MSDs were also highest in grocery stores (10,550 cases) in retail trade and grocery and related product wholesalers (5,060 cases) in wholesale trade, while incidence rates were highest in building material and supplies dealers (71 cases per 10,000 workers) in retail trade and alcoholic beverage merchant wholesalers (127 cases per 10,000 workers) in wholesale trade.

Discussion: This study ranked WRT subsectors by the economic burden of occupational MSDs, as well as by cases and rates of occupational MSDs. Policies targeting MSD prevention in high-cost and high-risk WRT subsectors would improve worker safety and health and help to reduce the societal economic burden of MSDs.

C5.4

Title: Work Precariousness and Mistreatment at Work

Authors: [Tapas Ray](#), [Paula Grubb](#), [Anasua Bhattacharya](#)

Background: Precarious work may adversely affect the health of workers, including by exposing them to stressors at work. One such stressor is workplace mistreatment by coworkers and supervisors. Objective: We developed a work precariousness scale and used it to examine the association between the level of work precariousness and the likelihood of experiencing mistreatment at work. There is no consensus on the definition of precarious work but there are working definitions of this concept and models of the broader social environment in which it is embedded. Precarious

work can be poorly paid and not sufficient to financially support a household, as well as work that is insecure. In addition, recent technological and work organization changes have resulted in an increased prevalence of non-standard work arrangements such as being paid by a temporary agency or working for a contractor. One of the consequences of this is the increased prevalence of precarious work. There is also evidence that lower income workers are more likely to experience mistreatment at work. Therefore, we wanted to assess the association between work precariousness and mistreatment at work. Data: We used data from the NIOSH-sponsored Quality of Worklife (QWL) module of the General Social Survey (GSS) conducted by the National Opinion Research Center. We pooled cross-sectional data from all four years in which QWL was administered: 2002, 2006, 2010, and 2014. We analyzed a weighted sample of 5,911 observations across these four survey years.

Methods: We developed a work precariousness scale by classifying variables into four components that assessed temporariness, disempowerment, vulnerability, and wage level. Specific elements in these components related to job insecurity, non-standard work arrangements (temporariness); uncertain and irregular work schedules, freedom to decide (disempowerment); limited supervisor and co-worker support, management employee relationship (vulnerability); and household financial constraints, insufficient fringe benefits, and non-working spouse (wage level). We used factor analysis to construct the work precariousness scale, and used it to classify workers according to their scores in three precariousness levels: low, medium and high. We used multinomial logistic regression to assess the association between the level of precariousness and the likelihood of mistreatment at work ("In the last 12 months were you threatened or harassed on the job in any way?" Yes/No). Covariates included age, gender, race and ethnicity, education, marital status, overall health status, industry, and work arrangement.

Results: We derived descriptive statistics for our sample of 5,911 respondents, of which fifty-two percent were female and fifty-eight percent were in the age group of 18 to 45 years. Approximately ten percent of respondents reported experiencing mistreatment at work. Mean work precariousness scores were highest for workers paid by temporary agencies, and those employed in the wholesale and retail trade sectors. Seven percent of workers in the low precariousness level

reported mistreatment, while twenty-one percent in the middle and fifty percent in the high level of precariousness level were mistreated. After controlling for covariates, the likelihood of mistreatment at work for respondents at the high precariousness level was three

times as high as that of respondents at the low precariousness level.

Discussion: Our results showed that statistically significant, positive associations existed between work precariousness and mistreatment at work.

Day 2: Wednesday October 17, 2018

Session D1

Title: Collaborative Robotics – New Era of Human-Robot Cooperation in the Workplace

Moderator: Carole Franklin

Collaborative robot systems are a new robotics technology that allows for robots and humans to work together in ways that were previously impossible. However, with this new capability comes new hazards and risks that must be evaluated for every application. This session will introduce what collaborative robots are and how they are being used in industry, discuss the safety standards related to collaborative robot applications, and how to evaluate and mitigate these new hazards related to collaborative robot applications.

Presentations: Paradigm Shift in Industrial Robot Safety - [Carole Franklin](#), Director of Standards Development, Robotic Industries Association. This session will describe how collaborative robotics is a paradigm shift from traditional methods of keeping workers safe around robotics (e.g., by safeguarding them away).

Introduction to Collaborative Robots and Applications - [Mark Lewandowski](#), Robotics Innovation Leader, Procter & Gamble. This session will discuss what collaborative robots are, the different modes of collaboration, and how collaborative robots are being used in industry.

Collaborative Robot Safety Standards - [Jeff Fryman](#), Robot System Safety Consultant and Trainer, JDF Consulting. This session will discuss the industry standards for collaborative robot systems safety and how they can be used to evaluate collaborative robot applications.

Risk Assessment and Hazard Mitigation for Collaborative Robot Applications - [Elena Dominguez](#), Senior Safety Consultant, Pilz Automation Safety. This session will discuss the new hazards related to collaborative robot applications and how to evaluate and mitigate these hazards.

Session Learning Objectives: Upon completion, participants will be able to explain what collaborative robots are, how they are being used in industry, what safety standards exist for collaborative robot applications, and how to evaluate and mitigate hazards related to collaborative robot applications.

Session D2

Title: Safety Climate/Safety Culture

Moderator: Lisa Steiner

D2.1

Title: Attitudes and Beliefs of Hourly Miners and Salaried Managers Regarding Safety and Health in U.S. Metal and Non-Metal Mines

Authors: [Douglas Myers](#), [Nancy Lessin](#), [James Frederick](#), [Michael Wright](#)

Background: The concept of culture, as commonly applied when describing safety culture, relies on the notion of culture as shared beliefs. However, many contemporary workplaces consist of multiple occupations, jobs, departments, bureaucratic levels and other formal and informal divisions. As a sub-component of a larger study of mine safety, the notion of culture as shared was examined by comparing perceptions of various aspects of safety practices and occupational hazards between hourly mine workers and mine managers in four United Steelworker (USW)-represented unionized mines.

Methods: In 2015-16, under a grant from the Alpha Foundation for the Improvement of Mine Safety and Health, researchers from the USW and West Virginia University surveyed hourly miners and salaried managers in four mines – two surface and two underground – mining four different commodities. Almost all hourly miners were USW members. A total of 1,150 participants – 988 hourly miners and 162 managers – completed surveys. Perceptions pertaining to identification,

reporting and fixing hazards and other safety practices were gathered via survey questionnaires.

Results: Responses to several survey items differed between hourly workers and managers. Themes that varied significantly (chi-square p-value < 0.05) include hazard identification, reporting, and correction, injury and illness reporting, and actions towards injured workers. While some perceptions were similar between workers and managers, overall, workers were often less enthusiastic about the efforts to identify and remedy hazards than were managers. Some results differed across mines, but often the associations held across all four locations.

Discussion: If culture is defined as a shared set of attitudes, beliefs, and norms, then a single “safety culture” does not appear to exist in these workplaces. It may be difficult to implement an effective and widely supported safety program when such differences exist in what is perceived to be needed to improve workplace safety and health. This study has implications for current efforts to promote a better “safety culture” as a fix for workplaces with safety and health problems.

D2.2

Title: Influence of Work Organization and Environment on Health and Productivity Outcomes among Construction Apprentices: A Total Worker Health Approach

Authors: [Bradley Evanoff](#), [Diane Rohlman](#), [Jaime Strickland](#), [Kevin Kelly](#), [Ann Marie Dale](#)

Background: Construction is among the most dangerous industries, with well-recognized risks of traumatic injury and high physical demands. In addition to traditional hazards for workplace injury and illness, other threats to construction workers’ health and well-being occur from work organization and work environment factors, including irregular employment, multiple job sites, long commutes, long work hours, and employer policies regarding health and safety. These non-traditional hazards have been associated with injury and illness, psychosocial stress, and unhealthy behaviors including poor diet and smoking. The cumulative impacts of both traditional and non-traditional hazards on the health and well-being of construction workers are largely unknown.

Methods: We are conducting annual surveys among

apprentice construction workers to identify relationships between work organization, environmental factors, health behaviors, and health outcomes.

Results: 963 surveys were completed and returned by apprentice construction workers (90% response rate). Respondents (mean age 28) reported high levels of job satisfaction, job security, and social support, but also reported high rates of musculoskeletal symptoms and various work organizational factors potentially affecting health outcomes and behaviors. Average commuting distance to work was 45 miles, and 63% reported no limits on daily working hours. Workers reported high smoking rates (28% were current smokers), and only 55% reported any restrictions on smoking at their worksites. Only 10% reported regularly using sunscreen when in the sun for >15 minutes; only 4% of worksites provided sunscreen. We examined associations between work organization and environmental factors and four self-reported outcomes: lower work ability, lower productivity, higher rates of missed days of work due to injury, and use of prescription pain medication. Preliminary analyses show that all four outcomes were associated with high job demands, low supervisor support, and low job security. Other factors were associated with one or more outcomes, including low job security, mandatory overtime, low coworker support, and low foreman supervision of safety. Compared to commercial construction workers, those in residential construction reported higher job demands and job strain, and had higher rates of missed days due to work injuries, bodily pain, and use of pain medication. One year follow-up surveys are now being conducted; we will report both cross-sectional and longitudinal associations between work organizational factors and health and productivity outcomes. Other ongoing analyses examine associations between work factors and health behaviors that may mediate health and productivity outcomes.

Discussion: These preliminary cross-sectional results highlight non-traditional worksite health risks, and suggest potential interventions that may improve health behaviors and outcomes among construction workers. As our study progresses, we plan to evaluate the longitudinal impact of work organization on health and health behaviors in construction trades, identify workplace programs, policies, and practices affecting worker health and well-being, and determine readiness for adoption of integrated interventions to improve worker health.

D2.3

Title: Testing the Associations Between Leading and Lagging Indicators in a Contractor Safety Pre-Qualification Database

Authors: [Jack Dennerlein](#), [Justin Manjourides](#)

Background: Many available tools for assessing and prequalifying construction subcontractors based on safety management procedures and performance rely on lagging indicators such as injury rates. Recent prequalification tools include leading safety indicators that are predictive antecedents to accidents and injuries, such as organizational safety management systems. Our goal was to determine the associations between leading and lagging indicators collected in a subcontractor pre-qualification assessment procedure that includes both leading indicators related to company-level safety policies and programs and lagging indicators related to company-level injury rates.

Methods: Data in this study were extracted from the ConstructSecure, Inc (Marlborough, Massachusetts) contractor safety assessment program of self-reported and validated company-level safety data. These surveys include measures of organizational systems of safety including Safety Management System; Safety Programs; Potential Hazards; Special Elements related to drug and alcohol programs; Non-drug and alcohol related Special Elements. Lagging injury indicators include all recordable injury cases (RC) and injuries involving days away, restricted, or transfer (DART). Companies also reported number of hours worked and number of employees. To examine associations between leading and lagging indicators of safety we fit Zero-Inflated Poisson models (due to a large number of companies reporting no injuries) to predict the company specific rates of DART or RC rates (DART per 100 Full-time Equivalent (FTEs), RC/100FTEs).

Results: In total, 2148 companies had up-to-date and complete data and reported greater than 10 FTE employees. Companies reported an average safety management score of 14.2 (Standard deviation (SD)=3.0), 4.6 hazards (SD=4.0), and 14.3 safety programs (SD=2.4). Companies also reported an average of three drug and alcohol screen programs (SD=1.2) and 1.1 additional safety special elements (SD=0.9). While over 75% of companies reported zero OSHA citations over the past 3 years, the average number of citations equaled 0.4 (SD=0.9). The average DART rate among companies

was 3.0 per 100 FTEs (SD=4.4), with 914 companies reporting 0 DART events. The average recordable case rate was 1.8 per 100 FTEs (SD=2.9), with 701 companies reporting 0 recordable cases. Crude ZIP models showed consistent statistically significant associations between Safety Management Systems (SMS) and Drug and Alcohol Special Elements (SE.D) and both RC and DART rates. Each one-point increase in a company's SMS score, was significantly associated with a 34% reduction in the odds of a recordable case event occurring (Odds ratio (OR): 0.66, 95% Confidence Interval (CI): (0.57, 0.79)), and a 9% reduction in the rate of recordable cases, if one does occur (Risk Ratio (RR): 0.91, 95% CI: (0.88, 0.94)). Similarly, each one-point increase in SMS score was significantly associated with a 28% reduction in the odds of DART incident (OR=0.72, 95%CI (0.56, 0.91)), and a 9% reduction in DART rate, if one does occur (RR=0.91, 95%CI (0.87, 0.95)). Associations in models that were fully adjusted for all leading safety indicators were generally consistent to those from crude models.

Discussion: Through this cross-sectional analysis, we have identified several organizational leading safety indicators that are associated with safety performance in the construction industry. More safety management systems were inversely associated with RC and DART rates, and companies with higher SMS scores were more likely to report no incidents. Similarly, the inclusion of drug and alcohol policy elements was associated with improved recordable case and DART rates. The associations documented here support the need for the implementation of safety management systems across the board in contractors small to large.

D2.4

Title: Preventable: Social Marketing to Reduce Preventable Injuries

Authors: [Ian Pike](#), [Jennifer Smith](#), [Kevin Lafreniere](#)

Background: The objective was to determine the efficacy of the Preventable social marketing campaign (www.preventable.ca) to raise awareness, change attitudes and behaviours to reduce the number and severity of injuries among workers aged 25–54 in British Columbia, Canada.

Methods: A multi-year, multi-faceted social marketing campaign, utilising TV, radio, print, signage, guerrilla events and social media launched in June, 2009, fol-

lowing 3-year formative evaluation. The formative evaluation found that most British Columbians already knew how to prevent injuries. The problem is that they believed injuries to be “an inevitable part of life”, but also that “it will never happen to me”. This attitude was the common thread underlying behaviors that lead to serious injuries at home, at play, at work and on the road. The campaign was therefore designed to change attitudes and behaviours, and to reduce serious injuries and deaths among 25-54 year-olds, and to change behaviours across multiple causes of injury by addressing the common attitude and connecting the dots between injuries that happen at home, at work, at play and on the road. The campaign launched in 2009 and public response was assessed through an online survey administered to a regionally-representative sample of 25-54 year-old adults 1-4 times per year on an ongoing basis since campaign launch. Analytics were applied to this data (N=8,217) to test the association between exposure to the campaign and scores on perceived preventability of injuries, as well as conscious forethought applied to injury-related behaviours. Injury-related deaths and time-loss claims were tracked. This study reports on the impact of the Preventable campaign to affect full-time worker attitudes and behaviours at the workplace, representing 58% (N=4,766) of respondents.

Results: On average, the campaign reaches over 2-million residents through over 100-million impressions annually. Over 80% of British Columbians surveyed support the brand and message. Ongoing evaluation shows that the campaign is consistently rated as informative, relevant, credible and generates self-reflection. Those who have seen the campaign score better on measures of attitudes, awareness and self-reported behaviors than those who have not seen the campaign, denoting a 5-15% shift from baseline ($p<0.05$). In addition, BC has seen a significant reduction ($p<0.05$) in injury-related deaths in both the 25-54 year-old age group, as well as the 0-24 year-olds (their children) since campaign launch. This translates into a 9% reduction among 25-54 year-olds, 27% reduction among 0-24 year-olds, and approximately 5 fewer injury deaths per year. Thirty-eight percent of those recalling the ads strongly agree, and 83% agree that ads that showed a variety of preventable injury scenarios at home, at work, at play and on the road made them think about and change their behaviour to prevent injuries at work, compared with those who did not recall the ads ($p<0.05$). When comparing full-time workers with the

general public, there was a 15% greater increase in the level of concern about the impact of injury, and a 33% decrease in the attitude that injuries are an inevitable part of life, among workers ($p<0.05$).

Discussion: The Preventable social marketing campaign featuring general injury prevention scenarios resulted in significant changes in awareness, attitudes and behaviours in the target population and among workers, which was associated with decreased injury mortality. Significance and Contributions: This project is the first jurisdiction wide, multi-partner collaboration, to support a social marketing campaign to address attitudes and behaviors to reduce injuries in BC. It is also the first to demonstrate that a social marketing campaign featuring general injury prevention scenarios can affect attitudes and behaviors to prevent injury among full-time workers.

Session D3

Title: Fatal Occupational Injuries

Moderator: Keshia Pollack Porter

D3.1

Title: Traffic Incident Managers – An Under-Recognized Work Group at Risk for Fatal Occupational Injuries

Authors: Terry Bunn, Svetla Slavova, Mark Chandler, Nancy Hanner, Michael Singleton

Background: Traffic incidents occurring on roadways require the coordinated effort of multiple responder and recovery entities including communications, law enforcement, fire and rescue, emergency medical services, hazardous materials, transportation agencies, and towing and recovery. Traffic incident management (TIM)-related response workers fall primarily within the protective services- and transportation- related industries and occupations (fire protection, police protection, emergency medical services, hazardous materials cleanup, transportation agencies, and towing and recovery). Information on the identification of TIM-relatedness of occupational fatalities, specific activities performed by TIM workers on the roadway (inside and outside the vehicle) at time of death (pre-event, event, and post-event) and TIM-related industries at highest risk for fatal occupational injuries, is lacking.

Methods: Kentucky Fatality Assessment and Control Evaluation (FACE) program analyzed 2005-2016

TIM occupational fatality data based on multiple data sources: death certificate data, Collision Report Analysis for Safer Highways (CRASH) data, and media reports, among others. TIM-related occupational fatalities were identified, and characterized; fatality investigations were performed (n=6), and hazard alerts (n=3) and a tool kit (n=1) were produced. Concordance of surveillance data sources in identifying TIM occupations, driver vs. pedestrian status, and occupational fatality incident location was assessed, and occupational fatality rates for TIM industries were determined. Literal text analysis was performed on FACE data, and a multiple linear regression model and SAS proc sgpanel were used to estimate and visualize the U.S. TIM occupational mortality trend lines and confidence bounds.

Results: There were 29 TIM fatalities from years 2005-2015 in Kentucky; 41% of decedents were in the police protection occupation, and 21% each were in the fire protection and motor vehicle towing industries. Over one-half of the TIM decedents were performing work activities as pedestrians when they died. Media reports identified the majority of the occupational fatalities as TIM-related (28 of 29 TIM-related deaths); the use of death certificates as the sole surveillance data source only identified 17 of the 29 deaths as TIM related, and the use of CRASH data only identified 4 of the 29 deaths as TIM-related. Injury scenario text analysis showed law enforcement vehicle pursuit, towing and recovery vehicle loading, and disabled vehicle response were particular high-risk activities that lead to TIM deaths. Using U.S. data, the motor vehicle towing industry had a significantly higher risk for occupational mortality compared to the fire protection and police protection industries.

Discussion: Multiple data sources and fatality investigations are needed to comprehensively identify TIM fatalities and to examine surrounding circumstances (pre-event, event, and post-event), since no one data source in itself was adequate in identifying and characterizing TIM fatalities, and undercounted the total number of TIM fatalities. The motor vehicle towing industry, in particular, is at elevated risk for occupational mortality. TIM responder training programs are offered in states by the Federal Highway Administration, and targeted mandatory TIM training for the motor vehicle towing industry should be considered. Also, enhanced law enforcement roadside safety training during vehicle pursuit and apprehension of suspects is recommended.

D3.2

Title: Cause-Specific Mortality Following Occupational Injury: An Exploratory Study

Authors: [Abay Asfaw](#), [Kate Applebaum](#), [Paul O'Leary](#), [Andrew Busey](#), [Yorghos Tripodis](#), [Leslie Boden](#)

Background: Since 1990, the U.S. Department of Health and Human Services has aimed to eliminate socioeconomic disparities in health and mortality. However, there is evidence that these disparities have been growing. A 2015 study showed that mortality among white, non-Hispanics who were 45-55 years of age grew between 1999 and 2013. Others have shown that occupational injury is associated with elevated mortality, anxiety and depression, chronic pain, and opioid use. This led us to hypothesize that the mortality of occupationally injured workers may be elevated for some specific causes of death. Objective: We examined whether workers with lost-time injuries (injuries involving more than 7 days off work or permanent disability) had a shorter time to death from drug overdose and suicide than workers with medical-only injuries. A secondary objective was to see whether time to death was shortened as well for malignant neoplasm, diseases of the respiratory system, and diseases of the circulatory system. Any such differences could shed light on possible specific mechanisms through which higher mortality occurs.

Methods: We used 1994-2000 injury data provided by the state of New Mexico Workers' Compensation Administration. Our analytic sample included 96,700 injured workers, of whom 64.4% suffered medical-only injuries and 35.6% suffered lost-time injuries. We then linked data on this cohort with data from the Social Security Administration (SSA) Death Master File (DMF) from 1994 through 2013. This created a cohort consisting of injured workers with mortality follow-up ranging from 13 to 20 years. Approximately 8% of the injured workers were deceased, based on the SSA data. We validated the deaths identified by SSA using the National Death Index database, which also provided us with cause of death information. Measurement of variables: The outcome variables were time to death from drug-related, self-harm, malignant neoplasm, diseases of the respiratory system, and diseases of the circulatory system. We considered both underlying and contributing causes. Because of the substantial gender differences in mortality hazard and causes of mortality,

we estimated separate models for men and women. Covariates included age (six categories), earnings before injury (six categories), and industry (ten categories), and the risk of death from other causes. We used a competing risks version of the Cox proportional hazards model. The follow-up period started on the date of injury and ended on the date of death or the last date of follow-up (12/31/2014), whichever came first.

Results: The median follow up period was 217 months. The shares of death from drug overdose, suicide, malignant neoplasm, diseases of the respiratory system, and diseases of the circulatory system were 8%, 6%, 24%, 19%, and 38%, respectively. Controlling for age, income, industry, and the risk of death from other causes, both women and men workers with lost-time injuries had an excess hazard of death from drug overdose, suicide, diseases of the respiratory system, and diseases of the circulatory system. However, there was no statistically significant difference in the risk of dying from malignant neoplasm between workers with lost time injury and medical only injury for both sexes.

Discussion: Workers who sustained severe lost-time injuries had a higher risk of mortality from respiratory disease, disease of the circulatory system, drug overdose, and suicide than workers who sustained medical only injuries. Demonstrating excess risks for specific causes of death is a prerequisite for future work that would identify the work hazards that contribute to these excess mortality risks. This would help to design better policies to eliminate or substantially reduce of those hazards.

D3.3

Title: Analysis of Experimental Drug and Alcohol Data from the Census of Fatal Occupational Injuries, 2011-2016

Author: [Christen Byler](#)

Background: Since the adoption of the current version of the Occupational Injuries and Illnesses Classification System (OIIICS) in 2011, the Census of Fatal Occupational Injury and Illness (CFOI) has seen a three-fold increase in accidental drug overdoses. Also in 2011, the program began a pilot to collect information on whether drugs or alcohol were present in the fatally injured worker's system at the time of incident and the specific substance found. This presentation will give an overview of the drug and alcohol data that is available

in the CFOI, including the experimental drug/ alcohol variables, and will seek to interpret these data in the context of appropriate qualifications based on data quality.

Methods: This study explores various gradients of drug involvement within CFOI data from years 2011-2016. These included drug overdoses, whether accidental, intentional, or with unknown intent (793 workers); traumatic injuries where the decedent was verified by a medical examiner or toxicology report to have had any legal or illegal drug or substance present in his or her system at the time of incident (1519 workers); other work injuries that were linked to a later drug overdose (21 workers) and any remaining cases not captured under the previous three criteria where source or secondary source was a drug (1 worker). Free form text fields containing information about the specific type of drug or substance were refined and classified into major drug type categories. Descriptive statistics were then generated using SAS 9.4.

Results: From 2011-2016, there were a total of 2332 work related deaths in the CFOI that were determined to be drug related or involved the decedent testing positive for a drug or substance at the time of incident. For all deaths, alcohol was found to be the most frequently identified substance in workers who died on the job, with a total of 635 fatal injured workers testing positive for alcohol at the time of incident. This included 90 workers who died due to overdose and 545 workers who succumbed to other traumatic injury. Of the 793 workplace deaths due to drug overdoses, the most frequently identified drug type was prescription opiates (found in 317 workers), followed by heroine (180 workers) and methamphetamine (137 workers). Nearly half of overdoses (387 deaths) resulted from use of legal prescription drugs only, while the other half involved the use of at least one illegal drug. Of overdose deaths, 513 fatalities were due to use of a single drug or substance, while 280 ODs were attributed to use of two or more substances.

Discussion: As drug deaths in the United States continue to increase, understanding the impact of drug and substance use in the context of work is critical. This study provides a more comprehensive picture of the nature of drug use leading to work-place overdoses, as well as providing important insights for types of drug use that may be associated with other types of traumatic fatal work injuries despite limitations of the data.

D3.4

Title: Explaining State-Level Variations in Construction Fatality Rates

Authors: [John Mendeloff](#), [Wayne Gray](#)

Background: Recent studies have shown two-fold and greater long-term differences in fatality rates in the construction sector across states in the United States. Differences this large deserve to be studied to see whether they arise from factors that can be affected by public and private policy choices. We focus on states as the unit of analysis because several public policies that may affect fatalities are determined at the state level. These include workers' compensation (WC) programs and the enforcement of occupational safety and health standards (for the 21 states that operate their own enforcement program in the private sector). We focus on fatalities because states appear to vary considerably in their underreporting of non-fatal injuries. We focus on construction because of the sector's contribution to overall occupational deaths in the economy as a whole and the persistence of high rates of fatalities in the industry relative to other industries. The relatively high number of fatalities in construction also allows statistical identification of correlates with fatalities given the stochastic nature of fatal occupational injuries.

Methods: The fatality data we use come from the Census of Fatal Occupational Injuries (CFOI), a data set collected by the U.S. Bureau of Labor Statistics since 1992. To obtain state identifiers, we carried out the work at the BLS Headquarters. We examine deaths through 2014 and exclude deaths due to either highway accidents or violence because these are less likely to involve traditional construction safety issues. Because of limitations on the use of data when there were fewer than 3 deaths in a state/year, our analysis looks at 32 states for 23 years. The policy variables we look at include the frequency of inspections and the size of penalties and the magnitude of workers' compensation costs. We also consider a set of control variables.

Results/Discussion: An increase from the sample mean of 6 inspections per hundred construction establishments to 9 inspections is associated with a reduction in the fatality rate of about 0.6 per 100,000, about 5%. In 2013 and 2014 inspection rates varied from only 2% in Florida to 16% in Minnesota. The other significant policy variable was the length of the waiting period before a

worker could receive indemnity benefits. Those with 7-day waiting periods had substantially higher fatality rates than states with 3-day waiting periods. However, this variable is clearly capturing other features that we need to examine further.

Session D4

Title: Shift Work and Injury

Moderator: [John Violanti](#)

D4.1

Title: Association Between Hour of Work and Injury Occurrence and Severity in the Oregon Construction Industry: Analysis of Workers' Compensation Disabling Claims, 2007-2013

Authors: [Liu Yang](#), [Adam Branscum](#), [Ellen Smit](#), [David Dreher](#), [Karen Howard](#), [Laurel Kincl](#)

Background: Despite ample research on extended shiftwork and working overtime, studies on the hourly trend of work-related injuries and illnesses have been limited, especially for workers in the construction industry. This study was to determine the distribution of work-related injuries and illnesses by hour of work and estimate the association between hour of work and injury severity among Oregon construction workers using workers' compensation data.

Methods: De-identified Oregon workers' compensation accepted disabling claims data in the construction industry from 2007 to 2013 were analyzed. A new variable, hour of work, was created by calculating the difference between two existing variables in the dataset: time the claimant started the shift on date of injury and time the injury occurred. Cases with more than 12 for the hour of work were excluded from analyses to reduce misclassifications. Numbers of claims in each hour of work were tabulated to determine the frequency distribution. Linear regression models were used to examine the association between hour of work and injury severity (measured as medical cost, log-transformed in the models), adjusted for age, gender, construction sector, occupation, weekly wage, and injury nature. Medical cost and weekly wage were standardized to the 2013 US dollar in these analyses. Construction sector, occupation, and injury nature was coded using standard codes, including NAICS, SOC, and OIICS (v1.01).

Results: Of the 12,222 accepted workers' compensation disabling claims in Oregon construction industry from 2007 to 2013, 7382 claims (60.4%) contained complete data for calculating hour of work. Among the cases with complete data, 7148 cases (97%) were within the first 12 hours of work, and thus the following analyses only included the 7148 cases. The majority of claimants (90%) started their work shift between 6am and 8am. The average medical cost involved in a claim was approximately \$12,000 (ranging from \$7.8 to \$417,200). The distribution of work-related disabling injuries and illnesses by the hour of work was bimodal, with the 3rd hour of work corresponded to the highest number of disabling injuries and illnesses (970 cases, 13.6%). Compared to the first hour of work, there were 28% more injuries and illnesses reported in the 3rd hour (95% CI: 1.16-1.41). Fewer injuries and illnesses occurred in the middle hours of a normal work shift (the 4th, 5th, and 6th hour of work), while the number of injuries and illnesses reached the second peak in the 7th hour of work (relative mean compared to the 5th hour of work: 1.18, 95% CI: 1.07-1.31). This pattern was fairly consistent across different age groups, construction sectors and occupations. Linear regression models indicated that injuries and illnesses occurred in the 4th, 5th, and 6th hour of work tended to be more severe, indicated by significantly higher medical cost (adjusted relative median: ≥ 1.23 , p-values: ≤ 0.01).

Discussion: This study identified the pattern of work-related injuries and illnesses among construction workers in Oregon in relation to hour of work. Further research is needed to understand why the middle period of a normal work shift was associated with more severe disabling injuries and illnesses as well as to develop interventions to prevent these injuries and illnesses.

D4.2

Title: Transportation-Related Fatalities Among Taxi Drivers from 2003 Through 2015: Older Drivers and Night Driving Can Benefit from Road Safety Programs

**Authors: [Cammie Chaumont Menéndez](#),
[Christina Socias-Morales](#), [Melody Gwilliam](#)**

Background: Transportation-related incidents continue to lead injury deaths, with workers who drive for a living at highest risk. Taxi drivers routinely transport passengers in highly congested metropolitan areas any time of

day or night, on demand, under any weather conditions. Taxi drivers average 7.2 transportation deaths annually per 100,000 drivers – double the rate of all workers at 3.6 per 100,000. Current momentum in workplaces adopting road safety programs and policies further highlights the need for a similar, standardized approach for taxi drivers who are independent contractors rather than employees and may not uniformly receive the benefits of road safety measures. We describe at a national level the study population and the factors associated with increased rates due to transportation-related fatalities among taxi drivers over a 13-year timespan.

Methods: The Census of Fatal Occupational Injuries managed by the Bureau of Labor Statistics provided the number of all taxi drivers fatally injured due to transportation-related incidents from 2003 to 2015. Corresponding national estimates of taxi drivers working during the same period were obtained from the Current Population Survey to calculate rates per 100,000 drivers. Poisson regression analysis using SAS generated rate ratios adjusted for sex, age, race/ ethnicity, nativity and region.

Results: The predominant establishment size was fewer than 10 employees (39%). Almost half (48%) of transportation-related fatalities occurred on an interstate, freeway or expressway. The overwhelming proportion of events occurred on the roadway (91%). The peak times for transportation-related fatalities among taxi drivers occurred between 11pm and 7am, exactly the opposite for peak times for transportation-related fatalities among all workers (7am through 7pm). From 2003-2015, 215 drivers died with men [RRadj 2.2; 95% CI 1.1-4.5] and drivers aged >55 [RRadj 2.4; 95% CI 1.3-4.3] experiencing more than double the rates of women and younger drivers. Asian drivers experienced the lowest rates of all races and ethnicities reported [RRadj 0.3; 95% CI 0.1-0.7]. Foreign-born drivers experienced notably lower rates than U.S. born drivers [RRadj 0.7; 95% CI 0.5-1.1]. Adjusted rate ratios did not reveal any significant differences in transportation-related fatalities by region.

Discussion: Sub-populations of drivers based on non-modifiable characteristics such as sex, age and other socio-demographic factors are experiencing different rates of transportation-related fatalities. Road safety measures that include safety training, in-vehicle monitoring systems and road safety management programs are typically mandated as municipal ordinances or a

company level policy. There is substantial variability in road safety measures across the major metropolitan areas. The NIOSH Center for Motor Vehicle Safety publishes informational resources, such as older driver safety, that taxi companies and city regulators can use to implement road safety management programs or strengthen pre-existing ones. The uniform adoption and implementation of road safety management programs, demonstrated to be effective in reducing safety critical events that lead to motor vehicle crashes, is crucial to ensure all taxi drivers have access to public safety programs that benefit all who share the road.

D4.3

Title: Adapting Sleep Hygiene and Vehicle Operator Fatigue Management for EMS Ambulance Crews

Authors: [Gerald Krueger](#), [Billy Rutherford](#)

Background: Increasing evidence in EMS operations indicates some ambulance crews, especially vehicle drivers, are not obtaining sufficient sleep; and due to uncompromising work-rest schedules and demanding op tempos, EMS crews experience driver fatigue, which has occasionally led to ambulance crashes on our roadways. Ambulance crashes, especially in municipalities, tend to be among the most costly (financially and otherwise) of all roadway crashes.

Methods: In conjunction with frequent conduct of Emergency Vehicle Operator Course (EVOC) training programs, American Integrated Training Systems, Inc. (AITS) visited/ interviewed EMS ambulance crews in different settings around the country (e.g. at a variety of fire companies) in an attempt to discern the root of such safety concerns.

Results: There is a significant variety of EMS work-rest schedules, work-place policies, and operational procedures, across different settings (e.g. municipalities vs. rural, busy vs. slack operations, and in different regions of the country). However, there is evidence that some of the disparate accommodations for EMS crews adversely affect crews abilities to obtain sufficient quality rest and sleep, and combined with high op tempos, some EMS operator-fatigue situations continues to degrade situational safety in many of the country's EMS operations.

Discussion: DOT's NHTSA is currently doing research work to develop a model, and to establish guidelines for

sleep/ rest and fatigue management for EMS organizations. However, that undoubtedly will take years. In the interim, AITS, Inc. has already added a module on sleep hygiene and operator fatigue management principles into its EVOC courses widely offered around the country and in a few overseas operations. For a variety of reasons, Fire Department and other EMS-related response to such proposed guidance has been quite mixed. Some of these will be highlighted in this short talk. AITS also has offered up early suggestions for alternative design modifications to firehouse and ambulance crew facilities, especially with an eye toward improving sleeping accommodations at the workplace. Some Departments, about to undergo upgrade modifications to their facilities are listening to the suggestions and adopting some of the principles of crew fatigue management in facility design and they also are modifying their operational procedures to improve on-the-job quality of life for EMS crews, and as a result increase crew safety.

D4.4

Title: Red Light: A Novel, Nonpharmacological Intervention to Help Increase Alertness in Shift Workers

Authors: [Mariana Figueiro](#), [Barbara Plitnick](#), [Charles Roohan](#), [Mark Rea](#)

Background: In the U.S., an estimated 15% of full-time wage and salaried employees work outside regular daytime working hours, with over 10 million Americans following evening, night, or rotating shift schedules. Shift work, especially when it involves working through the night, disrupts workers' sleep-wake cycles and increases the likelihood that they will experience sleepiness and insomnia, decreased productivity, work-related injuries, and diminished general well-being. Shift work's attendant disruptions of the human circadian system and melatonin cycle have been associated with increased risk for metabolic syndrome, diabetes, cardiovascular disease, and cancer. While light exposure can be used to improve worker alertness and performance, melatonin suppression associated with exposure to short-wavelength ("blue") light at night has been linked to a higher risk for breast cancer. Our laboratory studies have demonstrated that exposure to longer wavelength ("red") light, which does not suppress melatonin, has an acute alerting effect. For this study, we hypothesized that both blue and red light would positively affect measures of

alertness and performance, but only blue light would suppress nocturnal melatonin.

Methods: Thirty-five nurses (22 day shift and 13 night shift) have completed the within-subjects protocol to date. After a 2-week baseline assessment, the nurses experienced one of three experimental lighting conditions: (1) blue light, (2) red light, and (3) dim white light (the control). These conditions were administered for 30-minute periods at the beginning, middle, and end of the nurses' 12-hour shifts. The nurses were exposed to all three conditions over the course of the study, with a washout period of 2-4 weeks occurring between the conditions. Both immediately prior to and immediately following each light exposure, the nurses were asked to complete a series of three short-term visual performance tests (psychomotor vigilance task, one-back task, go/ no-go task); collect saliva samples for melatonin and cortisol assays; and provide self-reports of sleepiness.

Results: The study's preliminary results show a statistically significant decrease in reaction times for the one-back task under the red light condition. As hypothesized, only the blue light condition significantly suppressed melatonin in night-shift workers.

Discussion: While these results are preliminary, they are consistent with the results of our laboratory studies, which show that appropriately timed and specified (i.e., light level, spectrum, and duration) light exposures can promote alertness at any time of day or night. These data should be of particular interest to anyone concerned with fatigue, sleep, and work hours as well as the promotion of workers' health and safety. More importantly, providing a lighting intervention that increases alertness while maintaining high levels of melatonin at night may be beneficial for shift workers.

Session D5

Title: Injury Prevention and Economics

Moderator: Melvin Myers

D5.1

Title: Perceptions of Rural Residents' Off-Road Vehicle Insurance Coverage

Authors: [Charles Jennissen](#), Karen Thornton, Kristel Wetjen, Pam Hoogerwerf, Lauren O'Donnell, Gerene Denning

Background: All-terrain vehicles (ATVs) and side-by-sides (SxSs) are frequently operated unsafely on the farm resulting in catastrophic injuries and death of owners, family members, employees and others visiting the farm. We hypothesize that insurance requirements and concern about liability could act to promote safer behaviors that prevent might prevent crash-related injury and death. The study objective was to determine if ATV and SxS owners' responses to off-road vehicle insurance questions matched actual insurance coverage.

Methods: A survey was administered to visitors at the 2016 Farm Progress Show in Boone, Iowa, to ask owners what ATV and SxS damages and liabilities were covered under their insurance policies. Survey questions included vehicle type, demographics, number of crashes, and insurance coverage information. Frequency and chi-square analysis was conducted on the demographic, crash, and insurance coverage data. The four most frequently named insurance companies were interviewed to determine what was actually covered under their policies. The insurance company and participant responses were analyzed to ascertain if and how well participant responses match with actual coverage.

Results: 262 ATV/ SxS owners completed the survey. Over four-fifths of participants were male and one-half were between 45-64 years old. Over 85% lived on a farm, and over half owned both an ATV and SxS. Owners were more likely to use SxS vehicles exclusively for work and not recreation than ATV vehicles. Nearly two-fifths had had at least one lifetime ATV crash and 7.5% had had at least one lifetime SxS crash. Approximately 1/4 of the survey participants were not able to list the insurance company covering their off-road vehicle. More participants were not sure of their coverage if the crash was: on the road versus off the road, for recreational rather than occupational use, due to non-family versus family members operating the vehicle. The top four insurance companies covered 38.5% of the participants. Insurance company interviews revealed that they insure off-road vehicles in two ways: (1) a separate policy in which case the vehicle is covered similar to an automobile policy or (2) under a farm policy which in most cases if the vehicle leaves the property there is no coverage. Analyzing data for both types of coverage, owners were more accurate in their insurance coverage assessment if they had a separate policy than if they were covered under a farm policy. Survey participants who stated they were covered under a farm policy for

many of the situations questioned likely misunderstood their coverage.

Discussion: ATV and SxS vehicle use is growing in the agricultural sector. Crashes of both vehicles can cause catastrophic injuries and death. Prior research indicates that vehicle operators and passengers frequently use unsafe behaviors. Understanding insurance requirements may influence owners to use safer behaviors and prevent the inappropriate use of their vehicles by others including employees, family members and those visiting the farm. This may result in reduced crash-related deaths and injuries.

D5.2

Title: Farm-Related Injuries: Cost and Risk Estimations by the Type of Injury Claims

Authors: [Navneet Kaur Baidwan](#), [Carri Casteel](#), [Fredric Gerr](#), [Marizen Ramirez](#)

Background: Farm-related work is one of the most hazardous occupations in the United States (U.S.) with high fatal and nonfatal injury rates. Data pertaining to acute farm-related injuries are limited, and not readily available. The purpose of this paper is to measure the burden of, costs associated, and the likelihood of such injuries with respect to three injury characteristics including, i) body parts involved, ii) causes, and iii) nature.

Methods: Workers' compensation (WC) data for small farm-related injuries from 2010-2016 were provided by a large insurance company that covers Arkansas, Arizona, Georgia, Iowa, Illinois, Indiana, Kansas, Maryland, Michigan, Minnesota, Montana, Nebraska, New Hampshire, New York, Philadelphia, South Carolina, South Dakota, Tennessee, Texas, Vermont, Virginia, and Wisconsin. Besides descriptive statistics, regression models accounting for within-policy correlations, and adjusting for the state were employed to investigate the association between the injury characteristics and respective costs incurred. These were further stratified by the severity of claim, i.e. more severe (permanent or temporary disability and death-related) and less severe (medical only). The relative risk of having a more severe as opposed to less severe claim was estimated similarly for each of three injury characteristics.

Results: Out of a total 1,059 claims, most (66%) were less severe or medical-related claims. The most commonly injured body part was upper distal (lower arm, elbow, hands, fingers, and wrist) (n=298, 28%). The most

common causes were slips/ trips/ falls (n=196, 19%), and animal/ insects (n=151, 14%). The most common nature of injuries included sprains/ strains (n=271, 26%), and superficial/ open wounds (n=209, 20%). Overall, 917 claims were paid by the insurance company, of which 65% were less severe or medical only claims. The overall cost paid by WC for these 917 claims was around \$22.7 million. Out of this, 96% were more severe claims that led to death or disability. Adjusted regression models showed that the mean cost associated with the injury characteristics varied by the severity of the claim. Head/ face/ neck injuries resulted in a mean medical claim cost of \$3,242, while the same injuries resulting in more severe death/ disability claims cost of \$70,361. In general, severe injuries cost the most for all categories. The mean costs associated with the body parts injured were highest for system wide/ multiple injuries that resulted in death or disability (\$84,813). By cause and nature of injuries, flying objects/ falling objects/ collision with objects (\$88,761) and dislocations/ fractures (\$41,556) resulting in death/ disability were most the expensive claims. The risk of having a more severe death/ disability claims as opposed to less severe medical only claims also varied by the body part, cause, and nature of injury. Twisting and slips/ trips/ falls and flying objects were over two times more likely to be severe injuries than injuries caused by tool/ machine use.

Discussion: There are high WC-related costs associated with small farm-related injuries. Costs are particularly high for system wide/ multiple injuries, flying objects/ falling objects/ collision with objects, and slips/ trips/ falls. Similarly, injuries by twisting and slips/ trips and falls are more likely to lead to more severe or death or disability-related claims. Priority interventions should target preventing these injuries accordingly.

D5.3

Title: Cost-Effectiveness of the New York ROPS Rebate Program: An Update

Authors: [Paul Jenkins](#), [Melvin Myers](#), [Julie Sorensen](#), [Pamela Tinc](#), [Timothy Kelsey](#)

Background: For decades, tractor overturn fatalities have plagued farmers in the United States. As the leading cause of death on farms for many years, this issue has also been a primary focus among safety researchers. Rollover protective structures (ROPS) were first introduced in the United States in the 1960s. When

used with seatbelts, ROPS have been proven to be 99% effective in preventing death and serious injury in the event of an overturn. Though ROPS were included as standard on new tractors sold after 1985, many older tractors are still in use today, and need to be retrofitted in order to protect operators. Despite the availability of ROPS, farmers are hesitant to retrofit their tractors, citing cost, time constraints, and optimism bias as the primary barriers. In the early 2000s, the New York ROPS Rebate Program was established to encourage farmers in the state to retrofit their older tractors with ROPS by reducing those barriers. The Program offers farmers sourcing assistance and a 70% rebate toward the cost of the ROPS and installation. In addition, promotions for the Program were designed with the help of farmers. In 2009, a cost-effectiveness analysis of the Program was published, which estimated a 10-year savings of \$1,910,000. This study seeks to update the prior analysis and determine the accuracy of this prediction.

Methods: A cost-effectiveness analysis of the ROPS Rebate Program in New York was performed based on data from the program's inception (2006) through 2017. Data were collected through annual surveys with participants, in which they were asked to report rollovers, tip overs, close-calls, and other potentially fatal events, as well as injuries. Exposure time was calculated for each participant based on the date of retrofit through to the last follow-up. In cases in which an event occurred, follow-up was considered to be the date the event was reported. Program expenses included promotion and administration of the Program, as well as the total cost of rebates. Program costs per event, as well as the estimated cost of injuries and fatalities due to tractor overturns, were calculated and compared.

Results: Of the 1,054 Program participants for which follow-up was available (67.2% of all participants), 17 reported rollover or tip over events during the follow-up period. Based on these events, the estimated cost savings of the Program to date, and projections into the future, have been calculated and will be presented.

Discussion: Though the analysis demonstrates a significant cost savings because of the Program, additional savings would likely have occurred if the option of custom fabricated ROPS were a more palatable option for tractor manufacturers. The study also reveals that falling objects are a frequent source of potential death or injury that can be addressed by ROPS. If these events had been included in the analysis, program savings

would have been significantly increased. Overall these savings, along with the preservation of life, families, and farms, demonstrate the importance of such programs, providing sufficient motivation for the recent expansion of the ROPS Rebate Program to the national level.

D5.4

Title: Optimal Investment in Engineering Controls and Personal Protective Equipment

Authors: [Brian Quay](#), [Regina Pana-Cryan](#), [Tim Bushnell](#)

Background: Engineering controls (EC) are often more protective than personal protective equipment (PPE) but the initial investment in EC might seem cost-prohibitive to a firm. In addition, employers may not understand how the cost of PPE and EC can change over time. Therefore, firms may choose not to invest in EC but rather in less expensive and less protective PPE. In most cases, firms do not face a binary decision (EC versus PPE) but must decide what the most cost-effective mix of EC and PPE would be to address their specific occupational safety and health (OSH) needs. In order to promote best practices in injury prevention, there is a need for more guidance on the relative cost-effectiveness of EC and PPE.

Methods: We used a cost-minimization model to estimate how much a firm should invest in EC and PPE in order to minimize the cost of injury prevention (intervention) over time, subject to a specified level of injury reduction. The assumption of a specified injury reduction as well as other assumptions can be relaxed in future models. Our current model included two functions: (1) the firm's cost function, which shows how much it will cost to purchase EC and PPE, and (2) the production function, which shows how effective EC and PPE are with regard to injury prevention. Using the Lagrange Method, we combined these functions to find the optimal amounts of EC and PPE that minimize the firm's costs. For example, if a firm wanted to decrease its expected injuries per year from five to four, the model would solve for the least costly way to use EC and PPE to achieve this goal. The firm is responsive to the cost of EC and PPE, the relative effectiveness of EC and PPE in terms of injury prevention, and the specified level of injury reduction. The cost of EC is the cost of the equipment plus training and upkeep costs. The cost of PPE is the cost of the PPE program over the lifetime of the EC,

which includes the cost of units of PPE, fitting, education, and training. The production function should portray the ways in which EC and PPE interact to prevent injuries. Different functional forms depict the complex relationships between PPE and EC in different settings.

Results: We found that as the cost of EC and PPE change, so does the firm's optimal quantity of EC and PPE, as the firm is responding to a change in relative costs. The firm is highly responsive to the EC lifetime, which then affects the cost of the PPE. An EC with a relatively long life implicitly raises the cost of PPE, resulting in a relative increase in the optimal amount of EC and decrease in the optimal amount of PPE. Additionally, there were settings where it was optimal for the firm to invest either solely in EC or solely in PPE, a result driven by the form of the production function. To illustrate the method and present numerical results, we used a simple optimization example that involves a series of strong assumptions: the firm produces a hazard at a fixed and known quantity and is acting only in the short-run. In this example, the short-run is implicitly modeled and reflects the time necessary to achieve the hazard reduction. We assumed that PPE cost \$50 per unit; EC cost \$300 per unit; the production function was Cobb-Douglas; and EC was 9 times more effective than PPE to prevent injuries. Then if a firm aimed to decrease expected injuries by 5, it would minimize its intervention cost by purchasing roughly 25 units of PPE and 4 units of EC, totaling around \$2,500.

Discussion: Firms can use our model to understand how to evaluate both the effectiveness and the cost of EC and PPE over time and respond to changes following the passage of new regulation or the development of new standards and technology. This may encourage increased adoption of EC and optimal mix of EC and PPE, thereby improving worker protection. Our model contributes to the OSH literature by providing a new economic perspective to hazard control decision-making.

Session E1

Title: Fatal Injuries in the U.S. Construction Industry

Moderator: Christine Branche

This session is composed of four presentations, providing updated injury data and information on database development from the CPWR safety and health surveillance research.

E1.1

Title: Trends and Patterns of the Construction Focus Four 1992-2016

Authors: [Xiuwen Sue Dong](#), [Xuanwen Wang](#), [Rebecca Katz](#)

Background: Fall, struck-by, electrocution, and caught-in/ between are the Focus Four hazards identified by the U.S. Occupational Safety and Health Administration as the leading causes of fatalities in the construction industry. This study examines fatal injuries among construction workers caused by these four hazards.

Methods: Three large national datasets (Census of Fatal Occupational Injuries, Current Population Survey, and Current Employment Statistics), covering 1992 to 2016, were analyzed. Stratified and time series analyses were conducted using SAS 9.4 to identify high-risk subgroups in construction over time.

Results: From 1992 through 2015, the Focus Four claimed the lives of 745 construction workers annually, accounting for 70% of all construction fatalities. Specifically, 8,211 deaths were from falls to a lower level, 4,648 deaths were due to being struck by an object or a vehicle, 2,807 deaths were caused by contact with electric current, and 2,207 deaths were from caught-in/ between injuries over this period. Each of these causes of death hit their lowest point between 2010 and 2012 during the latest recession and increased since then, though at different paces. Risks of the Focus Four vary by demographics and occupation. Deaths from falls to a lower level reached 353 in 2015, a 36% increase since 2011 and more rapid growth than the other three causes. Increases in fall fatalities were disproportionately high in residential construction and among Hispanic and foreign-born workers. The risk of struck-by was higher among highway maintenance workers and power-line installers, while the risk of caught-in/ between injuries was highest among ironworkers. In addition, excavating or loading machine operators had a higher risk of fatality from being struck-by as well as caught-in/ between injuries. Although electrocutions remained the third leading cause of death in construction, such deaths decreased by 39% between 2003 and 2015, suggesting effective interventions. Overall, older construction workers had an elevated risk for fatal injuries caused by the Focus Four. (Results will be updated to cover the 2016 data).

Discussion: This study identifies worker groups and occupations with high risk of the fatal four hazards in construction. Enhanced hazard controls and interventions are needed to improve construction safety and health overall.

E1.2

Title: Fatal Occupational Injuries at Road Construction Sites from 2003–2016

Authors: [Xuanwen Wang](#), [Xiuwen Sue Dong](#), [Rebecca Katz](#)

Background: Working at road construction sites is dangerous. This study examines the trends and patterns of fatal occupational injuries among construction workers at road construction sites over time, especially after the recent economic downturn.

Methods: Two large national datasets from 2003 to 2016 were analyzed, including the Census of Fatal Occupational Injuries and the Current Population Survey. Stratified and time series analyses were conducted to identify differences among subgroups in construction over time. Linear regression and odds ratios with 95% confidence intervals were utilized to measure whether changes or differences are statistically significant.

Results: From 2003 to 2015, 1,166 construction workers died at road construction sites, comprising more than 70% of such deaths in all industries. Coinciding with the employment trend, the number of fatalities at road construction sites climbed from a low of 73 in 2010 to 87 in 2015, a nearly 20% increase over five years. In terms of event or exposure, more than half of road construction deaths between 2011 and 2015 were pedestrian vehicular incidents where a worker was struck by a vehicle or mobile equipment. Another 12.6% were roadway incidents that occurred while a worker was operating a vehicle. Trucks were the top source of deaths at road construction sites, involved in nearly one-quarter of road construction site fatalities. Passenger vehicles (including automobiles, buses, and passenger vans) were the second most common source, causing 17.5% of construction fatalities at those sites. By industry subsector, 309 workers in the Highway, Street, and Bridge subsector (NAICS 2373) were killed at road construction sites, accounting for 72% of all road construction fatalities during these years. By occupation, construction laborers had the highest number of fatalities at road construction sites, while highway maintenance workers

had the highest risk of such deaths (14.2 deaths per 100,000 full-time equivalent workers). Workers 55 years and older as well as African American workers also experienced an elevated risk of such fatalities.

Discussion: Compared to other major industries, the construction industry experiences a large burden of deaths at road construction sites. Interventions should be enhanced for high-risk occupations and worker groups. Note: The numbers will be updated to 2016 when the 2016 CFOI micro data are available.

E1.3

Title: Mapping and Dissemination of Data on Fatal Construction Injuries in the United States, 2011-2018

Author: [Gavin West](#)

Background: Falls from elevation are the leading cause of fatal and non-fatal injuries in construction. Approximately one-third of work-related deaths in construction are due to falls. Hundreds of construction workers in the U.S. are killed every year due to on-the-job falls, and over 10,000 are seriously injured. In 2012, a national campaign was launched to raise awareness and prevent fatal falls in construction. One aspect of supporting the campaign's objectives was to provide construction industry stakeholders and campaign partners with readily accessible, current, and detailed information about fatal falls in their geographic areas.

Methods: Incident-specific information on work-related construction fatalities was collected for calendar years 2011 to 2017. OSHA records of construction fatality investigations, including open investigations, were obtained on a quarterly basis. Daily reviews of Google Alerts results using the search term "worker killed" were used to identify news reports of construction fatalities. Incident-specific fatality data were extracted from news reports, combined with OSHA data, and disseminated to stakeholders and the general public on a quarterly basis via CPWR's campaign website (www.stopconstruction-falls.com). Information collected included age, occupation, industry, address and location of death, major cause of death, etc. The data were made readily accessible via interactive online maps and downloadable spreadsheets. Descriptive statistics were calculated to summarize the data contained in the maps and usage.

Results: The mapping project has facilitated access to

information on approximately 4,500 on-the-job construction deaths, of which approximately 1,500 were fatal falls. Geographically, fatal falls occurred across the entire United States with clustering in and around densely populated cities. On average, data were obtained for an estimated 73% of the actual number of construction fatalities that occurred annually in the U.S. since 2011. The maps continue to be a frequently used resource with over 130,000 total views.

Discussion: The fatality maps have helped to achieve the campaign's goal of raising awareness about the unacceptable number lives being lost in the construction industry, particularly as a result of fatal falls. Users have provided positive feedback on the maps and accompanying data sets, which have been used in Workers' Memorial Day events and reports, fall prevention campaign efforts at the local level, worker training; and to access specific information (e.g., recent information about deaths of female construction workers in California, fatalities in which construction workers were backed over by heavy equipment, struck-by deaths where excavator buckets became detached, and confined space deaths involving would-be rescuers).

E1.4

Title: Recommendations for Construction Safety and Injury Prevention: Findings from the Construction FACE Database

Authors: [Rebecca Katz](#), [Xiuwen Sue Dong](#), [Xuanwen Wang](#)

Background: This study analyzed the Construction FACE Database (CFD), a quantitative database developed by CPWR from reports of the Fatality Assessment and Control Evaluation (FACE) program conducted by the National Institute for Occupational Safety and Health (NIOSH). The CFD contains detailed data on 768 fatalities in the construction industry reported by NIOSH and individual states from 1982 through June 30, 2015. In addition to information on workers' demographics and employment characteristics, the CFD includes information on the victim's employer and the overall job environment and safety climate when the incident occurred, such as use of personal protective equipment (PPE), safety training, etc. Recommendations from the FACE investigators, which may be unavailable in most existing data sources, were also categorized and coded in the CFD. This study focused on FACE recommendations.

Methods: Recommendations fell into five main categories: PPE (including provide functional personal fall arrest system or PFAS), Equipment (e.g., install safety protection, enforce proper use of equipment), Training (such as safety training or job training), Organizational Factors (e.g., conduct Job Safety/ Hazard Analysis), and Violations (such as enforce child labor laws). These recommendations were stratified by characteristics of the victim workers (e.g., race, gender, age, occupation, job tenure), and their employers (e.g., construction subsectors, years in business), as well as type of injuries (e.g., fall or struck-by injuries). SAS 9.4 was used for analyses.

Results: Of the 768 fatalities in the CFD, 42.3% were from falling, 17.7% were due to contact with electricity, and 17.3% were from being struck by objects, equipment, or vehicles. The majority of the victims were male, and one in five died within the first two months on the job. PFAS were not available to more than half of the fall decedents (54%). Lack of access to PFAS was particularly high among residential building contractors as well as roofing, siding, and sheet metal industry sectors (~70%). The FACE investigators gave specific recommendations to each case. Among deaths due to falls, 79% of reports recommended providing safety training and 54% recommended installing safety protections. Providing safety training and ensuring safe worksite conditions was recommended for 75% and 49% of the electrocution cases, respectively. For fatalities due to struck-by injuries, 64% of reports recommended providing safety training, and 42% called for installing safety protections. Conducting a job safety analysis was recommended more frequently for smaller businesses than larger businesses. Newly established businesses were more likely to receive recommendations for providing functional PFAS and proper equipment for the task. Providing safety training was also more likely to be recommended for workers under 25 years of age (> 85%) than for older workers (68% for workers 65+). Overall, the most common recommendations were providing safety training (75%) and installing safety protections (43%).

Discussion: Comprehensive research using FACE reports may improve understanding of work-related fatalities and provide much-needed information on injury prevention. Although the findings may not represent the entire construction industry today, they provide strong evidence in favor of protection requirements by the Occupational Safety and Health Administration (OSHA). In addition to stronger enforcement, educating employers

and workers about the importance and effectiveness of safety protection is crucial for compliance and injury prevention. (The CFD is freely accessible online: <https://www.cpwr.com/research/construction-face-database>.)

Session E2

Title: Young Worker Injuries/Fatalities

Moderator: Kimberly Rauscher

E2.1

Title: An Overview of Young Worker Deaths in the U.S.

Author: [Kitty Hendricks](#)

Background: Fatality rates and characteristics can differ significantly by industry and age of the decedent. Previous research has suggested that young workers are at increased risk for work-related injuries and fatalities. The National Institute for Occupational Safety and Health (NIOSH) has worked to advance workplace safety for young workers through surveillance, investigations, curriculum development, and research into risk factors and intervention evaluations.

Methods: Data from the Bureau of Labor Statistics' Census of Fatal Occupational Injuries will be examined for work-related fatalities for young workers less than 18 years of age. Employment data from the Current Population Survey will also be utilized to calculate fatality rates.

Results: Between the years 2011 and 2016, 142 working youth less than 18 years of age died in the United States. In 2016, there were an estimated 1.96 million young workers between 15 and 17 years of age employed across all industries. Although youth less than 18 years of age make up a small percentage of the overall workforce (<1.5%), their employment is often concentrated in specific industries, such as services, retail trade, construction, and agriculture. Between 1994 and 2013, services (12,821,000) and retail trade (5,851,000) industries had the highest full-time equivalent (FTE) counts for youth 15 to 17 years of age. However, the agricultural production and construction industries had the highest fatality rate for youth, with 19.7 and 16.5 deaths per 100,000 FTE, respectively. This presentation will examine young worker fatality rates by industry sector, injury characteristics, and demographic characteristics of the decedent.

Discussion: This review of young worker fatalities will build on previous NIOSH research in this area. The results will display recent trends in young worker deaths, identify factors common among workplace deaths for young workers, and assist policy makers and researchers in further efforts to reduce fatal injuries to young workers in the U.S.

E2.2

Title: Young Worker Reported Injuries in New Jersey for FY 2017 and Time Trends 1999-2017

Authors: [Derek Shendell](#), [Daniel Uhiara](#), [Judith Graber](#), [Lauren Gonzalez](#), [Maryanne Fakeh](#)

Background: New Jersey Department of Education (NJDOE) law requires accidents or incidents (injury) involving career-technical-vocational education (CTE) students, and/or staff, to be reported to the Commissioner of Education within five business days. Incidents (de-identified) get reported directly to NJ Safe Schools Program (NJSS) for analyses. Reporting began with original paper forms (I) in December 1998-January 1999, then a one-page revised print form 2005-2010 (II) followed by a two-page version for enhanced readability 2010-2012 (III). Starting in 2012, and mandated by law starting fall 2013, a newer online form was implemented (in PsychData); it also collects race and ethnicity data in addition to 23 other data fields.

Methods: 2016-2017 school year data were analyzed; specific variables were also compared to 1999-2016 data to examine trends in reported injuries. Variables examined included age, gender, race/ ethnicity, injury treatment received at hospital versus doctor's clinic, personal protective equipment use, and existence of an individualized education plan, an indicator of a student with special health care needs, e.g., various disabilities.

Results: After 1208 (I), 140 (II) and 594 (III) print form injury reports, as of 12/31/2017 there have been 324 reported incidents meeting NJ law criteria in the online form, 22 during phase-in period (1/2012-8/2013) and 302 during mandatory reporting period (9/2013-12/2017). Other detailed data summaries and descriptive time trends will be presented.

Discussion: NJSS/ NJDOE state law-based online injury surveillance for young workers in approved CTE programs improves upon the former paper-based system, allows examination of potential disparities, and enhances reporting completeness, accuracy and precision.

E2.3

Title: Hospitalization and Injury Fatality Rates Among New Jersey Youth Workers Ages 14 to 21

Author: [Derek Shendell](#), [Daniel Uhiara](#), [Margaret Lumia](#), [Marija Borjan](#)

Background: Injury at work is a public health concern, particularly among adolescent workers and young adults ages 14-21. Secondary school career-technical-vocational education (CTE) related injuries are mandated by law under jurisdiction of New Jersey (NJ) Department of Education to be reported to NJ Safe Schools Program (NJ SS) online reporting system, which is the only U.S. State law-based surveillance data for young workers. To date, reported injuries are generally less severe; cases of permanent disability or death are rare. NJ Department of Health's (NJDOH) hospitalization and injury fatality records provide additional information about other CTE and non-CTE related injuries not necessarily reported to NJ SS but captured due to required inpatient care. This report examined NJDOH hospitalization and fatality records, in comparison with NJ SS surveillance reports, on injury among young workers ages 14-21.

Methods: Details of NJ SS online injury surveillance for approved programs are cited elsewhere. Hospital discharge data (HDD) were used to obtain the annual number of work-related hospitalizations 2007-2016, for youths ages 14-21. Hospital discharge data were abstracted based on age, state of residency, calendar year, and Workers' Compensation as primary payer. To calculate the annual crude rate of hospitalizations per 100,000 employed persons, denominator data were obtained from the Bureau of Labor Statistics (BLS), Geographic Profile of Employment and Unemployment. Estimated hospitalization rates were stratified by demographic data available. Hospitalization rates for primary diagnoses and job title/ status with two or more documented cases were also reported. Fatality data for youth ages 14-21 were obtained from the NJDOH Occupational Health Surveillance Unit's Fatal Occupational Injuries Surveillance project. Annual crude fatality rates per 100,000 full time equivalent (FTE) workers, age 16 years and older, were estimated for 1990-2016 using annual average FTE workers age 16 years and older and NIOSH's Employed Labor Force Query System as denominator. Fatality rates were also estimated by various demographic data available, including industry and

occupation. U.S. BLS data query tool was used to help stratify data by age group. Analyses were carried out using Statistical Analysis Software, SAS (v.9.4, Cary, NC).

Results/Discussion: Annual crude hospitalization rates gradually decreased over time. Hospitalization and fatality rates were higher among young adult workers ages 19-21; non-Hispanic Whites (NHW); and males. The percent fatality for the 19-21 age group is over three times the combined percent fatality for ages 14-17 and 18. Racial disparity persists in injury distributions among youth workers with Black and NHW often bearing much of the injury burden. Higher rate of male injuries may suggest higher tendency for males to engage in more risky jobs than females or a reflection of the current gender distribution in the underlying population. Overall decline in hospitalizations rates corresponds to a decrease in reported injuries among CTE students in NJ as observed in the NJ SS annual injury report. Age distribution was slightly different between hospitalization rates and injuries reported to NJ SS. While people ages 19-21 had higher hospitalization rates, people ≤ 17 years of age had the most injury reports in NJ SS data. Calculated rates inherently vary based on differences in the denominator. NJ SS data are based on public secondary school CTE enrollment programs across NJ, while NJDOH data involve all youth workers in NJ, regardless of student/ CTE enrollment status. Estimated rates were not calculated. Understanding causes and mechanisms of injury creating the largest share of this burden, and understanding disparities among affected groups, can inform public health prevention efforts with collaboration among stakeholders involved in injury surveillance, treatment, education.

E2.4

Title: Workplace Violence Against Youth: Results from a National Telephone Survey

Authors: [Kimberly Rauscher](#), [Carri Casteel](#), [Doug Myers](#), [Corinne Peek-Asa](#), [Cassidy Branch](#)

Background: Surveillance data show that workers under the age of 25 have an increased risk of workplace violence compared to all workers combined. Given their predominant employment in the high-risk retail and service industries, the lack of violence prevention programs in these industries, and the fact that youth may be uniquely affected by workplace violence due to their ongoing physical and psychological develop-

ment, young workers are a vulnerable population at risk. Despite these facts, young workers have received little research attention when it comes to workplace violence. Objectives: The main objective of the present study is to improve our understanding of young workers' experiences with workplace violence. Key outcomes investigated are as follows: 12-month victimization prevalence; the forms of violence (e.g., assault, verbal abuse) experienced in the past year; the perpetrator of these incidents, and injury-related outcomes.

Methods: Using preliminary data (n=512) from a national telephone survey targeted at 1000 young workers ages 14 to 24 across the United States, we calculated descriptive statistics to determine the following: 12-month victimization prevalence and the distribution of the forms of violence experience in the past year. These include: verbal abuse; threats; sexual harassment; sexual assault; and other physical assault. We also surveyed respondents about their most recent experience with being victimized in the last year to investigate, among other outcomes, the distribution of perpetrators and the frequency with which these events resulted in an injury.

Results: Preliminary findings show the twelve-month workplace violence victimization prevalence was 59% (n=302). Verbal abuse (52%) was the most common form of violence experienced by youth; followed by sexual harassment (22%); threats (16%); physical attacks (7%) and sexual assault (5%) (categories are not mutually exclusive). Social media was used in 21% of the incidents involving sexual harassment and in 11% of those involving threats made against young workers in the previous year. When asked to report on the most recent incident they experienced, 4% of victims reported having been injured. Among these most recent incidents of workplace violence, perpetrators included customers/ clients (54%), co-workers (35%), supervisors (18%), and romantic partners (2%) (categories are not mutually exclusive). In cases where supervisors or co-workers were the perpetrators, respondents were mostly likely to report they were victims of verbal abuse (64% and 43%, respectively) and sexual harassment (22% and 42%, respectively). Data collection is expected to be completed this summer.

Discussion: This first of its kind national study of workplace violence among youth demonstrates the problem of violence at work is much wider spread among youth than national surveillance data indicate. Given that only

4% of victims reported they were injured; this suggests that as many as 96% (assuming no non-reporting) of young victims of workplace violence could go undetected in occupational surveillance systems. This indicates that to adequately grasp the extent and nature of workplace violence among young workers, alternative methods are needed. The role of supervisors, who should be protecting young workers, warrants further examination given that they were responsible for nearly 1 in 5 incidents of workplace violence. Attention to the use of social media in the perpetration of sexual harassment and threats against young people should also be explored further.

Session E3

Title: Safety Climate: Application to High-Risk Work

Moderator: Douglas Myers

E3.1

Title: Case Study: Two Fire Fighters Die and One Fire Fighter Injured When Struck at a Roadway Incident – NIOSH Fire Fighter Fatality Investigation and Prevention Program

Authors: [Karis Kline](#), [Murrey Loflin](#)

Background: Since inception in 1998, the National Institute for Occupational Safety and Health Fire Fighter Fatality Investigation and Prevention Program has been driven by 3 main objectives. To identify and define the characteristics of fire fighter line-of-duty deaths, and in turn recommend ways to prevent deaths and injuries are the program's driving forces. Using the information gathered from investigations, FFFIPP can then disseminate prevention strategies to the fire service. On March 15, 2017, an 80-year-old male volunteer deputy chief and a 53-year-old female volunteer fire fighter died and a 43-year-old volunteer fire fighter was injured while operating at an incident scene where a dump truck was tangled in downed telephone lines. The fire fighters were preparing to clear the incident when they were struck by a hit-and-run driver. Both the deputy chief and female fire fighter were pronounced dead at the incident scene from their injuries. The male fire fighter was transported to a local trauma center, treated, and released the next day. NIOSH received notification of these line-of-duty deaths (LODD) from the U.S. Fire Administration and a decision is made to investigate.

Methods: The NIOSH FFFIPP conducts select investigations using the NIOSH FACE method. Incidents with multiple fatalities, those that occur during structure fires or are related to motor vehicle incidents are of the highest priority. Investigations follow the public health model and depend on cooperation from fire departments, labor organizations and other investigative entities. FFFIPP investigators collect agent, host, and environmental information about the pre-event, event, and post-event phases of the fatal incident. For this case, investigators interviewed crews from the fire departments that had responded to the original emergency call, along with the police crews, EMS, and the emergency dispatchers who were on shift during the LODD event. The investigators also visited the scene of the incident to take pictures. The information collected was then evaluated to identify contributing factors and recommendations were developed aimed at controlling each factor. A narrative report describing the incident, contributing factors, and recommendations was developed. This report developed with fire service subject matter expert input and without personal identifiers was published on the FFFIPP web page.

Results: NIOSH investigators identified several factors that contributed to the incident, the most unique being the involvement of an alleged impaired civilian driver. It was determined that traffic incident management was also a contributing factor as fire fighters remained on-scene after the original emergency event was over, and were standing in proximity to moving traffic without protection.

Discussion: The NIOSH FFFIPP team developed several key recommendations to disseminate to the fire service. Pre-incident planning, including coordination with affiliate agencies (EMS, police, etc.) is crucial when dealing with traffic incidents. Routine training can aid in development of situational awareness amongst crews who will be better prepared to identify unsafe situations. Moving vehicles present a new set of hazards, and it is every responder's responsibility to continuously size up the scene, and report changes to incident command. Law enforcement should be utilized to control traffic, as those officers have completed extensive training in how to best direct civilians around roadway emergency work zones. Finally, a quick and efficient demobilization of unneeded personnel is pivotal to crew safety.

E3.2

Title: An Assessment of Confined Space Entry and Rescue Training Effectiveness for Aircraft Rescue and Firefighter (ARFF) Members

Authors: [Todd Smith](#), [Rene Herron](#), [Aurora Le](#), [Keith Wilson](#), [Dennis Vincenzi](#)

Background: Despite an OSHA standard and consensus standards for confined space entry and rescue, many workers die in confined spaces each year. According to the Bureau of Labor Statistics, 136 workers from various industries died in confined space incidents in 2015. To prevent these fatal events employers need to comply with appropriate standards, control hazards and ensure effective training of personnel. Effective training is especially necessary for high-level job skills that are rarely performed, such as confined space rescue. Aircraft Rescue and Firefighting (ARFF) members are among those emergency responders that may be required to perform confined space rescue operations. Per OSHA, training must be provided to ensure personnel have the knowledge and skills necessary to safely perform their duties associated with confined space entry and rescue. Currently, there is a knowledge gap, as researchers, practitioners and end-users of emergency rescue services do not know the present state of compliance or use of best practices by emergency service personnel during confined space entry and rescue, particularly among ARFF personnel. To address this dearth of knowledge and to determine if improvement plans should be implemented to abate gaps between current conditions and practices and desired levels of compliance and application, a multi-method gap analysis was completed.

Methods: The present study used a convergent, parallel mixed-methods approach. Quantitative data (n=158) were collected from ARFF Working Group (ARFFWG) members. Descriptive statistics were analyzed using SPSS. Qualitative data (n=20) were collected via semi-structured interviews of purposefully selected key informants at four separate work locations. Data from transcripts, derived from recorded interviews, were coded and analyzed using Nvivo. Super-ordinate and sub-ordinate themes were derived.

Results: Primary qualitative findings suggest the majority (60%) of interviewees believe there is a lack of standardization in training, which could be improved, but that conducting the training in the same

manner time-after-time was a problem. 50% of participants desired more realistic training. Other concerns that impacted training effectiveness included staffing, psychological and physical readiness and resource adequacy (equipment, schematics of aircraft, etc.). With regard to survey outcomes, most respondents reported that their organizations completed confined space training (69.8%), but only 55.3% indicated this training was conducted as a full-scale exercise and nearly 40% indicated that a rescue practice was not performed. Following training, 55.4% indicated that training evaluation information, such as critiques or after action reports, were not presented. Overall, participants mostly agreed their training was successful (31.5% strongly agree and 42.5% agree). Most agreed that their training effectively addressed OSHA requirements, such as how to test the atmosphere, the need for and use of protective equipment, how to identify pertinent permit information and retrieving victims in limited space.

Discussion: Some gaps exist between current training practices and established training requirements and standards. To bolster injury and fatality prevention efforts, ARFF organizations need to bolster aspects of their training, particularly with regard to standardizing training efforts, practicing rescues, providing evaluation feedback and written materials, providing needed resources such as schematics and by formulating specified training checklists and guides to ensure compliance. Although many participants agreed that the training provided by their employers was effective, any deficiencies associated with regulations and standards places workers at risk for injury or fatality.

E3.3

Title: The Validation of an Organizational Safety Culture Tool

Author: [Rebecca Green](#)

The occurrence of work-related injury and illness can have profound financial and social consequences for individuals and organisations. In Australia, work-related injury and disease costs in excess of \$60 billion dollars per annum, with 75% of this cost associated with indirect costs (i.e. lost productivity, loss of income, and quality of life). Recent research has demonstrated an association between workplace accident rates and safety culture indicators. Therefore, New South Wales Insurance and Care has begun collaborating with industry partners to reduce workplace risk through their

organisational safety climate and culture.

The current study focused on the validation of the Climate of Organisational Safety Tool (COST). The COST was developed for use within an occupational health and safety context as a diagnostic measure of risk. The tool was designed to identify relevant areas of safety culture that are amenable to intervention. Pre-pilot focus groups were conducted to collect qualitative feedback and quantitative data on the content coverage of the COST and relevance of the included domains. Pilot testing occurred using an online version of the tool with employees of a high-risk aged-care provider servicing metro and regional New South Wales. The current study reports on the validation and psychometric properties of the COST, and goes on to discuss its applicability in research and practice. particularly, the potential of the COST in prevention and early intervention of work-related injury and disease within high incidence and risk organisations.

E3.4

Title: Moving FOCUS – The Fire Service Safety Climate Tool – From Research to Practice

Authors: [Jennifer Taylor](#), [Andrea Davis](#), [Lauren Shepler](#)

Background: Safety climate is a strong predictor of safety outcomes (i.e., injuries) and organizational outcomes (i.e., burnout, job satisfaction). Safety climate is the measurable aspect of safety culture and is used by industries such as healthcare and manufacturing to gauge and improve safety performance. In 2017, The Fire Service Organizational Culture of Safety (FOCUS) survey was validated to assess safety climate in the fire service. Once validated, FOCUS was administered in 500 fire departments nationally. Each of these departments received a customized data report, in addition to the opportunity to partake in “Culture Camp,” a training on safety climate and the utility of FOCUS. This presentation will describe the FOCUS dissemination process and reflect on the utility of FOCUS feedback sessions and “Culture Camp” trainings for the fire service.

Methods: The FOCUS survey was developed to assess baseline and longitudinal safety climate in the fire service. FOCUS items were field-tested in a geographically-stratified random sample of 132 fire departments with over 720 stations and 10,000 respondents. The results were psychometrically validated through structural

equation modeling and factor analysis. FOCUS was predictive of safety outcomes such as injuries, as well as organizational outcomes such as burnout, job satisfaction, and engagement. After validation, the resultant FOCUS data was disseminated to participating fire departments through one-hour phone or video conferencing feedback sessions. Feedback sessions were recorded and/or followed-up via email to capture reflective comments from participants. Through a partnership with the Fire Departments Safety Officers Association (FDSOA), the FOCUS tool evolved from research to practice, administering the survey to 500 fire departments nationally. In addition, “Culture Camp,” a one-day intensive training session, was introduced to better educate departments on safety climate and their department’s results. Over five national sessions, 100 fire service members were trained on the science behind safety climate, the utility of FOCUS, and received in-depth guidance on their FOCUS results. Each training concluded with a multiple-choice and short answer online evaluation.

Results: The dissemination process that each participating fire department engaged in will be described, including strategies employed to return results to fire chiefs, challenges addressed during dissemination, improvements made to data visualization tools based on stakeholder recommendations, and reflections on the utility of the feedback sessions from our fire service partners. Our dissemination outreach effort will be quantified to describe the level of engagement in feedback session with our participating fire departments and qualitative data will be used to describe the utility of FOCUS feedback sessions for the fire service. “Culture Camp” trainings prepared and supported fire service members to feel competent in understanding the importance of safety climate, to better understand their FOCUS results, and return to their fire department equipped to present their FOCUS findings to peers. Qualitative data will be presented from the evaluations to demonstrate the utility and knowledge transfer.

Discussion: An examination of how FOCUS data is helping the fire service to lead, supervise, and organize their work environment around safety will be explored. FOCUS feedback and “Culture Camp” sessions seek to impart confidence and comfort using safety culture data within the fire service as they begin to use objective data to maintain or improve a positive safety culture in their departments. As such, FOCUS will advance fire service

injury prevention efforts through use of a validated tool to understand, maintain, or change the culture that creates safety. The future research to practice dissemination plan for FOCUS will be discussed.

Session E4

Title: Know Your Target, Hit Your Target, Move Your Results into Safety Practice

Moderator: David Fosbroke

There is much buzz about moving research into practice, but what does it take to move beyond distributing information and get to influencing changes in the workplace, based on our research? Learn what is needed to understand the person or people who motivate your research population. Learn how to craft your message to not only develop understanding, but initiate action. This workshop provides examples of how to identify different audiences within an occupation or industry, results of focus groups that discussed safety research information needs, information products targeting specific safety improvements, and how to develop effective safety messaging. Upon completion, participants will be able to identify specific target audiences for research results, determine appropriate message(s) for each target audience, and utilize appropriate channels to reach identified audiences.

Workshop Leader: David E. Fosbroke, Statistician, NIOSH DSR

Speakers: [Clayton Sinyai](#), Communications Research Manager, CPWR. The First Question in Communication: Who’s Your Audience? CPWR used the CDC Clear Communication Index to revise a handout on occupational heat stress designed for construction workers, then tested the old and new versions with an audience of more than 400 construction apprentices. Sinyai will share the results, and how identifying a target audience for your message before you begin writing is essential to effective communications. [Garrett Burnett](#), Health Communications Specialist and Small Business Coordinator, NIOSH. Getting to the Heart of Small Businesses. Small businesses aren’t different or notable simply because of their size: they have several key attributes that affect their priorities and their business needs. By understanding what keeps small business owners awake at night and what drives their decisions during the day, we can better translate our safety and health research into products that provide them with real value. [David](#)

[Fosbroke](#), Statistician, NIOSH. Design Safety Messages with Employers Needs and Constraints in Mind. One of the strategic goals of the NIOSH Center for Motor Vehicle Safety is to effectively communicate safety information to employers. To accomplish this goal, the Center worked with RTI International to conduct an audience analysis with managers of small businesses, which often have limited resources, across four different vehicle user groups. Findings from focus group discussions have contributed to a number of changes in the Center's current and planned health communication efforts.

[Theodore Teske](#), Health Communications Specialist, NIOSH. Live to be Salty: How NIOSH Got Fishermen to Wear PFDs. NIOSH engaged community partners and a strategic communication firm to develop an intervention to overcome existing barriers and encourage personal flotation device (PFD) use among fishermen. Campaign strategy focused on common touchpoints—coordinating concentrated community, point-of-sale, and digital channels to reach the target audience where they live, work, eat, and shop. The resulting intervention, Live to be Salty, was a 2-year multi-channel campaign featuring a developed spokesman, Angus, designed to be culturally relevant, memorable, and different from typical safety messages targeted at these audiences. A robust evaluation program was implemented to answer questions about PFD use, attitudes about man overboard risk, recognition and recall of the campaign spokesman and his message, and behavioral intention or change.

[Sydney Webb](#), Health Communications Specialist, NIOSH. Who DAT (Demographic Access Tool) you want to know more about? Who DAT is a one-stop-shop of web personas, which provide a snapshot of the attributes of a particular audience represented by a single, fictional person on CDC health and safety topics. The personas in this tool include quantitative and qualitative audience data as well as visual guidance to help health communicators develop effective messages that move people to action. [David Fosbroke](#), Statistician, [Rebecca Olsavsky](#), Health Communication Specialist, [Sydney Webb](#) Health Communication Specialist, NIOSH. Pulling It All Together—Improving Your Aim. This interactive portion of the workshop will review methods for effectively translating research findings into useful tools for workers, managers, and safety professionals to make changes in the workplace that improve safety outcomes. Participants are encouraged to bring examples from their own research to share and to discuss the role of product choice, format, and delivery channel in con-

veying new safety information in a way that produces lasting results.

Session F1

Title: Lessons from Surveys of Construction Stakeholders

Moderator: [Christine Branche](#)

CPWR – The Center for Construction Research and Training is dedicated to reducing occupational injuries, illnesses and fatalities in the construction industry. Effectively reaching, learning from, and communicating with the contractors, workers and other stakeholders who could contribute to or benefit from research findings is critical. This session will cover four distinct survey approaches used to inform and evaluate our ability to reach stakeholders.

F1.1

Title: Safety Management and Safety Culture in the Construction Industry

Authors: [Xiuwen Sue Dong](#), [Xuanwen Wang](#), [Rebecca Katz](#)

Background: CPWR has collaborated with Dodge Data & Analytics to conduct a biennial online Construction Safety Management Survey (CSMS) on Dodge's member contractor panel (>3,000) since 2012. This study examined safety management and safety culture in the construction industry using the CSMS data.

Methods: Data from three waves (2012, 2015, and 2017) of the CSMS were analyzed. Safety management was assessed by specific organizational and project safety practices, including the use of personal protective equipment (PPE), Prevention through Design (PtD), and safety and health training. Safety culture was measured by eight indicators, including owner/ client involvement, leadership, safety communication, and employee empowerment and involvement. These measures were stratified by business type, firm size, and union status. SAS 9.4 was used to conduct the analyses.

Results: The findings show broad progress in management commitment to a strong safety culture in the construction industry. Jobsite worker involvement was reported as the top practice in both the 2015 and 2017 surveys. Nearly 60% of the contractors surveyed believed that demonstrating management commitment had a high impact on workplace safety. Moreover, a

high percentage of contractors consistently reported a reduction in work-related injuries and improved project quality due to their investments in safety practices. However, disparities exist among firms with different organizational characteristics. Only 38% of small firms (<10 employees) adopted safety protections in the workplace, compared to nearly 90% of large firms (500+ employees). About 82% of large firms applied all five organizational safety practices, more than eight times the proportion among small firms. Compared to larger firms, smaller firms provided safety and health training to their employees less frequently. Similarly, non-union firms and trade contractors engaged in fewer safety practices than union firms and general contractors.

Discussion: Organizational factors significantly affect safety management and culture in construction. Small and non-union firms lag behind in almost every aspect of safety practices and safety culture measures. There is an urgency for smaller construction companies (which are more likely to be trade contractors and less likely to be unionized) to adopt effective safety practices to improve workplace safety and health.

F1.2

Title: Characterizing Indicators of a Positive Safety Climate in the Construction Industry

Authors: [Babak Memarian](#), [Sara Brooks](#), [Bruce Lippy](#)

Background: According to the Bureau of Labor Statistics' (BLS) latest report, the construction industry continues to be one of the highest-risk industries in the nation, with 991 fatalities and 197,700 nonfatal injuries in 2016. Safety climate measurements have been suggested as a proactive method of assessing an organization's effectiveness in identifying and addressing the hazards that lead to injuries and fatalities. Even though safety climate is often defined as employee perceptions of safety in the workplace, preventing work-related injuries and fatalities also depends on organizational practices. Thus, employers are responsible for understanding and addressing underlying systems that affect worker health and safety.

Methods: To explore and assess the leading indicators that contributed to the successful safety performance of a major U.S. contractor, CPWR – The Center for Construction Research and Training conducted site

safety climate assessments on multiple jobsites in different states. To create a better understanding of both worker perceptions and organizational practices, CPWR conducted several in-depth field studies that included surveys of 219 craft workers and interviews with 41 members of project management teams across four projects of the same company. Furthermore, researchers conducted jobsite walk-throughs to closely observe site conditions. The questionnaires used for this project drew extensively from the Safety Climate Assessment Tool (S-CAT) developed by CPWR. This presentation will summarize findings and lessons learned under seven major leading indicators of safety climate: (1) demonstrating management commitment, (2) aligning and integrating safety as a value, (3) ensuring accountability at all levels, (4) improving supervisory leadership, (5) empowering and involving employees, (6) improving communication, and (7) providing training at all levels.

Results: Survey results indicated that about 83% of respondents believed "all levels of management were committed to worker safety and health." A vast majority (95%) of participants responded that "their supervisor demonstrated safety leadership" and 87% responded that "their supervisor often would ask for their input on safety." Of all respondents, nearly 91% stated that "they were taught how to protect themselves from jobsite hazards," which was an indicator of effective safety training across the organization. However, only 73% of participants responded that "their employer would share accident investigation results with everyone," which was attributed to the employer's lack of an effective communication system on jobsites. Also, about 25% of respondents perceived that productivity was valued more than safety by the employer, which was mainly attributed to aggressive schedule pressure.

Discussion: Safety appeared to be well integrated into work processes at the participating contractors' jobsites. At these sites, craft workers' perception of the health and safety program and also safety leadership were remarkably positive, and safety was perceived as "everyone's" responsibility. However, communication and production pressure control were two critical issues that needed to be improved.

F1.3

Title: **A Social Network Analysis of the National Campaign to Prevent Falls in Construction**

Authors: **Eileen Betit, Danielle Varda, Jessica Bunting, Chris Trahan Cain, Dean McKenzie, Elizabeth Garza, Scott Earnest, Christine Branche**

Background: Falls are a leading cause of injuries and deaths in construction. In 2012, OSHA, NIOSH and CPWR (lead organizations) launched the National Campaign to Prevent Falls in Construction (Campaign) to raise awareness of fall hazards and prevent injuries and deaths. The Campaign and associated National Safety Stand-Down have been successful, but evaluation efforts have been limited to the lead organizations' reach. In 2017, the OSHA-NIOSH-CPWR r2p Working Group worked with the Center on Network Science (CNS) to pilot use of Social Network Analysis (SNA) to evaluate the Campaign. The SNA focused on identifying the Campaign's network (partners), the audiences' reached, how partners work together, the benefits and challenges of participation, and opportunities to strengthen the network.

Methods: In 2017, an online survey was conducted using CNS' PARTNER Tool, which includes a validated survey instrument, data collection methodology, and evaluation framework. The Campaign survey was customized to include the 19 PARTNER questions and 13 additional questions. It was distributed via email to 157 partners identified by the lead organizations. The latter represented a "bounded" network. As part of the survey, these partners were asked to list the organizations they work with on the Campaign and answer questions about their relationships with those organizations. The organizations identified included new organizations that represent the broader "informal" network created through the Campaign.

Results: Of the 157 partners surveyed, 77 (49%) responded. The most common reason for becoming involved in the Campaign was an invitation from a lead organization (60%), but the most common reason for staying involved was to demonstrate an organizational commitment to safety (57%). The 77 respondents listed an additional 117 organizations as partners, for a total of 274 unique Campaign network partners. Excluding the lead organizations, the remaining partners reported reaching between 36 and 2,500,000 individuals a year. The majority engaged in Campaign activities leading up

to or during the annual Stand-Down. The most common activities were distributing or posting materials, articles or blog posts, and email promotions. Fewer partners reported time- or resource-intensive activities, such as equipment audits or falls safety drills. The top benefits to participating were being part of a national campaign (80%); access to materials (70%); increased opportunities to share resources (67%); motivation to focus on fall safety (66%); and improved relationships with other stakeholders (66%). The challenges most often cited included time constraints (35%); uncertainty about the impact (33%); and being able to generate interest (33%). For outcomes, roughly 3 out of 4 partners said they have seen "a fair amount" or "a great deal" of change around fall prevention and overall safety and health initiatives within their organization or the industry. Despite the majority reporting a positive change, several partners expressed doubts about whether those most at-risk are being reached.

Discussion: The SNA provided important insights into the size of the audience reached through the Campaign network, the types of organizations involved and activities undertaken, benefits and challenges, and opportunities to help the network develop further and function more effectively.

F1.4

Title: **Using Stakeholder Feedback to Create an Online Network for Building Research to Practice (r2p) Capacity**

Authors: **Jessica Bunting, Eileen Betit**

Background: The construction industry is highly decentralized, creating unique challenges for communicating safety and health information and sharing resources with stakeholder audiences. There are many individuals and organizations concerned about improving safety and health; however, on their own they only have the ability to reach a limited number of audiences with safety and health information and products. By working with industry partnerships and on other collaborative efforts, CPWR found when we are able to tap into others' networks, we can reach a higher number and wider variety of audiences than any one group can on their own. Recognizing the barriers to sharing network contacts, CPWR began exploring the development of a Construction Safety & Health Network, which would bring together safety and health minded individuals and organizations, establish a central platform for

posting research and resources, and provide an easy to use mechanisms to quickly share postings with their individual networks using their preferred electronic communication method.

Methods: Prior to developing this Network, we solicited input from potential participants in a variety of ways, with the goal of determining 1) whether they would participate, 2) what features would prompt them to use the network, and 3) how best to structure it to facilitate participation. CPWR introduced the concept of a safety and health partnership network at our first annual Research to Practice (r2p) Seminar and Partnership Workshop in 2015 (r2p Seminar). A workshop at this meeting, attended by many of the audiences that could benefit from such a network, was used to explore ways to improve connectivity within and between their networks, and solicit reactions to the idea of creating an online network focused on construction safety and health. We used attendee input to refine the concept. A year later, at the 2016 r2p Seminar, we presented a more fleshed out concept and solicited feedback during two interactive workshop sessions. Based on the feedback received from workshop participants, we conducted another round of revisions to our concept and planned online mechanism functionality. These revisions were presented to a group of workshop attendees during a web-based meeting in February 2017. After this final round of feedback, we began development, presented mock-ups at the 2017 r2p Seminar, and provided those interested with the option of registering for the network in advance of the launch.

Results: The Safety & Health Network launched in March 2018. We are now focused on growing both Network membership and site content, as well as learning how to best utilize the collaboration functionality of the Network. As we do so, we are gathering additional information about what our audiences want and will actually use in practice, both as it relates to this Network and to inform our r2p efforts overall. One result is that through our iterative feedback process and observing member use of the Network since its launch, CPWR has improved its understanding of the needs, desires, communication preferences, and constraints of our target audiences. We have also learned more about the importance of obtaining audience buy-in early on in the process. The result of the Network itself is that members have the ability to easily disseminate information to new and broader audiences, find new information to share with existing networks, address emerging haz-

ards, and build sustainable relationships with partners they may not have previously considered or had the ability to connect with.

Discussion: Disseminating information is difficult in a decentralized, ever changing industry. Utilizing multiple rounds of feedback from various stakeholder audiences, CPWR was able to create an online Construction Safety & Health Network that improves the r2p capacity of individuals, organizations, and the industry as a whole.

Session F2

Title: Current Research on Truck Driver Safety

Moderator: Stephanie Pratt

This session will bring together results from NIOSH's National Survey of Long-haul Truck Driver Health and Injury with related research conducted by leading university-based researchers. The presentations will address a range of themes relevant to truck driver safety: fatigue, substance use, safety culture, and driving behaviors.

F2.1

Title: Tight Delivery Schedules Linked to Job Satisfaction, Opinions on Maximum Speed Limits and Hour of Service Rules, and Noncompliance: NIOSH National Survey of U.S. Long-Haul Truck Driver Health and Injury

Authors: [Guang Chen](#), [W. Karl Sieber](#), [Jan Birdsey](#), [Edward Hitchcock](#), [Jennifer Lincoln](#), [Stephanie Pratt](#), [Cynthia Robinson](#), [Marie Sweeney](#)

Background: There are approximately 1.8 million heavy and tractor-trailer truck drivers in the U.S, the majority of whom are long-haul truck drivers (LHTDs). LHTDs work long hours, irregular work schedules, and face high risks of truck crashes and occupational injuries. The objectives of this study were to: (1) assess U.S. LHTDs' opinions on their safety needs, and (2) quantify the interconnections among delivery schedules, job satisfaction, and opinions on and compliance with hours of service (HOS) regulations and maximum speed limits.

Methods: The National Institute for Occupational Safety and Health conducted the National Survey of LHTD Health and Injury, which collected information from a nationally representative sample of 1,265 U.S. LHTDs at 32 truck stops in 2010. The survey collected

data on broad aspects of truck driver health and injury. Drivers were asked their opinions on eleven potential safety strategies, as well as the frequency with which the driver engaged in unsafe driving behavior.

Results: Among the 11 potential safety strategies, the largest percentage of LHTDs (95.4%) agreed that building more truck stops/ parking areas would improve safety, followed by strictly enforcing traffic laws on car and truck drivers equally (90.6%), paying drivers by the hour for loading and unloading time (87.7%), and equalizing maximum speed limits for cars and trucks on interstate highways (86.6%). An estimated 15.5% of LHTDs reported often receiving an unrealistically tight delivery schedule. There were significant associations between often receiving an unrealistically tight delivery schedule and drivers' beliefs that: their work was never adequately rewarded (odds ratio (OR) =4.5); increasing the current maximum speed limit on interstate highways by 10 miles per hour (mph) would improve safety (OR=2.1); and strictly enforcing HOS rules would not improve safety (OR=1.8). Drivers who perceived that their schedules were often unrealistically tight were also significantly more likely to report often: driving ≥ 10 mph over the speed limit (OR=7.5); continuing to drive despite fatigue or other adverse conditions (OR=7.5); and violating HOS regulations (OR=10.9). LHTDs who agreed that increasing the current speed limit by 10 mph would improve safety were significantly more likely (OR=4.4) to report often driving ≥ 10 mph over the speed limit compared to drivers who did not agree. Drivers who did not agree that strictly enforcing HOS rules would improve safety were more likely to report often violating HOS regulations than drivers who did agree (OR=6.1). Drivers who reported often driving ≥ 10 mph over the speed limit had 2.1 times the odds of having received moving violation tickets in the previous 12 months compared to drivers who reported never driving like that. A higher annual income was linked to a higher level of job satisfaction.

Discussion: Findings highlighted the need for building more truck stops/ parking areas. Driver perceived unrealistically tight delivery schedules are associated with lower job satisfaction and lower compliance with laws and regulations. Tight delivery schedules also influence opinions on maximum speed limits and HOS rules. To improve LHTD safety: (1) government and private partners can build more truck stops/ rest areas; (2) carriers and dispatchers can adopt recommendations

in the North American Fatigue Management Program (www.nafmp.com) and schedule delivery times so that drivers can have adequate time for sleep and rest; and (3) management can cultivate a safety culture that supports drivers in saying no to unrealistically tight schedules.

F2.2

Title: Fatigue Among Long-Haul Truck Drivers

Author: [W. Karl Sieber](#)

Background: Work-related, demographic, and health factors among long-haul truck drivers are associated with sleepiness and fatigue leading to increased crash risk and poor health.

Methods: In 2010, NIOSH conducted a nationally representative survey of long-haul truck drivers to help characterize health and safety risk factors in this population. Self-reported health conditions, hours of driving or on-duty, and hours of sleep were collected from 937 truck drivers by personal interview and through a retrospective 72-hour sleep and activity diary. Multivariable logistic regression was used to investigate how long-haul truck drivers' sleep time and working and health conditions interact to produce driver fatigue. Fatigue was defined as a driver being so tired that the driver needed a break or sleep.

Results: Thirty-three percent of drivers indicated fatigue at the time of interview. Number of hours driving or on-duty, 6 hours or less of sleep, lack of physical activity, stress, and age were found to be statistically significantly associated with fatigue. Fatigue increased with the number of hours driving or on-duty. The odds of developing fatigue increased 20% after driving or on duty one hour, doubled after 4 hours driving and tripled after seven hours. When time period driven was considered, odds of fatigue double after 3 hours of driving or on-duty time during the period 12 AM – 6 AM, compared to doubling after 5 hours during later periods of the day. Fatigue was twice as likely for drivers who reported stressful conditions during deliveries such as tight delivery times and 80% more likely with limited physical activity.

Discussion: Many of the factors found to be associated with driver fatigue can be addressed by organizational changes such as implementation of health programs or changes in administrative practices. For example, use of more efficient scheduling tools by dispatchers could

minimize driving times. This study suggests a need for targeted interventions and other changes to minimize fatigue among drivers to help guide development of trucking policy and health programs.

F2.3

Title: Identification of Factors Associated with Drug and Alcohol Screening of Fatally Injured Motor Vehicle Drivers Using Multiple Data Sources

Authors: [Terry Bunn](#), [Michael Singleton](#), [I-Chen Chen](#)

Background: Comprehensive drug (including alcohol) screening of fatally injured drivers is not routinely or universally performed. Fatality Analysis Reporting System (FARS) data is based on multiple data sources (CRASH, death certificate, medical, toxicology testing, and medical examiner records) and is routinely analyzed for drug-related driving studies. FARS data may not capture and identify drug-screened drivers who were fatally injured in motor vehicle crashes, and additional data sources that are routinely updated and amended may be needed to comprehensively identify drug categories and drugs present among fatally injured drivers in motor vehicle crashes.

Methods: The study population was all drivers (Kentucky residents and non-residents) (including large truck and light truck drivers) who died in motor vehicle crashes in Kentucky between January 1, 2010, and December 31, 2014. Study data were obtained from three sources: Kentucky Collision Report Analysis for Safer Highways (CRASH), Kentucky mortality, and FARS records. The CRASH, FARS, and mortality databases were linked using probabilistic methods. Evidence of drug screening in fatally injured motor vehicle drivers was identified through analysis of relevant data variables with positive or negative findings in any the three linked data sets. If there were no positive or negative drug screen findings recorded in any of the three data sets through analysis of the relevant data variables above, the fatally injured driver was presumed not to have been tested for drugs.

Results: Of the fatally injured drivers aged 65 and older, only 61% were drug screened compared to those aged 25-34 where 88% were drug screened. A higher percentage of the fatally injured drivers that were drug screened were unrestrained (67%) vs restrained (33%). Eighty-three percent of at-fault light truck drivers were drug screened compared to 72% of not-at-fault light

truck drivers. For large truck drivers, 93% of at-fault large truck drivers were drug screened compared to 84% of not-at-fault large truck drivers. Of the light truck and large truck drivers who died in the hospital or emergency department, 59% of fatally injured light truck drivers were drug screened compared to 83% of fatally injured large truck drivers that were drug screened. For coroner certified deaths, a lower percentage of light truck driver decedents were drug screened compared to large truck driver decedents (83% vs. 92%). Of the light truck and large truck drivers who were drug screened in fatal crashes, 88% of the light truck crashes occurred in rural land use areas compared to 93% of large truck crashes. Alcohol was listed as a human factor in CRASH data for 17% of fatal light truck driver crashes compared to 2% of fatal large truck crashes. Of the fatal drivers who were drug tested, a higher percentage of light truck driver CRASH reports listed speeding as a human factor (9%) more frequently than large truck driver CRASH reports (2%). In contrast, large truck driver drug screened CRASH reports listed sleepiness/ fatigue, distraction/ inattention, and not under proper control more frequently compared than light truck driver drug screened CRASH reports. Alcohol (39%), depressants (20%), and narcotics (12%) were most frequently identified in light truck driver positive drug or alcohol screens. In contrast, very few large truck driver drug screens were positive for alcohol, narcotics, or depressants.

Discussion: Multiple data sources are needed for comprehensive identification of drugs among fatally injured motor vehicle drivers, including occupational vehicle such as light trucks and large trucks. Almost all fatally injured large truck drivers were drug screened; fatally injured drivers of other vehicle types should be drug screened similar to large truck drivers. More and enhanced drug screening of fatally injured motor vehicle drivers is advocated for, especially in the hospital setting.

F2.4

Title: Time-Varying Coefficient Model for Evaluating Commercial Truck Driver Performance

Authors: [Feng Guo](#), [Yi Liu](#), [Richard Hanowski](#)

Background: Driving fatigue is a major safety concern for commercial truck drivers and has been shown to be directly related to the total hours of sleep prior to the trip. This study evaluated how sleeping time prior to a shift affects drivers' performance over the course of a

long driving shift using high-resolution in situ collected naturalistic driving data. This study uses data from the Commercial Truck Driver NDS, a large-scale data collection study 100 drivers from four for-hire trucking companies in the U.S. Each driver drove an instrumented truck for approximately four weeks. The trucks were fitted with unobtrusive data-collection equipment, including four video cameras, radar, a Global Positioning System (GPS), and kinematic sensors. Driving data were recorded continuously from ignition-on to ignition-off at high frequency, for example 10 Hz for video, radar, and three-dimensional accelerometers. The study also collected drivers' on- and off-duty activities through a daily activity register. The activity register form requested data such as the beginning and ending times of sleep, breaks, and driving and other activities.

Methods: To evaluate changes in driving performance over the course of a long on-duty driving period, we utilized a mixed Poisson process model for recurrent event data incorporating time-varying coefficients. We used data from 96 commercial truck drivers whose trucks were instrumented with an advanced in situ data collection system. Driver sleep time and other activities were extracted from a detailed driver activity register. The model uses time-varying coefficients to model the baseline intensity and difference among sleep cohorts. The time-varying coefficients are modeled using the penalized B-splines approach. In penalized splines, the smoothness of a spline fit is controlled by the value of smoothing parameter and procedures such as cross-validation are commonly used for smoothing parameter selection. However, such procedure is computationally intensive in our setting. To achieve automatic estimation of smoothing parameters, we adopt a mixed-model representation approach based on the connection between penalized likelihood and random effect models. An EM algorithm with embedded penalized quasi-likelihood approximation is used to fit the proposed model. Simulation studies show that the proposed model fits low and moderate event rate data well and performs well for time-varying coefficients with different degrees of curvature.

Results: The analysis data contain 1880 on-duty driving trips. For each trip, sleep time was considered insufficient if the off-duty sleep duration was less than 7 hours, normal if the off-duty sleep was between 7 and 9 hours, and abundant if it was more than 9 hours. The event of interest was unintentional lane deviation

(ULD). There is a significant difference in the ULD intensity after 8 hours of driving between trips with insufficient and normal sleep time. It should be noted that there is a complex interaction among sleep time, break activity, and ULD intensity. In our data, trips with abundant sleep time (more than 9 hours) tended to have fewer and shorter breaks, especially after 8 hours of driving. The lack of breaks could be the reason that the ULD intensity increases after 8–9 hours of driving for this group of trips. There is a moderate increase in the intensity for trips with normal sleep time (7 to 9 hours) around 5 hours of driving, which coincides with an increased break frequency during the same time period.

Discussion: The application results reveal that lack of sleep primarily affects driving performance, as measured by unintentional lane deviations, after 8 to 9 hours of driving in a given shift. That is, the negative impacts of insufficient sleep are most apparent in terms of performance decrement well into the driver's shift. The results also indicate a complexed relationship among total duration of sleep, the driver's choice to take breaks while on duty, and driving performance. The results highlight the importance of drivers beginning their shift well-rested and having sufficient sleep the night before driving. Furthermore, a driver's fitness-to-drive, in terms of increased safety risk while on the road, can be assessed, in part, by measuring how much sleep the driver received prior to beginning the shift. The finding that a performance decrement appears after 8 to 9 hours into the shift also provides important information for technology developers aimed at fatigue detection, and for those interested in determining the impact that fatigue may play in a road crash.

F3 Session

Title: Safe Patient Handling

Moderator: Jim Collins

F3.1

Title: Safe Patient Handling and Mobility Injury to Staff in K-12 School Settings

Author: [Katherine Schofield](#)

Background: Safe patient handling and mobility (SPHM) is a recognized occupational risk in healthcare settings. However, SPHM also occurs every day in K-12 school settings with transfer and movement of students. Small children are routinely lifted, carried, and assisted.

Physically disabled and/or special education students may need specialized and complete transfer and mobility assistance through age of adulthood. K-12 settings differ greatly from healthcare. Staff typically do not have nursing or patient care backgrounds and focus is on the educational mission.

Methods: Workers' compensation data were used to identify incidence and severity of SPHM injuries to faculty and staff in school districts. From a large dataset of injuries in schools, 270 related to SPHM were identified. Text was analyzed to ascertain characteristics of SPHM injury events and determine potential methods to reduce risk of injury.

Results: The majority of injuries were medical-only (87.4%), but 12.6% were severe enough to be classified as lost-time, of which 2.6% of employees suffered permanent partial disability. Costs of injury varied, however 28% ranged from \$1000 to \$10,000 of total incurred costs (undeveloped) and 6% incurred over \$10,000 in costs (undeveloped). Female employees suffered 92.6% of injuries. Special education assistants had the highest burden of injury (66.7%) followed by licensed staff (teachers, therapists, counselors) with 16.7% of SPHM injuries. Workers aged 51-60 incurred 35.2% of injuries, followed by ages 41-50 with 27.4%. Those over 61 only had 5.2% of injuries. Injuries occurred most frequently to the back (31.8%) and arms and hands (27%). Text analyses revealed top causes of SPHM injuries included transfers and lifts from a variety of sources including wheelchair, floor, toilet, and tables (55%). When able to discern from the injury description, it appeared that focused transfers of students in behavioral crisis using specialized holding techniques accounted for additional transfer-type injuries. Transportation-related circumstances were also mentioned frequently; car seats, bus harnesses, wheel-chair tie-downs, and assisting students on and off the bus caused injuries. Manual lifting was used the majority of the time; use of equipment was captured in only 5% of claims.

Discussion: Assisting physically disabled students occurs on a frequent, daily basis in schools. Injuries have the risk of being severe if they occur. Environmental modifications and installation and use of mechanical lifting equipment, similar to methods used in health-care facilities, could prevent injuries to staff and also provide improved safety for students. SPHM policies and procedures must be implemented and utilized. Training, input and feedback from staff is vital; student parental

permission and involvement is also necessary as well as addition of equipment or techniques to individualized educational programs. Zero lift policies may not be feasible in districts due to work with small children, toddlers, infants; minimal lift policies may be most appropriate. Barriers to improved SPHM may include district funding for equipment and training time, especially paid time for non-licensed staff such as SEAs.

F3.2

Title: A Summary of Job Physical Exposure Measured Using the Revised NIOSH Lifting Equation in a Pooled Cohort

Authors: Tyler Trogon, Andrew Merryweather, Sue Ferguson, William Marras, Matthew Thiese, Ming-Lun Lu, Jay Kapellusch, Ruoliang Tang, Kurt Hegmann, Arun Garg

Background: Low back pain (LBP) is a large contributor to activity limitation and lost workdays in the working population. LBP has a complex and multifaceted etiology which makes it a difficult problem to address. As a result, in the early 2000's, NIOSH funded three prospective cohort studies (The Ohio State University, NIOSH, Wisconsin/Texas/Utah) to examine the associations between biomechanical stressors and LBP. We present a summary of the job physical exposures in a pooled cohort population (N=1624) that combined these three original cohorts. Variables used to calculate the Lifting Index and Composite Lifting Index (CLI) described in the Revised NIOSH Lifting Equation (RNLE) were summarized because of their relationship to LBP.

Methods: Pooled data were analyzed to describe the nature of job physical exposure across the 47 different study sites represented. Variables of interest for this study include object weight (W), horizontal locations of hands (H), vertical locations of hands (V), travel distance (D), asymmetric angle (A) and frequency of lifting/ lowering (F). All studies were approved by their respective Institutional Review Boards. Variables were obtained from field measurements, frame-by-frame video and using the Load Moment Monitor developed at the Ohio State University. Risk categories were assigned to CLI values based on a four-category system: $CLI \leq 1$ = low, $1 < CLI \leq 2$ = med, $2 < CLI \leq 3$ = high, $3 < CLI$ = very high. Summary statistics by risk category are provided for H, V, D, A, F, and W. Type of grasp was not considered to be a significant contributor to exposure risk and was

therefore removed from consideration. All statistical analysis was performed in R under version 3.3.2.

Results: The average (\bar{x}), standard deviation (s.d.), median (\tilde{x}), and range (y) were summarized for each variable. H (\bar{x} : 0.39 m; x : 0.38; y : 0.019 – 0.99), V (\bar{x} : 1.093 m; x : 1.092; y : 0.000 – 2.06), A (\bar{x} : 23.2 deg; x : 17.4; y : 0.0 – 120.7), D (\bar{x} : 0.21 m; x : 0.15; y : 0.00 – 1.63), W (\bar{x} : 6.47 kg; x : 5.31; y : 0.18 – 54.43), and F (\bar{x} : 2.64 lift/min; x : 1.59; y : 0.00 – 13.13). The H and W variables have a positive linear relationship to CLI category increase. The A has a slightly negative linear relationship. The other variables did not show any meaningful relationships.

Discussion: The summary values of each of the variables represents typical exposures across multiple worksites represented in the US. The A variable's distribution did not center on zero as was expected. This is perhaps an area which could be improved to ensure workers are avoiding asymmetry while lifting. The horizontal distance (H) was the most influential factor contributing to an elevated risk followed by object weight (W). Asymmetry was observed to be inversely proportional to CLI category. Based on the results in this study, it is recommended that horizontal distance and load weight be prioritized when analyzing job exposure.

F3.3

Title: The Inequality Paradox: Hospital-Based Safe Patient Handling Intervention Decreases Overall Worker Injuries and Pain, but Widens Socioeconomic Disparities

Authors: [Erika Sabbath](#), [Jie Yang](#), [Jack Dennerlein](#), [Leslie Boden](#), [Gregory Wagner](#), [Karen Hopcia](#), [Dean Hashimoto](#), [Glorian Sorensen](#)

Background: The “inequality paradox” posits that public health interventions, even if they improve overall population health, may increase health disparities by improving outcomes primarily in more-advantaged groups. This phenomenon has received scant attention in the occupational health literature. Evaluation of a comprehensive, hospital-wide safe patient handling intervention among hospital patient care workers in 2013 found that, compared with workers at a control hospital, those at a hospital who received the intervention had improved perceptions of workplace norms around safe patient handling and reduced workplace injuries (particularly lifting and exertion injuries). The

present study aims to test whether the intervention improved safe patient handling behavior and reduced injury for everyone, or whether such changes occurred primarily in higher-wage workers (nurses), who as a group perform fewer patient lifts and have lower overall injury rates than low-wage workers (patient care associates or PCAs).

Methods: For these analyses, we used data from the Boston Hospital Workers Health Study, a cohort study of approximately 8,500 nurses and nursing assistants at two large Boston-area hospitals. We also had longitudinal survey data from 2012 and 2014 on a subset ($n=1,595$) of workers across the two hospitals. First, using the survey data and comparing high-wage and low-wage workers, we examined changes in perceptions of workplace health and safety, and in self-reported pain, before and after the intervention. We also had employer-provided injury data and payroll data for the entire cohort. We used the latter data sources to examine changes in injury rates in the two hospitals, again comparing high-wage and low-wage workers.

Results: In the intervention hospital, low-wage workers showed more improvements than high-wage workers in self-reported safe patient handling behaviors and bigger reductions in number of lifts per shift, comparing pre-intervention and post-intervention surveys. While both high-wage and low-wage workers had improvements in self-reported overall pain, only high-wage workers reported reductions in shoulder/ neck pain, pain interference with work, and moderate to high pain severity; low-wage workers actually reported (non-significantly) higher levels of the preceding three variables post-intervention. Among high-wage workers, administratively-reported injury rates decreased from 14% to 12% pre- to post-intervention, but for low-wage workers, injury rates remained steady at 20% both pre- and post-intervention. Therefore, while the overall injury rate decreased following the intervention, the disparity in injury rates between high- and low-wage workers actually grew wider.

Discussion: These results have implications for both intervention development and analysis. In terms of intervention development, low-wage workers in this study received the same training in safe patient handling as their high-wage counterparts, and they did report that their handling practices improved, but they did not see the concomitant reductions in pain and injury that were seen in high-wage workers. Further analyses may reveal

the explanation for this disconnect, and could potentially point to ways that this intervention (and others) could be delivered in a way that has similar uptake for diverse working populations. From an analytic perspective, this paper demonstrates the necessity of analyzing occupational health interventions for disparities in intervention effectiveness, and of collecting data on relevant social and demographic characteristics so that researchers are able to test for such disparities.

F3.4

Title: Uncovering a Hidden JEM: A General Population Job Exposure Matrix to Estimate Biomechanical Work Exposures

Authors: [Marcus Yung](#), [Ann Marie Dale](#), [Skye Buckner-Petty](#), [Alexis D'Escatha](#), [Bradley Evanoff](#)

Background: Effective prevention efforts in the development of musculoskeletal disorders (MSD) involve identification and assessment of workplace biomechanical exposures. There is increasing interest in the use of job exposure matrices (JEMs). A JEM estimates exposures of occupational risk factors based on job titles, industry information, and group-level exposure data. Unlike individual-level measures, JEMs can be applied to large populations for relatively low cost, minimizes information bias between cases and non-cases, and can estimate exposures of both current and past jobs. JEMs based on self-reported exposures make use of workers' knowledge of their job and assign these exposures at the group level, minimizing information bias due to individual variation in reporting. The French CONSTANCES project provides an opportunity to create a JEM using self-reported exposure data and to enable large-scale studies of associations between workplace exposures and chronic diseases, including MSD. This presentation describes the creation of a JEM based on CONSTANCES data, evaluation of its ability to create homogenous exposure groups, and comparison of exposure estimates to those of an existing American JEM based on O*NET.

Methods: Self-reported biomechanical exposure data were obtained from the CONSTANCES project, a large prospective French cohort study that includes self-reported occupational exposures. Job titles were coded using French national job codes, the 4-digit PCS (Profession et Catégorie Sociale). A non-parametric multivariate analysis of variance (NPMANOVA) with

Manhattan distances between ranks of exposures assessed between-group and within-group variance. Individually reported exposure responses were then compared to JEM assigned exposure values. We created a crosswalk to match PCS codes with American SOC (Standard Occupational Classification) job codes found within O*NET. The 27 physical exposures identified in the French CONSTANCES JEM were compared with 24 O*NET exposures. Two comparison methods are reported: Spearman correlations and Cohen's Kappa agreements.

Results: CONSTANCES subjects who were currently employed ($n = 81,425$) were considered for the creation of the JEM. Subjects who were not currently working or not assigned a PCS code were excluded, leaving 35,563 eligible subjects. The NPMANOVA model indicates significantly higher between-group variance than within-group variance among the 27 exposures ($F[253,21964] = 61.33, p < 0.0001$); 41.4% of the variance in individual exposures were accounted for by PCS groups. A 24×27 Spearman correlation matrix of biomechanical exposures was created between the French CONSTANCES JEM and the O*NET JEM. Exposure variable pairs measuring similar exposures [e.g., carry loads (French JEM) and trunk strength (O*NET JEM)] demonstrated moderate to strong correlations. Cohen's Kappa demonstrated moderate to strong agreement between high and low exposure levels for variable pairs measuring similar exposures.

Discussion: A JEM was developed based on individual-level self-reported exposure data from a general population cohort of working-aged people in France. This French CONSTANCES JEM classified individual subjects based on their membership in specific job titles, and created homogenous exposure groups. JEM assigned exposure values approximated individual exposure responses reasonably well. Exposure estimates from the French JEM appear to be broadly consistent with exposure estimates calculated using American O*NET data. Continued validation of this French JEM is underway; preliminary results indicate that this JEM is a promising tool for biomechanical exposure assessment.

Session F4

Title: Use of Claims Data to Advance Safety **Moderator: Steve Wurzelbacher**

F4.1

Title: Targeting Industry Groups for Loss Prevention Services

Authors: [Michael Lampl](#), [Steven Naber](#), [Ibraheem Al-Tarawneh](#)

Background: The Ohio Bureau of Workers' Compensation (OBWC) Division of Safety and Hygiene (DSH) offers loss prevention services to Ohio employers. These services include ergonomics, industrial safety, and industrial hygiene consulting. Services also include occupational safety and health training and education, Safety Congress and Expo (3-day conference), and sponsorship of local safety councils. These services are funded by policy holder paid premiums and assessments paid by self-insured companies in Ohio. The DSH Research Department conducted a study that analyzed OBWC's claims injury and employment data to determine which industry groups had either a high rate of injury or a high percentage of more severe claims (lost time claims with 8 or more lost workdays) in order to aid in allocating the appropriate loss prevention resources to targeted industry groups.

Methods: We selected claims data for analysis from 2001 – 2011 to use in identifying those industries on which to focus more attention with DSH loss prevention services, especially consulting services. These data included 1.3 million claims and 324,000 employers. We linked records for OBWC-insured, private employers to Unemployment Insurance (UI) records using Federal Employer Identification Numbers common to both databases to obtain each employer's NAICS industry code and number of employees. We calculated injury rates per 100 employees for each NAICS industry and made full-time equivalent (FTE) adjustments using the BLS Labor Productivity and Costs (LPC) program data, multiplying employment count data for individual employers by the industry group's ratio of FTEs per employee. We identified 3-digit NAICS groups that had either high claims rates or a high ratio of lost time to total claims for inclusion in the groups to be targeted.

Results: From this study we identified 28 industry groups for targeting from a total of 89 3-digit NAICS groups. The group with the highest claims rate was Primary Metal Manufacturing (NAICS-331), and the group with the highest ratio of lost-time claims was Truck Transportation (NAICS-484). Three NAICS groups met inclusion criteria for both priority groups: Support

Activities for Mining (NAICS-213), Warehousing and Storage (NAICS-493), and Waste Management and Remediation (NAICS-562). Our priority groups included 23% of employers, 36% of claims, and 42% of costs. By eliminating some 4-digit NAICS groups within the priority group that had low claims rates and loss-time ratios and annual payroll less than \$500,000, we were able to reduce the number of employers to 4% while including 28% of the statewide claims and 30% of the statewide costs.

Discussion: To aid in interpreting the data, we developed relative risks for each industry group based on claims rates and lost-time claims ratios as compared to the rates and ratios for Office Administrative Services (NAICS-5611). While helping to identify high-risk industries, these relative risks do not differentiate employers with better or worse experience within each high-risk industry group. In the future, examining common characteristics of good-performing employers within high-risk groups could be beneficial to identify workplace improvements for loss-prevention targeting.

F4.2

Title: Using Workers' Compensation Claims Data to Characterize Non-Fatal Injuries in Aviation Workers in Alaska

Authors: [Kyle Moller](#), [Jennifer Lee](#), [Joanna Watson](#), [Mary O'Connor](#)

Background: Aviation operations in Alaska often take place in remote locations and under extreme weather conditions. Aviation companies frequently have a limited number of employees performing multiple tasks and limited infrastructure often requires that tasks such as baggage handling be performed manually. Previous NIOSH research described non-fatal injuries and illnesses among aviation workers requiring hospitalization. However, little is known about injuries that did not result in hospitalization. In an effort to further characterize these non-fatal injuries and illnesses, researchers identified workers' compensation (WC) claims as a valuable data source. Detailed individual level data from WC claims can provide information on specific occupations at highest risk, injury types, and body parts injured.

Methods: In 2015, the NIOSH Western States Division (WSD) entered into a data use agreement with the State of Alaska's Department of Labor and Workforce Development, allowing WSD to obtain and analyze WC claims

data. We have analyzed these data to better understand non-fatal injury and illness in the aviation industry, and also to identify the strengths and weaknesses of using Alaskan WC data for similar research in other industries. WC claims data were assessed for completeness, consistency, and accuracy of data for several key industry and injury variable fields. Aviation-related claims were identified using keyword searches of the narrative field, aviation-specific North American Industrial Classification System (NAICS) codes (e.g. NAICS code 481*, 611512), and NAICS codes of industries likely to be found in an aviation setting. Potential claims were manually reviewed to determine if aviation related. Injury description codes using the Workers Compensation Insurance Organizations' system for part of body, cause of injury, and nature of injury were provided in the claims data. Occupational groups were coded from the free-text occupation description variable.

Results: There were 925 aviation-related injury and illness claims during 2014–2015. Scheduled Passenger Air Transportation [NAICS code 481111] accounted for 510 claims (55% of all claims), followed by Other Airport Operations [NAICS code 488119] (147, 16%). Ramp agents incurred the most injuries (298, 32%), followed by mechanics or maintenance workers (129, 14%) and customer service and administrative flight support workers (104, 11%). The lower back was the most commonly injured body part (149, 16%) and was one of the top three most frequently injured body parts among all occupational groups. Among all workers, lifting, pushing, or pulling (215, 23%) was most often cited as the cause of injury, followed by falling, slipping, or tripping (174, 19%). Sprains, strains, and tears were the primary nature of injury (498, 54%).

Discussion: Ground handlers and flight crew shared similar injury profiles, possibly due to the workers performing similar tasks. For example, pilots at remote locations are often responsible for loading cargo into their aircraft. Injuries associated with lifting and affecting the lower back are likely due to lifting heavy cargo and baggage without assistance. These results agree with previous NIOSH research on non-fatal aviation injuries that required hospitalization and indicate that interventions should be directed toward workers performing similar tasks rather than specific occupational groups. Future efforts by NIOSH include a statewide survey of aviation workers to better understand the tasks and

circumstances related to injuries. NIOSH researchers will use WC findings and survey results to inform the development of interventions targeted toward the most hazardous tasks.

F4.3

Title: The Economic Effect of Chronic Comorbidities in Carpal Tunnel Syndrome Workers' Compensation Claimants, Washington State

Authors: [Michael Foley](#), [Jennifer Marcum](#), [Anne McHugh](#)

Background: Carpal Tunnel Syndrome (CTS) is especially burdensome on workers and their families. Workers with CTS were followed over time to determine the effect of chronic comorbidities on their ability to reenter into the workforce after their injury.

Methods: We identified a sample of workers' compensation claimants with CTS and controls (upper extremity fracture claimants) in the Washington workers' compensation data, and classified claimants with chronic comorbidities using medical bills in this system. The quarterly hours worked and earnings was collected for these claimants by linking to Washington unemployment insurance data for a one-year period before their work-related injury through five years post-injury. Adjusted logistic and linear regression modeling methods were used to investigate differences by chronic comorbidity status and injury type in whether the claimant returned to work post-injury, or if they returned to work, the relative number of hours (RHR) and earnings (RER) post-injury compared to pre-injury status.

Results: The majority, 56%, of CTS claimants had diagnosed chronic comorbidity, while 45% of the UEF claimants had a diagnosed chronic comorbidity. A significantly greater proportion of CTS claimants were no longer working one through five post-injury if they had a diagnosed chronic comorbidity, compared to other CTS claimants. Chronic comorbidity status did not consistently affect proportion of UEF claimants not working post-injury. Among claimants still working post-injury, chronic comorbidities had no significant effect on RHR at one year post-injury, but significantly decrease both RHR and RERs for claimants at all other time points.

Discussion: This research suggests that chronic conditions should be considered as potential barriers to

recovery for injured workers. Policies should be put in place for consistent reporting, and to direct medical attention and treatment of all chronic comorbidities affecting workers.

F4.4

Title: Measuring the Cost of Injuries with Workers' Compensation Data

Author: **Tim Bushnell**

Background: The workers' compensation system is the largest and most often used source of data on occupational injury costs. However, workers' compensation cost data is complex, and it is often not interpreted or used in the most appropriate way. This presentation will give an overview of the types of injury cost information available in workers' compensation data, and illustrate how they have been used in several recent projects of the NIOSH Center for Workers' Compensation Studies (CWCS).

Methods: First, an overview of basic cost metrics used in the workers' compensation insurance system will be provided, including concepts of claim cost vs. premium cost, medical cost vs. indemnity cost, and paid cost vs. reserves. Following this introduction, three basic cost measurement tasks will be discussed: trend measurement, total cost measurement, and the characterization of claim cost distribution. Each of these tasks present problems, for which reasonable solutions have been devised. These solutions, and potential improvements to these solutions, will be described, based on publications by NIOSH in collaboration with the Ohio Bureau of Workers' Compensation (BWC), a study by the RAND Corporation partially focusing on an Ohio BWC injury prevention program (rand.org/pubs/research_reports/RR2256), and a NIOSH tool for helping mining employers estimate injury costs (cdc.gov/niosh/mining/content/economics/safetypays).

Results: Trend measurement: The NIOSH CWCS, working with the Ohio BWC, has measured trends in workers' compensation costs in Ohio, both as a matter of interest in itself, and as a means of determining whether grants for safety equipment provided to employers by the BWC were successful in causing a steeper downward trend in injury costs than that experienced by employers who did not receive grants. Trends based on three different cost metrics were estimated, yielding declines of 34% to 56% in claim cost per employee over 5 years (2004-2009),

although this difference was not statistically significant. One of the three claim cost metrics was selected for the safety grant study. Total cost measurement: Measurement of total injury cost often requires the use of cost metrics that are different from those used for measurement of cost trends. Total cost becomes of particular interest when we ask whether the total cost of injuries prevented by an intervention exceed the cost of the intervention. Recently, the RAND Corporation published a study on the cost reductions resulting from the Ohio safety grant program. Difficulties were encountered in the measurement of workers' compensation administrative costs associated with the prevented injuries, the expected future costs of avoided injury claims, and the earnings losses for which workers receive indemnity benefit payments. RAND arrived at provisional solutions to these problems, but improved solutions are desired for future analyses. Characterizing claim cost distribution: NIOSH created an online software tool entitled Safety Pays in Mining to assist mining employers in estimating the potential cost savings from reducing specific types of injuries, as defined by nature or cause of injury. The tool is geared to large employers who pay the cost of their claims directly rather than through an insurance policy. The difficulty was that estimating the typical cost of a specific injury type based only on the mean or median cost could be misleading. This is because claim costs vary so widely, and because the distribution of these costs is highly skewed. The software tool was enhanced to provide employers insight into how their expected cost savings per injury could depend partly upon how many injuries they expect to prevent.

Discussion: Understanding differences among metrics for the cost of workers' compensation claims will assist in using them appropriately. More work is needed to improve estimates of the total cost of injuries associated with workers' compensation claims.

Session G1

Title: Connecting Safety Culture to Safety and Health Management on Construction Jobsites

Moderator: **Christine Branche**

Discussant: **Scott Schneider**

Emily Haas, Murrey Loflin and Ted Scharf, representing the NIOSH Safety Culture/ Safety Climate Working Group: Recent progress in safety culture/ safety climate research has demonstrated this construct to be a valid

leading indicator of safety in hazardous work environments. While an active, worldwide research effort continues to refine these measures, the focus of this research is gradually shifting to the workplace context for which safety culture and climate may serve as a leading indicator. The most important context is the occupational safety and health management system (OSHMS) on the jobsite, combined with the contract schedule and associated productivity demands. The importance of improving safe work policies and practices in construction is reinforced by the 2016 fatality and injury data from the Bureau of Labor Statistics. With the return to close-to full employment (following the Great Recession of 2008), we see that the number and rate of occupational fatalities have both increased to just below the data recorded for 2008. The CPWR Construction Chart Book (2018) Ch.38 traces these trends in the construction industry from 1992-2015. Note: we might expect that the absolute numbers of fatal and non-fatal injuries would increase as employment increases. However, effective safety interventions predict that the rates of fatal and non-fatal injuries should continue to decline regardless of the level of employment, and they are not doing so. For example, falls from above ground level accounted for 37% of the 991 construction fatalities in 2016. Similarly, falls from above ground level accounted for nearly 15% of the 82,760 construction injuries and illnesses resulting in days away from work in 2016. This trend stubbornly persists despite extensive and ongoing, national, regional, and local efforts by construction safety professionals.

This session will explore research studies and an intervention in safety training and safety management that demonstrate the interdependence of safety culture/ safety climate with safe work policies and practices in construction. The session begins with three different approaches to measuring and evaluating safety climate in the construction work environment. The session concludes with an intervention that is a direct outgrowth of the S-CAT by CPWR: The Foundations for Safety Leadership. The FSL curriculum was recently approved as an elective in the OSHA 30-hour certification for construction. This training intervention is an important step in moving safety climate/ culture into everyday safety management for front-line supervisors and workers. Following the four presentations, a discussion will be led by Scott Schneider, Director of Occupational Safety and Health for the Laborers' Health and Safety Fund of North America (retired).

G1.1

Title: Subcontractor Safety Management Programs and Worker Perceived Safety Climate in Commercial Construction Projects

Authors: Ann Marie Dale, Skye Buckner-Petty, Marco Barrera, [Bradley Evanoff](#)

Background: There is increasing interest in evaluating safety management programs with leading indicators rather than lagging indicators of risk such as injuries and fatalities. Safety climate measures may be used as a leading indicator of safety on construction projects. What is not known is how workers' safety climate scores relate to safety management programs. The aims of this project were to examine the relationship between subcontractor safety management programs and safety climate scores, and to assess safety climate at different levels of the project organization.

Methods: Subcontractors from three large commercial projects were recruited and asked to provide safety program documents and to participate in interviews describing their safety programs. Employees of these subcontractors completed surveys to report their subcontractor's safety climate, their coworkers' safety climate, their own safety behaviors, and crew safety behaviors. Safety climate and behavior scores were computed as the average of responses for each group and standardized to 0-100 point scales. The subcontractors' safety information from interviews and written documents were reviewed and scored on a checklist of 17 safety items. The safety items covered four domains: organizational management (7 items), worker participation (4 items), hazard identification (3 items), and training (3 items). The proportion of safety items created the subcontractor's safety program score. Contractors were categorized as large (>200 employees), medium (51-200 employees) and small (0-50 employees). Hierarchical linear regression models accounted for contractor size and number of workers, nested in subcontractors within projects. These models examined the relationships between proportion of safety items and 1) subcontractor and coworkers safety climate scores, and 2) crew and employees' own behavior scores.

Results: Preliminary results on 446 workers employed by forty subcontractors on three projects were predominately male (98.9%), Caucasian (87.5%), with a mean age of 38 years (SD 11), and mean tenure with subcontractor of 4 years (SD 5.9). Most workers

performed electrical (19%), carpentry (17%), pipefitting (7%) or drywall (10%) tasks, covering 18 tasks overall. Many subcontractors (n=16) had fairly comprehensive safety programs incorporating 90% of the checklist of safety items in their program. Safety programs with 90% or more of the safety items were strongly associated with higher safety climate scores for the subcontractor safety climate (5.15 point difference on a 100 point scale, $p=0.05$) and coworkers safety climate (6.69 points, $p=0.01$) as well as crew safety behaviors (5.34 points, $p=0.02$) and their own behavior scores (5.14 points, $p=0.02$) compared to safety programs with fewer than 90% of safety items.

Discussion: Workers employed by subcontractors with more comprehensive safety programs perceived their projects to be safer than employees of subcontractors with fewer safety program items. Similarly, workers from subcontractors with more comprehensive safety programs report their coworkers and their own behaviors were safer. Most of the stronger safety programs incorporated activities from all four domains including organizational management, worker participation, hazard identification, and training. Additional data collected from this ongoing study will provide the ability to explore the influence of the specific domains within the safety programs as well as comparing the safety program against other leading indicators.

G1.2

Title: Safety Climate and its Relationship with Construction Company Safety Management Systems and Programs

Authors: [Luz Stella Marin](#), [Jack Dennerlein](#), [Michael Grant](#)

Background: Organizational models of safety climate suggest it is influenced by organizational policies, programs and practices such as safety management systems. However, evidence of these influences is still limited, particularly in construction. Often, construction companies report both low implementation of SMS and poor safety climate. Therefore, our three exploratory studies determined relationships between organization and workplace indicators of safety management systems and workers' perceptions of safety climate.

Methods: First, we completed a cross-sectional study of 401 workers from 26 construction sites from 58 companies registered with ConstructSecure Inc. (Lex-

ington, MA), a safety pre-qualification database. The database generates a score on a 100-point scale for each company, which is based on measurements of the company's SMS as well as other safety programs and worker policies. Worker surveys assessed safety climate based on the 9 questions in a measure for construction. Spearman rank correlations evaluated the association between the CSAP score and the safety climate score. Second, we utilized weekly safety inspection scores from safety managers' walkthroughs and weekly safety climate scores from worker surveys collected at six commercial construction sites (20,000 sq ft to 485,000 sq ft) over a four to five-month period per site. Linear mixed effects models estimated weekly safety climate scores from the concurrent and the previous weekly work site safety inspections scores. Third, using a sample of 25 commercial construction companies in Colombia, we examined the relationship between workers' safety climate perceptions and SMS. Implementation of SMS was evaluated using 86 desirable practices, and the Nordic Safety Climate Questionnaire (NOSACQ-50) was used to assess workers' perceptions of safety climate. Injury rates were calculated from a database of claims provided by the 25 companies. Generalized linear models were used to test associations.

Results: For our first study, there were, at best, weak correlations between workers' safety climate scores and the measurements of the company's safety management systems scores, with marginal statistical significance with two groupings of the data. However, for the second study, concurrent weekly safety inspections were significant predictors of safety climate in our unadjusted and adjusted analysis ($p < 0.0001$). Safety inspections were not significant ($p=0.9426$) predictors of safety climate measured one week after the inspection. Finally in the third study, workers' perceptions of safety climate were independent of their own company's implementation of SMS, and its injury rates. However, injury rates were negatively related to the implementation of SMSs.

Discussion: Our goal was to examine the relationship between safety climate and SMS for construction companies. We saw weak correlations between our metrics of safety management systems and safety climate in these construction companies. We examined associations between physical working conditions and safety climate measures that appeared to be somewhat temporal in nature. Given the dynamic aspects of construction worksites, traditional theories surrounding safety

climate suggest that a worker who is on site for a short period of time may not be able to perceive a company's safety management system. However, since the ultimate goal of a strong, positive SMS is to reduce risk, working conditions in a construction site may be a better measure of the effectiveness of the SMS articulated through the working condition rather than through verbal and policy communications.

G1.3

Title: The Safety Climate Assessment Tool: Rubric-Based Approach to Measuring Construction Safety Climate

Authors: [Linda Goldenhar](#), [Tahira Probst](#), [Jesse Byrd](#), [Eileen Betit](#)

Background: Safety climate - employee's shared perceptions of the degree to which their organization values safety - has been linked to numerous health and safety outcomes. A recent review article showed that a plethora of organizational safety climate and culture surveys have been developed over the last 20 years. The majority ask respondents to record their safety climate perceptions using 5-point Likert response scales ranging from strongly agree to strongly disagree which are then combined to create a summary score. Although empirical research has demonstrated that safety climate scores are significantly related to important safe work practices, the scores alone do not provide guidance on what an organization can do to improve their own safety management systems and thus safety climate. Many consulting companies charge a fee to conduct an assessment of an organization's safety climate. This can be cost-prohibitive for many construction companies, which data show have 10 or fewer employees. Thus, the practical application of 2 decades of safety climate research remains largely out of reach for the vast majority of construction firms. Further, the translational "research-to-practice" activities that could enable companies of any size to assess their own safety climate and produce actionable ideas for improving their safety management systems, has been limited. The project goal was to develop and validate a new rubric-based tool - the Safety Climate Assessment tool or S-CAT. This tool gives any sized company the opportunity to not only self-assess their level of safety climate maturity, but the rubric descriptors give respondents a concrete idea of specific practices that can lead to a more or less mature safety climate. While the rubric-based approach

to measuring safety climate may be an innovative shift from more traditional assessment methodology, it still must be empirically tested to determine factor structure and reliability. Its criterion-related validity must also be assessed by examining the degree to which the scores correlate with key lagging indicators such as organizational recordable injury rates (RIR).

Methods: Nine hundred eighty-five respondents from the construction industry completed the S-CAT scale, which contains 37 indicators designed to measure the safety climate maturity for 8 leading safety climate factors identified by construction stakeholders at a 2013 workshop. Each factor uses between 3-6 rubric-based response scales (one for each factor's indicators) that contain specific descriptors for each level of safety climate maturity ranging from 1 (inattentive) to 5 (exemplary). We used company recordable incident rate (RIR) to assess the S-CAT's criterion validity.

Results: Cronbach alpha reliabilities ranged from .77 (Empowering and Involving Employees) to .90 (Owner/Client Involvement) and the confirmatory factor analysis supported the hypothesized 8 factor structure with a higher-order safety climate factor. Moreover, 7 of 8 factor scores and the overall S-CAT score were negatively correlated with RIR values supporting the S-CATs criterion validity. A regression analysis indicated that a company's total S-CAT score accounted for 9% of the variability in organizational recordable injury rates.

Discussion: These findings provide evidence that the S-CAT, a new rubric-based assessment tool, is both reliable and valid. Qualitative data also show that the S-CAT has provided companies not only with safety climate scores but they've also used the rubric descriptors to strengthen their safety management systems and move up the safety climate maturity scale.

G1.4

Title: Evaluation of Safety Leadership Training to Enhance Construction Jobsite Safety Climate: The Foundations for Safety Leadership (FSL)

Authors: [Natalie Schwatka](#), [Linda Goldenhar](#), [Stefanie Johnson](#), [Marissa Beldon](#), [Jamie Tessler](#), [Jack Dennerlein](#), [Mark Fullen](#), [Dan Weinstein](#), [Hao Trieu](#)

Background: Recent research has shown a positive

relationship between safety leadership, safety climate, and other safety outcomes across multiple industry sectors, including the construction industry. Despite the evidence, few training interventions have been developed to improve safety leadership skills, and none have evaluated training effectiveness on improving construction frontline supervisor's safety leadership and jobsite safety climate. This was the goal of our project.

Methods: The Foundations for Safety Leadership (FSL) training module was created collaboratively by CPWR, university researchers, and a curriculum development team comprised primarily of OSHA 30-hour trainers and safety professionals. The FSL focuses on five safety leadership skills including: 1) Leading by example, 2) Engaging and empowering team members, 3) Actively listening and practicing 3-way communication, 4) Developing team members through teaching, coaching and feedback, and 5) Recognizing team members for a job well done. These five skills closely align with the four core factors of safety-specific transformational leadership. The 2.5 hour interactive, scenario-based FSL module was approved by OSHA to be an elective in the 30-hour course and can also be used as a stand-alone training. Using a switching replications study design, we evaluated the FSL to examine if after participating in the FSL, frontline supervisors' improved their understanding and practice of safety leadership skills and if their crew members perceived a difference in their supervisors' safety leadership practices and improved jobsite safety climate. We recruited 286 supervisors and 1173 workers who worked at 20 construction specialty subcontractor companies that differed in terms of geographic location, union or non-union status, size, and trade type. We randomized companies to either an early or lagged training group. This allowed us to consider the lagged group companies as controls yet still provide them with the FSL training. We collected pre-post training survey data from participants 4 and 3 times over a 6-week period for supervisors and workers, respectively. We analyzed the data using a mixed-effects regression modeling procedure with scores at each time point nested within supervisor to account for repeated measures. The main effects were time of survey and intervention group, and a random intercept was used to allow scores to vary across supervisors. All models controlled for ethnicity (Hispanic vs. Non-Hispanic), survey language (Spanish vs. English), and supervisors' self-reported learning goal orientation.

Results: Results showed that compared to the lagged

(control) group, supervisors in the early group had improved understanding of ($p < 0.01$) and greater self-reported practice ($p < 0.01$) of the 5 safety leadership skills from immediately before to 2-weeks after the FSL training. No significant group differences were found in workers' reports of their supervisor's safety leadership practices ($p = 0.11$) and safety climate perceptions ($p = 0.72$) from 1-week before to 2-weeks after their supervisor's FSL training.

Discussion: Findings from the study add to the safety leadership and occupational health and safety training literatures by demonstrating that frontline supervisors who participated in the FSL training reported improved understanding and practicing of safety leadership skills. It is possible that the lack of change in worker's perceptions of leadership practices or safety climate may be due in part to the fact that the mean scores on these variables were already relatively high at baseline and that a longer time period may be needed for changes to be perceived.

Session G2

Title: Occupational Injuries Among First Responders

Moderator: William Haskell

First responders are persons who are generally the first to be dispatched to the scene of an emergency. First responders are critical in ensuring scene safety and protecting and preserving life and property. Occupations commonly identified in this category include fire fighters, law enforcement officers, and emergency medical services (EMS) workers. Less recognized occupations in this category include skilled support personnel such as those in the motor vehicle towing industry and 911 call operators. All of these workers provide immediate support during response and recovery efforts. First responders are exposed to a variety of occupational hazards including unstable and unknown environments, assaults, extreme physical activity demands, hazardous substances, and close contact with roadway traffic. They have higher rates of injuries compared to other workers. This session will include four presentations describing injuries to fire fighters, law enforcement officers, EMS workers, as well as workers in the motor vehicle towing industry. Session attendees will have a better understanding of the injuries that are most likely to impact these critical first responders. Attendees will also gain

knowledge of future research efforts planned by the National Institute for Occupational Safety and Health (NIOSH) to address injuries among these workers.

G2.1

Title: Nonfatal Injuries to Emergency Medical Services Workers

Authors: [Audrey Reichard](#), [Suzanne Marsh](#), [Srinivas Konda](#), [Theresa Tonozzi](#), [Mirinda Gormley](#)

Background: Emergency medical services (EMS) workers are critical to supporting and maintaining public health and safety. Their work involves hazardous activities and environments that can lead to injuries, including body motion injuries and harmful exposures. Their occupational injuries occur at rates higher than the general workforce. Such injuries have negative impacts on the worker and the workforce, resulting in missed work days and decreased work performance. More serious injuries can impact the growth and retention of the EMS workforce.

Methods: This presentation will highlight detailed results from a collaborative study between the National Institute for Occupational Safety and Health and the National Highway Traffic Safety Administration. The study captured data via a telephone interview follow-back survey of EMS workers treated for occupational injuries in emergency departments (EDs) from 2010 to 2014. Injured EMS workers were identified from data routinely captured by the occupational supplement to the National Electronic Injury Surveillance System (NEISS-Work). A total of 572 EMS workers completed the interview survey and results were weighted, adjusted, and summed to produce national estimates describing EMS workers treated in EDs. All estimates are presented with 95% confidence intervals (CI). This presentation will also provide an updated overview of EMS injuries from an analysis of the 2015-2016 NEISS-Work data. These data were weighted and summed to produce national estimates for the two-year period.

Results: Follow-back survey respondents represented 89,100 (95% CI: 54,400-123,800) EMS workers who sought treatment in EDs from 2010 through 2014. Two-thirds of the workers were male (59,900; 95% CI: 35,200-84,600) and 42% were 18-29 years old (37,300; 95% CI: 19,700-54,700). Three-quarters of the workers were full-time (66,800; 95% CI: 39,800-93,800) and an additional 10% were part-time or on-call (9,300; 95% CI: 4,900-

13,700). Among career EMS workers, the injury rate was 8.6 per 100 full-time equivalent EMS workers (95% CI: 5.3-11.8). Over half of all injured workers had less than ten years of work experience (46,300; 95% CI: 26,600-66,100). Sprains and strains accounted for over 40% of all injuries (37,000; 95% CI: 22,000-52,000). Body motion injuries were the leading event (24,900; 95% CI: 14,900-35,000), with 90% (20,500; 95% CI: 12,800-32,100) attributed to lifting, carrying, or transferring a patient and/or equipment. Exposures to harmful substances were the second leading event (24,400; 95% CI: 11,700-37,100), most often occurring from needlesticks or patients unintentionally or intentionally spitting on the worker. An analysis of the routinely collected NEISS-Work data from 2015-2016 indicated a total of 40,000 (95% CI: 24,900-55,200) ED-treated injuries to EMS workers, and almost one-third were sprains and strains (13,200; 95% CI: 8,300-18,100). Body motion injuries continued to be the leading event (13,700; 95% CI: 8,400-18,900) and exposures to harmful substances continued to be the second leading event (7,800; 95% CI: 4,800-10,900).

Discussion: New and enhanced efforts to prevent EMS worker injuries are needed, especially those aimed at preventing body motion injuries and exposures. Follow-back study results can encourage EMS and public safety agencies to address occupational safety and promote the health and performance of the EMS workforce. Study results from the follow-back survey were disseminated in various formats (e.g., fact sheet, infographic) to reach intended audiences. Additionally, routinely collected NEISS-Work data analyses of EMS worker injuries continue to be updated to monitor changes in injury trends. A summary of these analyses is available to the public on the NIOSH EMS worker website.

G2.2

Title: A Study of Nonfatal Injuries to Fire Fighters Treated in U.S. Emergency Departments

Authors: [Suzanne Marsh](#), [Melody Gwilliam](#), [Srinivas Konda](#), [Hope Tiesman](#), [Rita Fahy](#)

Background: Fire fighters (FFs) perform crucial tasks to ensure public safety and health, including fighting structure and wildland fires, responding to vehicle incidents, and assisting during medical calls. These tasks can lead to worker injury and death. Several studies of nonfatal FF injuries have been conducted but are limited by inclusion and coverage. These studies included a

limited number of departments, a portion of the workforce, and generally excluded volunteers. To address some of these limitations, the aim of this presentation will be to enhance current knowledge by providing national estimates of nonfatal injuries to FFs treated in U.S. emergency departments (EDs).

Methods: Nonfatal injuries from 2003 through 2014 were extracted from the National Electronic Injury Surveillance System occupational supplement (NEISS-Work). NEISS-Work captures nonfatal occupational injuries, including exposures, treated in a sample of U.S. EDs. Nonfatal injury rates were calculated based on NEISS-Work injury counts and National Fire Protection Association employee counts.

Results: Between 2003 and 2014, an estimated 351,800 ($\pm 126,300$) FFs were treated in EDs for nonfatal injuries. The overall rate was 260 (± 92) per 10,000 FFs. Career FFs had an annual rate of 699 (± 288); volunteers had a rate of 39 (± 19). Leading injury events were fires and explosions (36%, 41,300, $\pm 20,900$) and overexertion and bodily reactions (20%, 23,400, $\pm 7,600$). The largest share of injuries (38%, 134,900, $\pm 63,000$) occurred during fire fighting activities, 7% (23,100, $\pm 11,100$) occurred during training and 7% (23,800, $\pm 12,000$) occurred during patient care. Sprains and strains accounted for the largest proportion of injuries in all three of these activities: 28% (37,200, $\pm 23,400$), 32% (7,300, $\pm 3,600$), and 36% (8,600, $\pm 5,500$), respectively.

Discussion: Unlike other studies that have explored FF injuries, this study offers a national perspective of nonfatal FF injuries without establishment ownership or industry restrictions. The results demonstrate that nonfatal injuries for FFs remained high. Although the results also demonstrate that sprains and strains – not burns – were the most common injury among FFs, the data do not include enough detail to suggest specific prevention needs. Conclusions: Identifying and understanding risks that FFs face is complex as no single, comprehensive data source exists. Thus, risks must be identified via analysis of available data, including the ED data used in the current study. While information generated through this analysis is useful, more detailed data are needed to refine information on the specific risks that FFs face. Next Steps: The National Institute for Occupational Safety and Health Division of Safety Research will be implementing a follow-up study to collect more detailed information on FFs later in 2018. The NEISS-Work ED data will be used to identify potential respondents for

follow-back interviews. Data collection will be done via a telephone interview survey containing questions about the respondent's injury that sent them to the ED, their specific activity at the time of their injury, work experience and competencies, and recovery experience. The survey was pilot tested among nine career and volunteer fire fighters. Results from this pilot test were used to improve the survey and will be summarized. While results from the survey will not be available, we expect the data results to build on findings from the routinely collected NEISS-Work data and provide deeper insight into the characteristics of nonfatal injuries among FFs.

G2.3

Title: Injured On Duty: Non-Fatal Injuries to U.S. Law Enforcement Officers

Authors: [Hope Tiesman](#), [Jeff Rojek](#), [Suzanne Marsh](#), [Srinivas Konda](#), [Melody Gwilliam](#), [Julie Grieco](#)

Background: Several national systems exist that document fatalities among law enforcement officers (LEOs); however, much less is known about how nonfatal injuries impact LEOs and their agencies. A handful of studies exist but are limited by size or scope. Recent events have called attention to a wide range of internal policing issues and caused law enforcement practitioners, criminologists, and occupational safety and health professionals to consider the impact of police work on the health and safety of officers. The purpose of this presentation is to enumerate and describe nonfatal injuries among LEOs treated in U.S. emergency departments (EDs) between 2003 and 2014 and discuss next steps in this research.

Methods: Nonfatal injuries from 2003 through 2014 were obtained from the National Electronic Injury Surveillance System occupational supplement (NEISS-Work). NEISS-Work captures nonfatal occupational injuries, illnesses, and exposures (hereafter referred to as injuries) treated in a sample of U.S. emergency departments. Nonfatal weighted injury rates were calculated using denominators from the Current Population Survey. Negative binomial regression was used to analyze temporal trends.

Results: Between 2003 and 2014, an estimated 669,100 LEOs (95% CI 461,000-877,200) were treated in U.S. EDs for on-duty nonfatal injuries. The overall rate of 635 per 10,000 FTEs (95% CI 436-834) was three times higher than the rate for all other U.S. workers. The three lead-

ing injury events were assaults and violent acts (35%), bodily reactions and exertion (15%), and transportation incidents (14%). Injury rates were highest for LEOs aged 21–24 years. Male and female LEOs had similar nonfatal injury rates. Rates for most injuries remained stable across the time period; however, rates for assault-related injuries grew substantively between 2003 and 2011.

Discussion: We found that LEOs had high nonfatal injury rates compared with other U.S. workers, and these rates increased from 2007 until 2011. This increase may be driven by a large and significant increase in assault-related injuries that started in 2008 and continued until 2012. This was the first study to demonstrate an upward national trend in assault-related injuries among LEOs. One theory for the increase is that the law enforcement community may have changed policies to require officers to visit EDs to document all civilian encounters that result in an injury, regardless of the severity of the injury. A second hypothesis is that the landscape of civilian–officer dynamics is changing. A more thorough secondary analysis, as well as a new study, are underway to explore these findings in more detail. Next Steps: To better understand these findings, two activities are underway to obtain more detailed information. First, a secondary analysis will explore the ED-treated assaults in more detail to identify risk factors and situations surrounding the assaults. A second task is a follow-up study that will collect more detailed information through interviews of LEOs treated in EDs. The NEISS-Work ED data will be used to identify potential respondents for follow-back interviews. A questionnaire will be used to collect information about the respondent’s injury, their specific activity at the time of their injury, work and sleep experience, and follow-up care. During the pilot-testing of the questionnaire, it was learned that there are strong discrepancies in both nomenclature and comfort level in answering survey questions between large and small law enforcement agencies. These differences and the challenges in doing national research in officer safety will be discussed. An overview of the survey and its goals will also be presented. While results from the survey will not be available, we expect the study results to build on findings from the routinely collected NEISS-Work data and provide a deeper insight into the characteristics of nonfatal injuries among LEOs.

G2.4

Title: Occupational Injuries in the U.S. Motor Vehicle Towing Industry, 2011-2016

Authors: [Srinivas Konda](#), [Audrey Reichard](#), [Suzanne Marsh](#), [Hope Tiesman](#)

Background: Motor-vehicle roadway incidents require the efforts of various emergency responders, including law enforcement officers (LEOs), fire fighters, and emergency medical services (EMS) workers. Towing and recovery service workers are also an indispensable component in restoring traffic as quickly and safely as possible. While removing wrecked or disabled vehicles and debris from roadways, these workers incur injuries and deaths due to oncoming traffic. Although studies have focused on the safety of LEOs, fire fighters, and EMS workers, the magnitude and characteristics of injuries and deaths among towing and recovery service workers has not been studied. The purpose of this analysis was to describe fatal and nonfatal work-related injuries in the motor vehicle towing industry.

Methods: Data on fatal and nonfatal occupational injuries in the motor vehicle towing industry (North American Industry Classification System 488410) were obtained from the Bureau of Labor Statistics publicly available Census of Fatal Occupational Injuries (CFOI) and Survey of Occupational Injuries and Illnesses (SOII) data. Fatality rates per 100,000 workers for the motor vehicle towing industry and all U.S. private industries, including the motor vehicle towing industry, were calculated using the employment data from the Quarterly Census of Employment and Wages (QCEW). The QCEW data exclude self-employed workers. Thus, fatalities among self-employed workers were excluded for rate calculations. Nonfatal injuries and illnesses involving days away from work and rates per 10,000 full-time equivalent (FTE) workers for the private motor vehicle towing industry and all U.S. private industries, including the motor vehicle towing industry, were obtained from SOII.

Results: From 2011 through 2016, the CFOI identified 191 fatalities in the motor vehicle towing industry. The annual average fatality rate of the motor vehicle towing industry was 42.9 fatalities per 100,000 workers. Comparatively, the average annual fatality rate for all U.S. private industries was 2.9 fatalities per 100,000 workers. The majority of decedents were male (n=185,

97%), aged 45–54 (n=55, 29%), and non-Hispanic white (n=134, 70%). Motor vehicle incidents (n=122, 64%) and contact with objects and equipment (n=33, 17%) were the leading injury events. Of the motor vehicle incidents, workers in the motor vehicle towing industry were most frequently killed as pedestrians due to being struck by vehicles (n=76, 62%). During the same period, 6,400 nonfatal occupational injuries and illnesses involving days away from work were reported in the motor vehicle towing industry at a rate of 204.2 per 10,000 FTEs. Comparatively, the average annual injury and illness rate for all U.S. private industry workers was 98.2 per 10,000 FTEs. The majority of injuries and illnesses occurred to male (n=6,030, 94%), aged 35–44 (n=2,310, 36%), and white workers (n=3,920, 61%). Leading injury events were contact with objects and equipment (n=2,170, 34%) and overexertion and bodily reaction (2,040, 32%). A majority of injuries resulted in sprains, strains, and tears (n=2,450, 38%).

Discussion: We found that workers in the motor vehicle towing industry have a higher risk for fatal and nonfatal occupational injuries compared to all workers. The fatality rate in the motor vehicle towing industry was more than 15 times the rate in all U.S. private industries while the nonfatal injury and illness rate was more than double the rate in all U.S. private industries. Pedestrian workers in the motor vehicle towing industry were most at risk for being fatally struck by a motor vehicle. Nonfatal injuries most commonly resulted in sprains, strains, and tears. This is the first study to exclusively focus on the motor vehicle towing industry at a national level. Our findings of elevated injury and fatality risks justify the need for additional research and tailored prevention efforts in this largely overlooked industry.

Session G3

Title: Injuries in Commercial Fishing and Seafood Processing

Moderator: Devin Lucas

G3.1

Title: Crew Position and Injuries in the Dungeness Crab Fleet

Authors: Viktor Bovbjerg, Amelia Vaughan, Kaety Jacobson, Devin Lucas, Laura Syron, Laurel Kincl

Background: Commercial fishing is a dangerous occupation and the Dungeness crab fleet is considered a high-risk fleet based on fatality rates. The Fishermen Led Injury Prevention Program (FLIPP) in the Pacific Northwest aims to study and prevent traumatic injuries in the Dungeness crab fleet. The project engaged fishermen in research to understand high risk tasks, safety perceptions, and injury prevention opportunities. As part of a pre-season survey of Dungeness crab fishermen, we asked crew members to report on their recent injury history, and tested a commonly held view that crew position and lack of experience is associated with increased injury risk.

Methods: Prior to the 2015-2016 Dungeness crab fishing season, we administered a survey to 426 fishermen along the California, Oregon, and Washington coast. Surveys were conducted by community researchers with crews in gear yards and dockside. Participants recorded their recent and career injury history, nature of recent injuries, activities and conditions at the time of recent injuries, personal fishing and crabbing history, and crew position. We first examined whether crew position was associated with injury risk. We then determined whether injury risk differed by experience (years fishing, years crabbing), across the entire sample, and stratified by crew position (owner, captain, deckhand). Initial findings led to secondary analyses of potential explanatory factors.

Results: Of 420 surveys indicating crew position, 144 (34.3%) were vessel owners, 51 (12.1%) were captains, and 213 (50.7%) were deckhands. Not surprisingly, owners were older (51.0+/-13.2 years) than captains (42.2+/-12.8 years) or deckhands (31.9+/-10.3 years; $F=111.0$, $p<0.001$). Injury while fishing varied by crew position: deckhands were more likely to report having been injured in the past year (63, 29.6%), compared to captains (10, 19.6%) or owners (11, 7.7%; $\chi^2=27.7$, $p<0.001$). Overall, injury was associated with less experience: those injured, compared to those not injured, had fewer years of experience fishing (11.3+/-10.4 vs 19.1+/-14.6, $p<0.001$) and crab fishing (8.4+/-8.6 vs 12.7+/-11.5, $p<0.001$). The association of experience to injury varied by position. Among deckhands, those injured, compared to those not injured, had comparable years fishing (8.5+/-9.0 vs 9.7+/-9.2, $p=0.40$) and crab fishing (7.0+/-7.6 vs 7.0+/-7.4, $p=0.99$). Among captains, those injured, compared to those not injured, also had comparable years fishing (19.3+/-6.6

vs 21.6+/-11.3, $p=0.55$) and crab fishing (13.0+/-6.7 vs 14.1+/-10.2, $p=0.75$). However, among owners, those injured, compared to those not injured, had fewer years fishing (20.5+/-12.0 vs 29.6+/-13.5, $p=0.03$) and crab fishing (11.1+/-11.8 vs 19.1+/-12.6, $p=0.04$). Owners' injuries were more likely to be work limiting (10/11, 90.9%), compared to injuries to captains (6/10, 60%) or deckhands (31/62, 50%; chi-square=7.5, $p=0.02$). Injury among owners was associated with vessel length: injured owners worked on shorter vessels (43+/-13 ft) compared to injured captains and deckhands (58.5+/-16.2 ft; $p=0.003$). Fishing intensity, measured by months fished in the past year, did not differ significantly by injury status within position.

Discussion: As expected, injury risk among commercial fishermen was greatest among deckhands, compared to captains and owners. Contrary to expectations, experience was not associated with injury among deckhands, but rather only among owners: less experienced owners had greater injury risk. In the Dungeness crab fleet, there is substantial variation in the roles owners take on their vessels, and include those of skipper and deckhand. Injured owners were more likely to have worked on smaller vessels, where they may be more likely to engage in the full range of fishing activities (e.g. hauling gear); injury may also be related in some other way to fishing intensity. Analysis by work task may illuminate potential causal factors.

G3.2

Title: Traumatic Injuries in the Dungeness Crab Fleet: Engaging Fishermen to Prevent Injuries While Handling Crab Pots

Authors: [Laurel Kincl](#), [Viktor Bovbjerg](#), [Kaety Jacobson](#), [Samantha Case](#), [Devin Lucas](#), [Amelia Vaughan](#)

Background: Commercial fishing is a dangerous occupation and the Dungeness crab fleet is considered a high-risk fleet based on fatality rates. The Fishermen Led Injury Prevention Program (FLIPP) in the Pacific Northwest aims to study and prevent traumatic injuries in the Dungeness Crab Fleet. The goal is to engage fishermen in research to understand high risk tasks, safety perceptions, and injury prevention opportunities. This is the first study on non-fatal injuries in this fleet with the goal to develop injury prevention strategies.

Methods: Injury and incident information was abstracted from 2012-2014 Coast Guard injury reports. The FLIPP survey of crabbing-related injuries and fishermen's insights on safety was administered in person along the West Coast just before the 2015-16 crab season. Traumatic injury cases were coded using the Occupational Injury and Illness Classification System, an adaptation of the Abbreviated Injury Scale, and a Work Process Classification System. Descriptive statistics from both datasets characterized worker demographics, injuries, and factors relating to injury. The results from the Coast Guard data were discussed with fishermen in focus groups in key fishing ports in Oregon and California before the FLIPP survey was implemented. The results from the FLIPP survey were disseminated just before the 2016-17 crab season by mailing to pot license holders in Washington and Oregon, posting on social media, and in person in key fishing ports. Injury prevention ideas were solicited from stakeholders through a website, conversations in ports and through Oregon Sea Grant Facebook polls.

Results: Forty-five non-fatal injuries were reported to the Coast Guard between 2002 and 2014. The most frequent injury was to the upper extremities (48%) with fractures being most common (40%) and when fishermen were hauling gear (47%). With 436 fishermen responding to the FLIPP survey in 2015 to report injuries for the previous year, there were 68 injuries that limited the fishermen from continuing work as usual. The majority of limiting injuries (88%) occurred with deckhands. The most common were sprains and strains (36%) and most were associated with handling, hauling, and setting crab pots (72%). General injury prevention ideas about crews and safety training were generated. Among the ideas from fishermen was an engineering control related to handling crab pots. Crab pots are lowered on a line to the sea floor (setting) and retrieved (hauling) using a block that mechanically operates the line. To harvest the crab from the retrieved pots, they are manually tipped. A gear modification referred to as a "banger bar" adds padding and a stop bar to the crab sorting table that a retrieved pot can be tipped and banged against to release the crab. In addition to more efficient unloading, potential safety benefits include reduction of awkward postures, forceful exertions and repetitive motions, but the system might affect production and introduce pinch point hazards. After exploring the idea with stakeholders, we learned more information about the use, purpose, and limitations of such a system. We

identified factors related to designing for broader use since all vessels, decks and sorting tables vary. In addition, FLIPP conducted a poll through the Oregon Sea Grant Facebook page to solicit input from stakeholders. Sixty people responded to the poll with 78% saying they have used a banger bar. Of 43 comments received, 60% said bars helped dumping pots and/or improved safety.

Discussion: Targeted injury prevention strategies can be informed by injury surveillance and engaging fishermen. An engaged research approach has given the FLIPP team access to the industry and stimulated conversations about injury prevention ideas that can be tested for effectiveness, scalability and acceptability.

G3.3

Title: Perceived Causes of Injuries in U.S. West Coast Dungeness Crab Fishing

Authors: [Sabrina Pillai](#), [Viktor Bovbjerg](#), [Amelia Vaughan](#), [Kaety Jacobson](#), [Laura Syron](#), [Devin Lucas](#), [Laurel Kincl](#)

Background: Commercial fishing is a hazardous occupation in the United States. While much data exists about fatal injuries in commercial fishing, less is known about non-fatal injuries. Injury surveillance data relies heavily on US Coast Guard reports, which do not capture the full range of injuries experienced by fishermen. They also do not incorporate the fishermen's perspective on the factors contributing to injuries.

Methods: We conducted a pre-season survey of Dungeness crab fishermen in the states of Washington, Oregon, and California during 2015-2016. Community researchers administered the surveys to fishermen dockside. Respondents reported their opinions about factors that contribute to commercial fishing injuries. These responses were grouped into conceptually similar categories for analysis. Additional survey items included respondent-reported number of injuries in the past year and over the fishing career, crew position (deckhand, captain, or owner), and number of years of experience as a commercial fisherman.

Results: The fishermen's injury perceptions were sorted into 18 categories. Of 392 respondents, the most frequently cited causes of injury were heavy workload (86, 19.7%), followed by poor mental focus (78, 17.8%), and inexperience (56, 12.8%). Of 396 respondents, 203 (51.3%) reported that they experienced at least one in-

jury in their career. There was no statistically significant difference in injury opinions between those who had and those who had not experienced at least one injury in their career ($\chi^2=9.58$, $p=0.92$). Of 398 respondents, 207 (52.0%) were deckhands, 140 (35.2%) were owners, and 51 (12.8%) were captains. Fishermen had an average of 17.4 years of experience working in commercial fishing ($SD=14.2$). The ranking of the top three perceived causes of injury categories (heavy workload, poor mental focus, and inexperience) was consistent among years of experience in commercial fishing and among crew position.

Discussion: Fishermen report that heavy workload, poor mental focus, and inexperience of crew members are the leading contributing factors to injuries in the Dungeness crab fishery. These perceptions can be evaluated further and incorporated into revised safety training procedures for new and existing fishermen. The fishermen-led approach of this project lends itself to developing interventions that are realistic and suitable to the Dungeness crab fishing community. Reductions in injury can be achieved through collaboration and applied research translation.

G3.4

Title: Identifying Hazards at the Intersection of Manufacturing and Fishing: Traumatic Injuries Among Offshore Seafood Processors in Alaska, 2010-2015

Authors: [Laura Syron](#), [Laurel Kincl](#), [Viktor Bovbjerg](#), [Devin Lucas](#), [Samantha Case](#)

Background: Offshore seafood processors work in a demanding environment that combines the occupational safety and health challenges faced in the food manufacturing and commercial fishing industries. In Alaska, seafood processing is a critical step in the supply chain that brings this valuable natural resource to market. The US Coast Guard and Federal Occupational Safety and Health Administration have identified Alaska's offshore seafood processing industry as high-risk. However, to date, no epidemiologic study has focused solely on the safety of offshore processors across the multiple fleets in Alaska. This study used Coast Guard injury reports to describe patterns of traumatic injury among offshore seafood processors, as well as identify modifiable hazards.

Methods: Companies that operate commercial fishing vessels are required to report to the Coast Guard any injury that requires medical treatment beyond first aid or renders the individual unfit to perform routine duties. From the injury reports, we manually reviewed and abstracted information on the incident circumstances, injury characteristics and circumstances, and vessel. Traumatic injury cases were coded using the Occupational Injury and Illness Classification System, an adaptation of the Abbreviated Injury Scale, and a Work Process Classification System. Descriptive statistics characterized worker demographics, injuries, and fleets.

Results: One fatal and 304 nonfatal injuries among offshore processors were reported to the Coast Guard during 2010-2015 across multiple fleets of catcher-processor and mothership vessels. The single fatal injury was due to mechanical asphyxia in the freezer hold, which highlights the potential danger of working around conveyor systems. Among nonfatal injuries, severity levels were minor (158, 53%), moderate (116, 39%), and serious (22, 8%), with over one-third of cases resulting in lost work time and requiring advanced medical treatment. The most frequently occurring non-fatal injuries were sprains, strains, and tears (75, 25%), contusions (50, 16%), and fractures (45, 15%). Injuries most frequently affected workers' upper extremities (121, 40%) and trunk (75, 25%). Injuries mainly resulted from contact with objects and equipment (150, 49%), overexertion and bodily reaction (76, 25%), and slips, trips, and falls (65, 22%). Processing equipment and machinery were associated with almost one-third of the injuries (85, 28%). The work processes most frequently associated with injuries were: processing seafood on the production line (68, 22%); stacking boxes of frozen product (50, 17%); and repairing, maintaining, and cleaning equipment (28, 9%).

Discussion: Preventing musculoskeletal injuries, particularly to workers' upper extremities and trunk, is paramount. Some injuries, such as serious back injuries, intracranial injuries, and finger crushing and amputations, had the potential to lead to long-term disability. Hazard control measures should target: (a) overexertion from lifting and lowering objects and equipment; (b) equipment and boxes falling and striking workers; (c) workers being caught in running machinery during regular operations; and (d) slips, trips, and falls. Prevention strategies that have been successfully utilized in other food manufacturing industries, such as poultry

processing, to avoid overexertion and musculoskeletal injuries could potentially be translated to this offshore factory setting, with interventions tailored to the unique work processes. Developing "prevention through design" strategies is especially relevant as new catcher-processor and mothership vessels are designed and built. Future research is needed to determine workforce estimates by occupation and calculate injury rates for offshore processors. Safety and health professionals and researchers can use these detailed results to inform intervention efforts in this industry.

Session G4

Title: Slips, Trips and Falls:

Focus on the Footwear

Moderator: Jennifer Bell

G4.1

Title: Preventing Slip and Fall Accidents:

Focus on the Footwear

Authors: Kurt Beschoner, Sarah Hemler, Seyed Moghaddam, Arian Iraqi, Brian Moyer, Joel Haight, Mark Redfern

Falls are a leading and growing contributor of occupational injuries. Slipping events are estimated to account for approximately half of same-level falls. Slips occur when the amount of friction force required to sustain walking exceeds the amount of force that can be generated between the shoe and walking surface. Footwear has emerged as a critical factor influencing slip and fall risk. Furthermore, footwear is subject to engineering controls in many industries. However, few methods exist for assessing footwear in a workplace setting that are based on rigorous research. In this abstract, we review recent research performed by our group to better understand footwear friction mechanisms and use this improved understanding to suggest interventions for preventing slips and falls.

Our research uses novel in vitro experiments, in vivo experiments, and modeling methods (in silico) to develop an understanding of the shoe-floor friction mechanisms. This research has identified two main mechanisms that are relevant to slip and fall accidents: hydrodynamic pressures and hysteresis friction. Specifically, slip risk can be mitigated by reducing hydrodynamic pressures and maximizing hysteresis friction. Our

research has developed novel experimental methods that use pressure sensors embedded in the floor along with either a robotic slip-tester or human subjects to measure hydrodynamic pressures. In addition, our group has developed multiscale finite element modeling techniques to predict hysteresis friction based on shoe and floor roughness, shoe material properties and the geometry of tread. These models simulate hysteresis friction between micrometer scale shoe and floor asperities and integrate this information with a model that predicts contact pressures across a shoe heel surface. Collectively, these studies can be used to guide footwear design and inform safe footwear guidelines for preventing slip and fall accidents in organizations and industries that establish such footwear guidelines and policies.

Our research has led to findings that shoes with improper tread drainage or worn treads increase hydrodynamic pressures when contacting liquid contaminants. Shoes tend to wear unevenly and one region of tread typically becomes completely worn even as other regions are mostly intact. The worn patch is associated with an increase in hydrodynamic pressures and a reduction in friction. When hydrodynamic pressures are low, our research suggests that hysteresis friction can be increased by distributing the contact force over an increased tread area. This can be accomplished through softer shoe materials, beveling the heel of a shoe, or through the geometry of the tread. Interventions can be readily implemented in the workplace based upon these findings. First, the worn area of shoes can be easily measured with a ruler and increased risk occurs when the area is greater than a specific size (about the size of a dime). Furthermore, our research team has found two footwear measurements that are well correlated with friction in slip-resistant shoes: tread contact area and tread width. Tread contact area can be measured with an inkpad and paper, a scanner and simple image processing software. Tread width can be measured simply using a ruler. If verified as effective in field tests, these methods could reduce slip injuries in many workplaces. Acknowledgements: Research was funded by NIOSH (R01OH010940 and R01OH008986).

G4.2

Title: Evaluation of Slip Resistance Testing of Work Boots on Ice Surfaces

Authors: [Chantal Gauvin](#), [Yue Li](#), [Wayne Cheng](#), [Tilak Dutta](#)

Background: Slipping on ice is one of the main risks for occupational activities during winter. In Quebec, slips, trips and falls top the list of most frequent types of occupational accidents, for which ice and freezing rain were causative agents in 13% of cases from 2010 to 2012. In occupational activities for which control of walking surfaces is not practicable, workers rely mainly on their work boots to prevent slips. To evaluate the coefficient of friction (COF) of footwear on ice surfaces, the SATRA STM 603 whole shoe tester equipped with a refrigerated ice tray can be used. The SATRA TM144:2011 is the only mechanical test method that provides rough guidelines to test footwear on frosted and smooth ice surfaces. However, scarce information is published about this test method and the repeatability and reproducibility of such tests on ice surfaces have not been assessed. Recently, a human-centered test method has been developed to evaluate footwear slip resistance on ice surfaces using TRI-UHN's WinterLab. This method measures the steepest incline (on walkway covered with ice) that participants wearing test footwear can walk up and down without experiencing a two-foot slip. The equivalent COF is calculated from taking the tangent of the maximum achievable angle (MAA), similarly to the calculation used with a ramp test. The objectives of this study are: (1) to evaluate the repeatability and reproducibility of the results obtained with footwear using the SATRA test method on ice surfaces at two different laboratories, and (2) to compare the SATRA test method and the MAA human-centered test method for evaluation of slip performance of footwear on icy surfaces.

Methods: SATRA ice tray's ice temperatures (monitored using thermistors) were configured to match WinterLab's ice temperatures and an ice tray preparation protocol was developed. Ten types of occupational footwear were tested in both labs on melting and cold ice surfaces at different sliding modes. Each type of footwear was also tested by 4 participants using the MAA test method. The participants were asked to walk naturally throughout a 4 meters walkway in WinterLab while wearing a safety harness. Four MAAs were recorded for

each footwear style, each ice surface condition and each direction (descending or ascending).

Results: Repeatability and reproducibility of the SATRA testing: The ice surface temperature fluctuates as a function of the cooling cycle of the ice tray. This fluctuation showed slightly different patterns between the two labs. Specific temperature set points and restricted temperature ranges for testing on melting and cold ice surfaces have been determined for each lab to ensure the ice temperatures measured by the thermistors were as similar as possible in both labs. The results obtained in both labs for boots tested on melting ice were equivalent, both in COF values and footwear ranking. For cold ice, although the footwear ranking was equivalent between the two labs, the COF values obtained at the IRSST were systematically higher than those obtained at TRI. Comparison between SATRA and MAA test methods: The COF values and footwear ranking obtained on melting ice using the SATRA test method were close to those obtained using the MAA test method. However, for cold ice, the SATRA test method gave a different footwear ranking compared to the MAA test method. The difference observed may be due to the parameters that used by the SATRA test method did not reflect human walking gait.

Discussion: The impact of ice surface temperature on COF measurement makes reproducibility of SATRA testing between laboratories challenging. The SATRA test method on cold and melting ice surfaces were able to discriminate between some boots. However, the SATRA test method gave different rankings compared to the MAA human-centered test method and may need improvement to be reliable on ice surfaces.

G4.3

Title: Convolutional Neural Network with Wearable Inertial Sensors Can Recognize Surface Category and Turning Direction During Walking

Authors: [Boyi Hu](#), [Phil Dixon](#), [Jack Dennerlein](#)

Background: Falling is one of the leading causes of workplace injury. Previous laboratory investigations have shown that uneven surfaces, similar to those which may be encountered by delivery or outdoor site workers, can negatively affect walking and stability, and therefore contribute to falls. Same level falls can also be induced by changes in direction tasks during walking.

Detecting surface- and task-based threats to workers' balance and stability is relevant; however, it remains unknown if these threats can be detected by wearable devices such as Inertial Measurement Unit (IMU) sensors that could be implemented in the field. The purpose of this study was to evaluate the feasibility of using wearable IMU sensors to automatically detect different human motions across uneven and flat surfaces.

Methods: Thirteen older and eighteen young healthy adults participated in the study and walked over flat and uneven brick surfaces with an IMU positioned over the L5 vertebra. All participants completed a series of walking trials at a self-selected pace in three directions: 1) 4 m straight walking followed by a left turn; 2) 4 m straight walking followed by a right turn; 3) 8 m straight walking. IMU data were sampled at 128 Hz with the last 6 seconds of data from each trial saved for analysis. A deep learning convolutional neural network (CNN) was used to detect walking surface (flat, uneven) and walking direction (left, right, straight). CNNs are a subset of artificial intelligence machine learning methods that can discover underlying patterns in data without the need for human input. Nine data channels (accelerometer, gyroscope, and magnetometer in three dimensions) were used as inputs to the CNN model and the data were scaled to enable equal weights across channels. Adaptive moment estimation was used as the update rule during the model training procedure. The CNN model was developed with TensorFlow and Keras under Python, running on a Titan X GPU (3584 CUDA cores, 1417 MHz and 12 GB of RAM).

Results: In total, 1772 walking trials were collected from participants: 80% of the walking trials were used to train the CNN model, while the remaining 20% were saved as the testing set. The full model predicted walking surface type and direction with an overall accuracy of 92.4%. Precision, recall, and f1-score of 92.5, 92.4, and 92.4%, respectively, were obtained. Compared with recent machine learning-based human activity recognition studies, the current study demonstrates excellent prediction performance. Notably, the difference in human motion across surfaces and walking direction in the current study was more subtle than motions used in previous studies. Moreover, our deep learning approach enables the algorithm to learn directly from the raw data without complex human engineering procedures and expert domain knowledge.

Discussion: These results demonstrate that deep learning with a simple IMU setup can be applied to precisely recognize walking surfaces and movement directions. Given the portability of the wireless IMU setup, this protocol could be used for measurements directly in occupational work environments. These results could support future studies on workplace fall injury prevention and lead to a better design of workplace safety surveillance systems.

G4.4

Title: Mapping the Traction Performance of Work Shoes During Natural Progressive Wear

Authors: Sarah Hemler, Mark Redfern, Joel Haight, Kurt Beschoner

Background: Falls, slips, and trips continue to be a major cause of injury in the workplace. In 2016, these incidences accounted for over 26 percent of all nonfatal occupation injuries in the U.S. Furthermore, 40-50 percent of fall-related injuries can be attributed to slipping. As slipping incidences occur at the shoe-floor interface, shoe wear is a major risk factor for slip and fall accidents. Therefore, there is a need to better understand how shoe outsole design affects progressive shoe wear and therefore shoe performance. Slip-resistance is often measured by available coefficient of friction (ACOF) which is the friction that acts to prevent slipping between surfaces; a reduction in ACOF often leads to a higher chance of slipping. Higher under-shoe fluid pressures have been linked to lower ACOF and a higher likelihood of slipping in worn shoes.

Methods: In this pilot study, ACOF and fluid pressures were measured for two different shoe designs (Shoe A, Shoe B). Shoes were worn by 4 human subjects on man-made surfaces for 23 person-months and data was collected after each month of wear. Fluid pressures were numerically integrated across the shoe surface to calculate the fluid force (the load supported by the fluid

during slipping). A pedometer tracked the usage of each pair of shoes. Repeated-measures ANOVA was used to determine the impact of shoe design, distance walked, and side (left versus right) on ACOF and fluid pressures.

Results: The baseline ACOF values ranged from 0.17 to 0.41 and 0.13 to 0.20 and fluid forces ranged from 0 to 23.5 N and 0 to 10.1N at baseline levels for Shoe A and Shoe B, respectively. The change of ACOF from baseline values ranged from -0.058 to -0.226 for Shoe A and -0.017 to -0.049 for Shoe B. Although Shoe A exhibited the highest average baseline ACOF (39% higher than Shoe B), the two shoes had similar ACOF values after being worn. Repeated-measures ANOVA methods showed that the ACOF for both shoes was significantly affected by shoe type ($p=0.0192$, $F(1,52)=5.84$), the distance walked ($p<0.0001$, $F(1,54)=28.16$), and their interaction ($p=0.0024$, $F(1,52)=10.16$). The fluid force was affected by shoe type ($p<0.001$, $F(1,53)=39.03$), the distance walked ($p<0.0001$, $F(1,55)=37.00$), their interaction ($p=0.0006$, $F(1,52)=13.23$), as well as the interaction between side (left/ right) and the distance walked ($p=0.0441$, $F(1,52)=4.26$).

Discussion: This research supports previous findings that as shoes are worn, ACOF decreases and fluid force increases. Shoes vary in their sensitivity to shoe wear. Although current wear standards suggest replacing shoes after 6 months of wear, this research suggests that for certain shoe types, the point at which shoes should be replaced may occur before the time of recommended replacement. Overall, this research confirms that the shoe outsole design and shoe wear condition affect shoe performance and that replacement guidelines may require consideration of shoe design. Therefore, it is critical for footwear manufacturers to track the influence of wear on traction performance in order to develop appropriate replacement guidance for their shoes and for users to monitor shoe condition. **Acknowledgements:** Research was funded by NIOSH (R01OH010940).

NOIRS 2018 POSTER ABSTRACTS

(Presenters Underlined)

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POSTER SESSION/NETWORKING EVENT

LIST OF FEATURED POSTERS

P01

Title: Anthropometry of Emergency Medical Technicians in the U.S.

Authors: [Jinhua Guan](#), [Hongwei Hsiao](#), [James Green](#), [Richard Whisler](#)

Background: Deaths or serious injuries among emergency medical technicians (EMTs) and other ambulance occupants occur at a high rate during transport. To reduce injury potential to EMTs and other ambulance occupants, and increase EMT work efficiency, the National Institute for Occupation Safety and Health (NIOSH), the Department of Homeland Security, the U.S. General Services Administration, and the National Institute of Standards and Technology, along with private industry partners, have committed to improving the workspace design of ambulance patient compartments. This study was conducted to provide up-to-date anthropometric data to aid the design effort.

Methods: From 2013 to 2015, NIOSH conducted a nationwide anthropometric survey of 471 male and 161 female EMTs across the United States. Data were collected at 8 different locations in four data collection regions (Northeast, South, Pacific West, and Mid-West/Great Lakes). The sampling strategy took into account age, sex, and race categories. A total of 40 measurements were taken on each participant using standard manual anthropometry equipment. A weighting procedure was applied to the male and female samples, respectively, to ensure the samples represented the current EMT population. This dataset was compared with three comparably measured body dimensions (stature, waist circumference, and weight) found in the National Health and Nutrition Examination Survey (NHANES). Ninety-five percent confidence intervals with Bonferroni correction at 3 comparisons were employed to make these comparisons. The EMT dataset was also compared with the American portion of the Civilian American and European Surface Anthropometry Resource (CAESAR, 19 dimensions). Independent t-tests were used to evaluate each selected body dimension between the EMT database and the CAESAR database at $\alpha = 0.01$ (2-tailed) for each comparison. Both NHANES and CAESAR consisted of anthropometric data on the US general population.

Results: Comparisons with the NHANES database showed that, on average, male EMTs are significantly taller (18 mm) and heavier (7.3 kg) than males in the US general population. The data also showed female EMTs were significantly taller (25 mm) than females in the general population. Comparisons with the CAESAR database showed that 16 out of 19 analyzed dimensions were statistically significant for males. Among these 16 measurements, 14 of the dimensions for male EMTs (acromial height sitting, bideltoid breadth, buttock-knee length, crotch height, elbow rest height, eye height, hand circumference, head circumference, head length, knee height, sitting height, thigh circumference, thumb-tip reach, and weight) were larger than corresponding dimensions for males in the CAESAR database. On average, male EMTs were 12.8 kg heavier than males in the CAESAR database, but not taller in stature. For the females, 10 out of 19 dimensions were statistically significant. Of these 10 measurements, eight of the female EMT dimensions (bideltoid breadth, crotch height, hand circumference, knee height, sitting height, thigh circumference, thumb-tip reach, and weight) were larger than the corresponding dimensions in the CAESAR database. On average, female EMTs were 8.1 kg heavier, but not taller, than females in the CAESAR database.

Discussion: The study found that male EMTs were taller and heavier than males while the female EMTs were taller than the females in general population as sampled by NHANES. When compared with the CAESAR database, both male and female EMTs were found to be larger and heavier, though not taller in stature. This dataset will benefit the design of the patient compartment workspace in EMS vehicles.

P02

Title: Security Cameras in Three Row Seating Taxicab

Authors: [Shengke Zeng](#), [Bradley Newbraugh](#), [Darlene Weaver](#)

Background: The homicide rate among taxicab drivers (7.4 per 100,000 workers) was 20 times greater than that of all workers (0.37 per 100,000 workers). Taxicab security cameras are widely used in two- and three-row

seating taxicabs to deter crimes against taxicab drivers. Some cameras, which are suitable for two-row seating taxicabs, have difficulty for use in three-row seating taxicabs due to the added distance between the camera and third row seats. In order to help taxi fleets and transportation regulators select effective taxicab security cameras in customer facial identification, this project tested five sample taxicab security cameras with different image sensor definitions and lens configurations in a simulated three-row seating taxicab to determine their utility for three-row seating taxicabs.

Methods: The test procedures were designed to evaluate the camera resolution of sample security cameras in a simulated three-row seating taxicab for their compliance with the minimum resolution requirement. Sample security cameras with different image sensor definitions were selected for the evaluation. The cameras, which were mounted on the windshield or the ceiling of the simulated taxicab, recorded the taxicab images containing a specially designed image resolution test chart mounted in a third-row seat. The tests were conducted in sunny daylight and in dark condition with infrared irradiation. The camera resolution was determined by measuring the resolution of the test chart image using an image quality testing software. Finally, the camera resolutions were compared with the resolution threshold of 47.7 line-widths per head height (LPHH) (head height of a 99th percentile male: 25.5 cm) that was established in the previous study.

Results: The resolution of the following four cameras exceeded the resolution threshold of 47.7 LPHH: (1) a dome camera, mounted 80 cm from a third-row seated customer, with standard definition image sensor with 976×494 pixels (60.9 LPHH); (2) a windshield-mounted camera with full high definition image sensor with 1920×1080 pixels (56.8 LPHH), (3) another windshield-mounted camera with full high definition image sensor with 1920×1080 pixels (52.8 LPHH), and (4) a windshield-mounted camera with high definition image sensor with 1280×720 pixels (51.4 LPHH). The resolution of the fifth camera, which was a windshield-mounted camera with dual standard definition image sensors with 2×720×572 pixels and consisted of one wide-angle lens and one telephoto lens, was below the resolution threshold (42.3 LPHH).

Discussion: The findings of this study suggest the following: (1) a windshield-mounted camera with an image sensor with at least 1280×720 pixels (full high

definition or high definition) can adequately perform in three-row seating taxicabs; (2) a dome-mounted camera, with an image sensor with at least 976×494 pixels (standard definition), can adequately perform for the third-row seat imaging in three-row seating taxicabs; and (3) windshield-mounted cameras, with either single standard definition or dual standard definition image sensors, do not perform well and are not suggested for use in three-row seating taxicabs. Expected Impact to Industry: This study should open discussion among taxi fleets, transportation regulators and taxicab security camera manufacturers for consideration of effective security cameras in three-row seating taxicabs in reducing taxicab driver homicide rates.

P03

Title: Knee Tissue Deformation Measured In Vivo as a Result of Prolonged Standing

Authors: Stephanie Wiltman, April Chambers

Background: Prolonged standing is an occupational hazard leading to leg swelling, muscle fatigue, and joint compression in the lower extremities. Repeated exposure to prolonged standing in the workplace is linked to a multitude of serious chronic injuries and diseases, including osteoarthritis, chronic venous insufficiency, carotid arteriosclerosis, and increased blood pressure. Despite the clear health risks associated with prolonged standing, the Bureau of Labor Statistics reports that workers in the United States spend on average 61% of the workday standing or walking—with retail salespersons, welders, waiters/ waitresses, electricians, and pharmacists topping the list. These select five occupations consist of nearly 9 million people spending over 75% of their workday standing. Despite known health effects, very little is known about how tissue deformation occurs within the knee in vivo during prolonged standing. While cartilage deformation has been studied extensively in tissue mechanics laboratories, translating that information to an in vivo setting requires various assumptions that may not be true. Those studies that have measured knee tissue deformation in vivo have done so under controlled loading periods for short durations of time. The goal of this study is to investigate knee tissue deformation as a result of two hours of prolonged standing. In the long term, this information could be used to investigate links between tissue deformation and osteoarthritis development in the workplace.

Methods: Six healthy (BMI 18.0-29.9) adults ages 21-35 in the greater Pittsburgh area were recruited, screened, and consented before testing. Subjects were provided the same brand shoes and socks. Standing sessions began following a 30-minute seated rest. When asked to stand, each subject placed their feet in a box and were instructed to keep all their bodyweight over their feet. They were allowed to sway without lifting their feet, but were not directly instructed to do so. Once standing, subjects were loosely harnessed as a safety precaution. Subjects were provided a standing desk to finish any computer work, reading, or watch TV/ movies. Subjects stood for two hours while data was collected. A dual stereo x-ray (DSX) system collected highly synchronized radiographs of the knee at the time of standing, 60 minutes, and 120 minutes (100 Hz, 1 second). The subject performed a knee flexion task starting at approximately full extension through 20 degrees of flexion. This range of flexion angles were chosen based on the range of angles typically experienced during standing (determined through visual observation of our standing data). A 3D model of the knee, derived from a CT scan, was processed with these x-rays, outputting kinematics and minimum "gap distance" between the medial tibial plateau and femoral condyle. Prior literature has shown that gap distance is inversely related to tissue deformation in the knee. Data was analyzed using a one-way ANCOVA statistical method.

Results: After controlling for flexion angle, there are significant differences on gap distance by time. Time resulted in a significant effect on gap distance in 67% of cases (min $p < 0.0001$, max $p = 0.35$).

Discussion: This is consistent with prior literature in which tissue deformation occurred over time. Variation may be due to rotations in the frontal and transverse planes that were not considered for this analysis. Subjects also showed different weight distribution profiles over time, affecting tissue load bearing. Relationships between starting gap distance and obesity will also be investigated.

P04

Title: Association Between Occupational Injury and Mental Health Among U.S. Workers: The National Health Interview Study, 2004-2016

Authors: [Ja K. \(Jack\) Gu](#), Luenda Charles, Desta Fekedulegn, Claudia Ma, John Violanti, Michael Andrew

Background: Studies have reported that traumatic injury can lead to stress, depression, and anxiety due to disability and reduced income. Injuries at work may also negatively influence mental health as a result of lost or reduced working hours, financial burden of treatment, and unease in returning to work. This study investigated 1) the prevalence of serious psychological distress in U.S. workers by injury status (occupational, non-occupational, and no injury) and injury characteristics (injury site, injury type, external causes, treatment location, and the number of day missed), and 2) the association between injury and serious psychological distress.

Methods: Self-reported injuries within the previous three months were collected annually for 225,331 U.S. workers in the National Health Interview Survey during 2004-2016. Occupational injury was defined as injury that occurred in the work place of a paid job. Psychological distress during the past 30 days was assessed using the Kessler 6 questionnaire, which consists of six questions, each rated with Likert-type scale (0-4). The scores across the 6-items were summed (range: 0-24); higher total score indicates frequent distress in the past month. A value of 13 or more for this scale was as defined serious psychological distress (Kessler 6 ≥ 13). The prevalence and standard errors of serious psychological distress were estimated using SUDAAN to account for complex survey design. Prevalence ratios (PR) and 95% confidence intervals (95% CI) from fitted logistic regression models were used to assess relationships between injury and serious psychological distress after controlling for covariates; age, sex, race/ ethnicity, marital status, education, sleep duration, smoke status, alcohol consumption, physical activity, body mass index, employment status, and industrial groups.

Results: The prevalence of serious psychological distress was 4.74% in workers reporting occupational injury, 3.58% with non-occupational injury, and 1.56% without injury. Workers who were divorced or separated had the highest prevalence of serious psychological distress (prevalence=9.82, 95% CI: 6.50-14.56). Female

workers with occupational injury were 54% more likely to suffer serious psychological distress than those with non-occupational injury (PR: 1.54, 95% CI: 1.04-2.28). Workers with head and neck injury had the highest prevalence of serious psychological distress (prevalence=7.71, for those with occupational injury and 6.17 with non-occupational injury), followed by workers with scrape/ bruise/ burn/ bite (prevalence=6.32 for those with occupational injury). Workers reporting occupational injury were two and half times more likely to have serious psychological distress (PR: 2.41, 95% CI: 1.82-3.20) compared to those without injury after controlling for covariates. In addition, workers with occupational injury were 32% more likely to suffer serious psychological distress compared to those with non-occupational injury in the unadjusted model, but the association was not statistically significance (PR: 1.32, 95% CI: 0.95-1.85). Among workers who visited the emergency room, those reporting occupational injury were 78% more likely to suffer serious psychological distress than those with non-occupational injury after controlling for covariates.

Discussion: The prevalence of serious psychological distress varied by injury status with the highest being among workers reporting occupational injury. We found that the workers reporting occupational injury were significantly more likely to have serious psychological distress than those without injury, but not more than those with non-occupational injury.

P05

Title: The Relationship of Occupational Injury and Use of Mental Health Care

Authors: [María Andréa López Gómez](#), [Jessica Williams](#), [Karen Hopcia](#), [Dean Hashimoto](#), [Leslie Boden](#), [Erika Sabbath](#), [Glorian Sorensen](#)

Background: Healthcare industry workers suffer from high rates of musculoskeletal injury. In 2015, nursing assistants had among the highest incidence rates of musculoskeletal injuries (171.0 cases per 10,000 full-time workers). Occupational injuries have been studied using workers' compensation claims, using outcomes such as medical costs and days away from work. Nevertheless, there are only a few studies assessing comorbidities related to occupational injury. Studies of depressive symptoms and injury have established a strong link in both directions: depressive symptoms have been found to be a risk factor for unintentional injury, and

similarly, injured workers have been found to suffer high depressive symptoms levels after injury. Longitudinal studies assessing this relationship have focused on mental health as a precursor or a consequence of injury but few have covered the period before and after injury. The aim of this study was to examine the likelihood of workers with an occupational injury to have a mental health claim paid through employer-sponsored health insurance before and after injury.

Methods: Data from the Boston Hospital Workers Health Study (BHWHS) were used to assess the relationship of mental health care utilization and occupational injury. The BHWHS uses integrated administrative databases from two large academic hospitals in the Boston area. We used a matched cohort study design to assess the relationship of mental health and occupational injury in patient-care workers. Each injured worker (n=784) in 2012 to 2014 was randomly matched with replacement with three workers who did not report an injury at the time of injury of the case. The matching variables were job title (nurse or aide) and age. Medical claims for mental health care related to depression, anxiety, substance abuse and eating disorders were extracted for both injured and uninjured workers who were enrolled in their employer's sponsored health insurance. Observation of mental health care utilization occurred three months before and after the date of injury for injured workers and their uninjured counterparts. Using logistic regression models, we examined the association of occupational injury and use of mental health services before and after injury.

Results: The sample consisted of 3,117 workers out of which 784 workers reported an OSHA recordable injury. Overall, 170 (5.5%) and 164 (5.3%) workers had at least one visit to mental health care services before and after injury respectively. A higher proportion of injured workers (8.6%, n= 67) had at least one mental health visit before injury compared to uninjured workers (4.4%, n=103) and the proportions were similar after injury. The odds ratio for use of mental health services before injury for injured workers was 2.01 compared with uninjured workers. The odds ratio for injured workers for seeking mental health services post-injury controlling for pre-injury visits was 1.50 (95% Confidence interval, 0.92-2.48) compared with uninjured, but the relationship was not statistically significant. Analogous analyses segregated by type of injury (musculoskeletal vs. others) and days away from work showed similar results with

higher odds ratios for injuries that required days away from work (OR: 2.31, 95% confidence interval: 1.06-5.06).

Discussion: Injured workers were more likely to seek mental health care before injury than uninjured workers, but these differences dissolved for post-injury visits when controlling for pre-injury visits suggesting that ill-mental health is more of a precursor than a consequence of occupational injury. Results point to a potential venue of injury prevention by focusing on promoting mental health, an area that workers' compensation rarely covers.

P06

Title: Shift Work and Sleep Quality Among Police Officers: Is Age a Factor?

Authors: [John Violanti](#), [Anna Mnatsakanova](#), [Desta Fekedulegn](#), [Ja K. \(Jack\) Gu](#), [Emily Jenkins](#), [Michael Andrew](#)

Background: According to the U.S. Bureau of Labor Statistics about 40% of people over the age of 55 were working or actively looking for work in 2014. That number is expected to increase fastest for people ages 65-74 and 75 + through 2024. Aging is one of the most cited individual factors for decreased shiftwork tolerance and sleep problems. This may be a critical problem in first responder occupations that require quick decision making and alertness. Significant associations of night shift with elevated prevalence of poor sleep quality among police officers have been reported. The aim of the present cross-sectional study was to assess whether age modified the association between shiftwork and sleep quality in police officers.

Methods: A total of 363 police officers with complete data from the Buffalo Cardio-Metabolic Occupational Police Stress (BCOPS) study were included (2004-2009). The Pittsburgh Sleep Quality Index (PSQI) questionnaire was used to assess sleep quality. A PSQI global score of >5 was defined as 'poor' sleep quality. Electronic payroll work history records of each officer during the past month was used to define dominant shift (day, afternoon, or night) as the shift the officer spent the highest percent of his/her workhours. Analyses of variance/ covariance were used to examine mean global sleep score across shiftwork categories. Analyses were stratified by age using median age (40 years) as cut point to create the two strata.

Results: The mean age of officers was 41 years; 28% female. Shiftwork was significantly associated with PSQI global score. Associations were adjusted for age, sex, and race/ ethnicity. The officers who worked night shift had significantly worse sleep quality compared to those who worked day shift [Mean (SE): 7.48(0.4) vs. 5.90(0.3), respectively, with p-value = 0.004]. When stratified by median age, the associations remained significant only among younger officers (≤ 40 years): [Day Shift: 5.50 (0.4), Afternoon Shift: 6.49 (0.4), Night Shift: 7.71 (0.4), p-value = 0.001]. The adjusted mean global score was significantly higher among young officers who worked night shift compared to those who worked day or afternoon shifts (p-value=0.0003, and 0.044, respectively).

Discussion: Results of this study indicate significant associations of sleep quality with shiftwork among younger officers (< 40 years). Factors such as increased social activity, family responsibilities, or second jobs may account for poorer sleep among younger officers. Additionally, older officers with higher seniority tend to seek positions which involve less shift work, particularly night shifts. Further work is needed to examine social-psychological factors affecting sleep quality among police officers in order to create a healthier shift work environment in policing.

P07

Title: Injuries and Fatalities Among Meter Readers, 1995-2016

Authors: [Megan Leonhard](#), [Tiffani Fordyce](#), [Ximena Vergara](#), [Eric Bauman](#)

Background: The Electric Power Research Institute (EPRI) established the Occupational Health and Safety Database (OHSD) in 1999 to surveil workplace injury and illness among workers in the electric power industry. Meter readers have the second highest injury rate in the OHSD and constitute a high injury risk group.

Methods: Injury information was obtained from the EPRI OHSD which contains 2,118,459 employee-years of follow-up and 64,903 observed lost time and recordable injury/ illness events for years 1995-2016. Injury rates and full-time equivalents lost (FTEs) were calculated. Injuries among meter readers were examined by injury type, body region of injury, age, mechanism of injury, and year groupings. Tests for trend were performed by year groupings.

Results: Injuries among meter readers accounted for 12.0% of all reported injuries in the OHSD with an injury rate of 11.68 observed injuries per 100 employee-years. Meter readers experienced an FTE loss rate of 366.41 per 10,000 employee years. There has been a statistically significant reduction in injury when examined by year groupings among meter readers ($p < 0.001$), dropping from an injury rate of 25.45 per 100 employee-years in 1995-1999 to 2.04 per 100 employee-years in 2015-2016. Similarly, FTE loss rates have fallen from their highest in 1995-1999 (121.83 per 10,000 employee years) to their lowest in 2015-2016 (16.09 per 10,000 employee-years). The most common injury type among meter readers was sprains and strains which accounted for 41% of all injuries followed by cuts, lacerations, and punctures at 22.0%. The top four body regions injured by meter readers, accounting for half of all injuries, were other lower extremities (14.6%), back/ trunk (14.3%), hand/ finger (10.9%), and knees (10.2%). Injury rates amongst those under the age of 50 were at least double the injury rates of those 51 and older. Injury rates decreased with increasing age for all age groups except for those 65 and older which was slightly higher than that of those 61-65 (4.79 per 100 employee-years and 3.48 per 100 employee years, respectively). Female meter readers had a statistically significantly ($p < 0.001$) higher injury rate than males, approximately 57% higher. Injury rates for both males and females have significantly decreased over the 22-year period. Vehicle crash rates for meter readers have shown decreases when rates from 1995-1999 are compared to the most recent 2015-2016 range; however, there has been little change in rates since 2000-2004.

Discussion: The injury rate of meter readers has declined over the history of the OHSD; however, meter reader injury rates remain among highest in the OHSD. The injury rate reductions could be due in part to increased use of automated meters, leading to a reduction in in-field tasks. Nevertheless, examining meter reader injuries in-depth can lead to targeted injury prevention approaches and identification of high risk sub-populations among meter readers. Younger meter readers showed increased risk for injuries. Evaluation of safety training practices in this population as well as evaluation of compliance with safety policies could provide insight into the cause of this elevation. Gender differences in injury rate could be due in part to differences in tasks performed and/or potentially availability/ fit of personal protective equipment and warrant further

research. Despite marked injury rate reductions among meter readers, to continue the reduction, there is a need for identification of high-risk subpopulations and specific injury risk factors.

P08

Title: Difference in Occupational Injury Mortality Rate Among People Aged 15 to 69 Years in High-Income Versus Low-and-Middle Income Countries: 1990-2016

Authors: [Yue Wu](#), [David Schwebel](#), [Guoqing Hu](#)

Background: Using estimates from the Global Burden of Disease (GBD) study, we analyzed differences in occupational injury mortality rates from 1990 to 2016 between high-income countries (HICs) versus low- and middle-income countries (LMICs).

Methods: Occupational injury mortality rates were obtained through the GBD online visualization tool. We quantified differences over time between HICs and LMICs for external causes of injury for 15–49 years and 50–69 years separately using negative binomial regression models.

Results: In 2016, there were 24,404 and 303,635 occupational injury deaths among individuals aged 15 to 69 years in HICs and LMICs, respectively. Between 2006 and 2016, occupational injury mortality for people aged 15–69 years dropped from 5.7 to 3.1 per 100,000 people in HICs and 13.2 to 7.0 per 100,000 people in LMICs. Disparities between HICs and LMICs existed for both sexes and both age groups. All causes of death displayed substantial reduction with one exception (aged 15–49 years in HICs). Country-specific analysis showed large variations in occupational injury mortality and changes in occupational injury mortality between 1990 and 2016.

Discussion: Despite substantial decreases in mortality between 1990 and 2016 for both HICs and LMICs, a large gap remains between HICs and LMICs. Multifaceted efforts are needed to narrow the gap.

P09

Title: The NIOSH Fatality Assessment and Control Evaluation (FACE) Program

Authors: [Melanie Moore](#), [Nancy Romano](#)

Background: Each day, an average of 13 U.S. workers

die from traumatic injuries suffered in the workplace. To address these deaths, the National Institute for Occupational Safety and Health's (NIOSH) Fatality Assessment and Control Evaluation (FACE) Program studies fatal workplace injuries and disseminates intervention recommendations to prevent similar deaths. The Program has two components. NIOSH FACE consists of participating states that voluntarily notify NIOSH of fatalities occurring in targeted categories. These categories have included: falls in construction, foreign born workers, dual use machinery, temporary workers, and robot-related fatalities. Included in the State FACE component are 7 State health or labor departments (CA, KY, MA, MI, NY, OR and WA) that conduct State level surveillance, targeted investigations, and prevention activities through cooperative agreement with NIOSH. FACE uses a case series design to facilitate descriptive analysis of the incidents and to help develop recommendations for preventing similar deaths. Through field investigations, NIOSH and State FACE personnel collect agent, host, and environmental information from the pre-event, event, and post-event phases a fatal incident. The investigative information is evaluated to identify contributing factors which are addressed by recommendations aimed at controlling them. A narrative FACE investigation report that includes a description of the incident with all personal identifiers removed, factors that contributed to the incident, and recommendations to prevent similar deaths is developed and published on NIOSH and state level web pages. These reports are also support development of other dissemination products that are disseminated to targeted audiences and are available on NIOSH and state webpages.

Findings/Discussion: Between 1983 and 2018, NIOSH and State FACE published 2633 investigation reports. Beyond the reports, investigations also impact laws or new safety standards. For example Kentucky FACE investigated an incident in which an auto technician mistook a handicapped accessible accelerator pedal for brake pedal and was fatally injured while working on the vehicle. The KY FACE report was emailed to 45 Kentucky car dealerships and 11 handicapped-accessible gas pedal manufacturers. Based on the report, the left foot handicapped-accessible pedal was redesigned to retrofit a vehicle's steering column with a key switch so that, when starting a vehicle with the redesigned pedal, the system defaults to a standard factory pedal. This eliminates the need to remove the pedal for servicing and prevents unintended use of the left foot accelerator

pedal. This redesigned pedal was introduced at the National Mobility Equipment Dealers Conference in February 2015 and was available to the public in June 2015. In addition, the car dealership where the incident occurred established new employee policies based on the KY FACE report recommendations. The new policies require employees to remove all accessibility equipment before any work is started and perform all administrative duties in an area away from the service area. Taken together, the redesign of the handicapped-accessible gas pedal and establishment of employee policies will aid in the safety of auto technicians. The FACE Program allows researchers to gain knowledge about the specific circumstances that surround worker deaths and to formulate prevention strategies. FACE products provide employers and workers with recommendations to address safety policies, work practices and worker training. FACE also often makes recommendations to manufacturers for changes to equipment and tools.

P10

Title: Multi-Purpose Machinery Use – Using Excavators for Hoisting: A NIOSH Fatality Assessment and Control Evaluation Investigation

Authors: [Melanie Moore](#), [Nancy Romano](#), [Tony McKenzie](#)

Background: The National Institute for Occupational Safety and Health's (NIOSH) Fatality Assessment and Control Evaluation (FACE) Program studies fatal workplace injuries and disseminates intervention recommendations to prevent similar deaths. In 2012, an excavator operator died after a section of pipeline he was hoisting in tandem with another excavator plunged through his excavator windshield striking him in the chest. NIOSH FACE investigators learned of this incident from the Occupational Safety and Health Administration (OSHA) who had conducted an investigation of the fatality. In an effort to learn more about injury risks for situations when machines are used for purposes for which they may not have been originally designed, NIOSH investigators met with OSHA to review the case.

Methods: FACE investigators collect agent, host, and environmental information from all phases of the incident using a standardized procedure that may include witness and employer interviews, and the review of medical examiner, police, and OSHA reports. Using this

information, the circumstances surrounding the incident are evaluated to identify contributing factor toward the outcome and develop prevention recommendations. A report describing the event, contributing factors, and prevention recommendations is published on the NIOSH FACE web page. In August of 2014, a NIOSH FACE investigation team including a safety and occupational health specialist, a safety research engineer, and a guest researcher met with the OSHA compliance officer who investigated the incident and reviewed the case file. The medical report provided by the emergency response personnel who pronounced the operator dead at the scene was also reviewed. Using the information from the meeting and case files and knowledge of excavator capabilities, FACE investigators developed a likely incident scenario to explain the impact of the interaction of the two excavators during the hoisting operation upon the incident outcome.

Results: Contributing factors identified included: an informal lift procedure that did not address the coordination of the operation of the two excavators; communication among the workers performing the operation that depended upon voice and visual signals while in a low light and high noise environment; and limited visibility in the work area that may have prevented the excavator operators and ground workers from observing the unwanted reaction of the pipeline section to the excavator movements.

Discussion: The FACE investigation identified several prevention recommendations for this situation: 1) a comprehensive safe work procedure for tandem lifting operations should be implemented to ensure that equipment movement is coordinated to prevent unwanted motion of hoisted loads; 2) workers should be provided with training on hazard recognition and avoidance of unsafe conditions; 3) an effective method of communication, for example 2-way radios, should be implemented to eliminate or minimize the negative effects of the work environment; and 4) use adequate lighting to enhance visual observation of hazards and machine motion during all work activities.

P11

Title: Industrial Fire Accidents in Delhi and Prevention

Authors: [Pranab Kumar Goswami](#),
[Somendra Pal Rana](#)

Background: The industrial fire accident is a sudden and unforeseen event, attributable to any cause. Accidents are preventable, but steps must be taken to prevent them. It is a legal obligation of an organization to comply with the provisions of law, standard practises, and safety observations to avoid fire accidents. This paper investigated reasons of industrial fire accidents in Delhi, India and alternative ways to resolve them.

Methods: In this study information was collected from purposively selected five (5) major fire accidents that took place in Delhi in between 2015 to 2017. The entire study is based on the accident investigation report of Directorate of Industrial Safety and Health (DISH), First Information Report (FIR) and forensic report of Delhi Forensic Science Laboratory.

Results: It was found that 78% of industrial fire accidents took place in small and medium enterprises (SMEs) located in residential/ non-industrial areas in Delhi. The cause of fire accident was found to be electric short circuit, improper handling and storage of flammable substances and ignorance of workers.

Discussion: It was concluded from the study that unsafe electrical wiring and lack of proper training to the workers were two main reasons for increase in number of fire accidents. It was also concluded that the industries located in industrial areas were better placed in terms of workplace compliances. The managements who were running their operations from residential/ non-industrial areas were found to be less aware on health and safety issues. Lack of enforcement by government agencies in such areas has escalated this problem. Prevention of accident: By addressing issues like carelessness, stress and fatigue, unsafe acts, design of workplace, and safety committee, adequate training to workers, managing safe & healthy workplace and sustained enforcement can reduce fire accidents in such industries.

P12

Title: Cognitive-Based Human Error Detection on Construction Sites

Authors: [Sogand Hasanzadeh](#), [Behzad Esmaeili](#),
[Michael Dodd](#)

Background: Human error is one of the main causal factors in up to 80% of all accidents across various industries. Failures of cognitive processes have been found to make a significant contribution to the human

errors that lead to construction accidents. Although visual attention has been shown to correlate with inattentive blindness and memory lapses, no attempt has been made to investigate the potential of harnessing cognitive abilities as predictors of human error in the construction industry. To fill this gap, this study relies on construction workers' visual search patterns as indicators of their real-time cognitive processes to examine the impact of cognitive failure – specifically, memory and attention failure – in human error and fall risks. This study aims to: (1) measure visual attention to examine the influence of individual characteristics on workers' cognitive failure to detect hazards; (2) use visual attention metrics to detect at-risk workers and pinpoint personalized safety training to improve their hazard identification skills; (3) examine how distraction and working-memory load cause inattentive blindness and increase the probability of accident occurrences; and (4) use visual attention measures garnered via a mobile eye tracker to examine whether situation awareness, in terms of awareness of self and surroundings, apparently modulates attentional distribution and fall risks.

Methods: To accomplish these goals, total 100 construction workers are recruited, and both laboratory and field experiments are conducted. In lab experiments, the visual attention of workers are tracked while they searched for hazards in 35 randomly ordered construction scenario images. These experiments are conducted under three load conditions: no load, low load, and high load. In the field experiment, differences in attentional allocation between workers with low and high situation awareness levels are examined while exposed to fall hazards in a real construction site. Multiple qualitative and quantitative analyses (e.g., multivariate/ discriminate analysis and permutation simulation) are used to address the study aims.

Results: The results suggest that workers do not allocate their attention equally to all hazardous areas and these differences in attentional distribution are modulated by their work experience, and injury exposure, safety attitude, and personality characteristics. For example, in the construction environment which includes potential or active sources of hazards, more experienced workers tended to maintain a balance between processing and searching the scene by spending less time exploring hazardous areas and by more frequently tracking back to those hazardous areas. In addition, mathematical models are developed based on attention metrics as

predictors of workers' hazard identification skills to identify at-risk workers by tracking their performance in recognizing active and potential hazards. Moreover, the results of load manipulation also demonstrate that as working memory load increases, the ability of participants to identify hazards decreases. Workers under high-load conditions being 3.8 times more likely to miss fall hazards than subjects under low working memory-load conditions.

Discussion: The findings of this study reveal several search patterns that are predictive of hazard detection performance. The results of this experiment can thus support personalized safety training that targets at-risk workers. The adoption of the personalized safety intervention proposed based on the result of this study can improve visual search patterns of workers that ultimately translate to hazard detection performance. The outcomes of this study provide valuable insights to both practice and theory. Outcomes of this research related to the fundamental nature of human error due to cognitive failure will help safety managers detect at-risk workers, identify hidden and missed hazards, and pinpoint personalized safety training.

P13

Title: Implications for Risk Compensation in Construction Safety

Authors: [Sogand Hasanzadeh](#), [Jesus De la Garza](#)

Background: The construction industry is one of the most hazardous industry worldwide. While the construction industry has made considerable improvements to the physical environment through new regulations and diligent efforts to develop site-monitoring techniques that foster a safer workplace, previous studies have demonstrated that injuries still occur when the at-risk behaviors of workers coincide with site hazards. Both the research literature and conventional wisdom have showed that the most effective strategy for reducing human error is to increase the level of protective safeguarding of workers (e.g., developing legislation, engineering control interventions, providing safety training, implementing safety standards, and compelling the use of personal protective equipment). Known as safety interventions, each of these safeguards was designed to help keep hazards under control to some degree and employees injury free. Despite substantial efforts to address fall prevention and to curb the number

of injuries occurring in the construction industry, this sector still experiences the highest fatality rates among all industries. The fact that on-the-job injuries still occur even after implementing safety interventions highlights the need for research that identifies sources for the ineffectiveness of safety-related intervention and suggests strategies for making these interventions more effective. Since no systematic study has empirically examined the safety-related behaviors of roofers as a function of the number of safety interventions in place for their protection, there is a critical need to evaluate the potential of risk-compensatory behaviors of construction workers and to develop strategies for effectively mitigating the negative impact of risk compensation. The main objective of this study is to present the theoretical foundations and empirical applications of risk compensation and the resulting safety-related behavior adaptation in the construction setting.

Methods: To achieve this aim, within-subjects experiments representing hazardous fall scenarios virtually are developed in an immersive mixed reality environment—where physical and virtual objects co-exist and interact in real-time—to study changes in workers' risk-taking behavior and safety-related performance when they feel more protected. The risk-taking behavior and safety-related performance of participants are assessed regarding three intervention conditions (i.e., three level of protection) and different motivational manipulations (i.e., incentives), while they are asked to complete a roofing activity in the mixed-reality environment. Three real-time tracking sensors are used to track the worker motion, localize worker position, and obtain real-time musculoskeletal data in the mixed-reality experimental environment.

Findings/Discussion: The results of multiple qualitative and quantitative (Mixed Methods) analyses show that the safety benefits of safety interventions (i.e., fall protection equipment) are partially negated due to risk compensation; this is alarming—but vital—information for the construction safety community. This study defines the conditions under which roofers take more risks and determine how the risk-taking behavior of roofers affect the quality of their performance in the dynamic construction environment. Moreover, this study identifies factors that influence risk-compensatory behaviors, which can be used for reducing injury rates and will prompt the creation of more effective safety interventions, including training for mitigating workers' risk-

taking behaviors. In the long-term, the sustained benefits of these revised interventions may be observed once the mechanisms of risk compensation are better understood and certain risk-compensatory behaviors have been taken into account when developing and implementing safety-related interventions, which ultimately lead to a significant decrease in the number of injuries and fatalities occurring in the construction industry.

P14

Title: Safety Culture/Climate at Construction Sites: An Assessment of a Practical Model **Author: [Ahmed Al-Bayati](#)**

Background: Current research has demonstrated that safety culture and safety climate have a positive influence on overall safety performance. Despite the positive influence of safety culture, it has been suggested that there is a lack of clarity and that there is a significant amount of confusion when it comes to the definitions, measurements, and interrelationships between safety climate and safety culture. Furthermore, the existing models and definitions of safety culture and safety climate seem not to consider the unique nature of construction sites, as well as not provide a practical tool that can be used by construction practitioners to improve overall safety culture.

Methods: An extensive literature review has been conducted to assess the current models and definitions of safety culture. Accordingly, this study proposed a practical model. The proposed model suggests a partnership among workers, safety personnel, top management, and frontline supervisors to ensure that leading and lagging indicators are in-place and active. This model is expected to have a negative correlation with work-related accidents. This study tested the validity of the proposed model through examining the association between the new model and the Experience Modification Rate (EMR). The EMR is based on a company's safety records (i.e., injury claims vs. industry average claims) from the past three full years where the EMRs below 1.0 indicated injury rates lower than the average industry claims. Based on the proposed model and hypotheses 24 items have been suggested by the research team. These items which are intended to measure the safety performance of the four factors (i.e., workers, top management, frontline supervisors, and safety personnel), in addition to the EMR value, were used to create a survey that serves as a measurement tool.

Results: The survey was administered over a period of 4 months during which 94 valid responses were collected. To assess the structure of the proposed model, an Explanatory Factor Analysis (EFA) using Principal Axis Factoring with oblique rotation (Promax method) was conducted. The analysis shows that a two-factor structure should be retained due to a solid ability to fit and explain the observed data, $\chi^2 = 1482.506$, $df = 276$, $P < 0.001$. Factor one will be called Management Safety Factor (MS), since all its variables pertain to top management's and safety personnel's safety performance. Similarly, factor two will be designated Site Safety Factor (SS), since all its variables concern frontline supervisors' and workers' safety performance. The regression results suggest a significant proportion of the total variation in the Experience Modification Rate (EMR) scores was predicted by management safety (MS), $F(1, 93) = 5.206$, $p = 0.025$. Furthermore, the regression results suggest that a significant proportion of the total variation in Site Safety (SS) scores was predicted by Management Safety (MS), $F(1, 93) = 51.18$, $p < 0.001$. On the other hand, site safety factor (SS) seems to have a small contribution to the overall EMR values, $F(1, 93) = 0.091$, $p = 0.76$, which requires further investigation.

Discussion: The overall study findings provide a clear and easy to understand safety culture model that fits the construction industry's needs and continuously changing nature. The model is based on two factors which are management safety (i.e., top management and safety personnel) and site safety (i.e., frontline supervisors and workers involvement). The resulting model can also be used as a culture change intervention technique.

P15

Title: Participatory Safety Training: Stimulating Worker Engagement

Authors: Ted Scharf, Joseph Hunt, Ronald Repmann, William Wiehagen, Gene Lineberry, Michael McCann, James Creegan, William Hohlfeld

Background: This poster reports results from extension ladder safety training conducted during the Ironworkers' Instructors Summer Training Program in 2012 and 2013. In a study with Ironworker journeymen and apprentices, 80% of respondents (total $n=376$) reported that they use a ladder at least once per week (55% at least once per day). The mean and median age at which these respondents first learned to use a ladder is 9.0, (SD:

4.4). Nearly 60% of these respondents were first taught to use a ladder by a parent. An additional 33% reported that they taught themselves growing up. Thus, while there are several comprehensive and valuable ladder safety training interventions extant, the current training techniques may not be effective in overcoming practices learned early in one's youth. The materials presented in 2012 ($n=41$) and 2013 ($n=17$), are standard extension ladder set-up (39 items) and use (36 items) checklists. We tested the method of presentation.

Findings/Discussion: The results from these classes are the focus of this poster. Class participants in 2012 were asked to sort these items into 5 categories: 1) important, 2) very important, 3) medium, 4) critical, 5) very critical. This Q-Sort was conducted for routine conditions on the jobsite. Then, the Q-Sort was repeated for an emergency following an arrested fall with the worker suspended in his/her harness; further, only ladders were accessible to reach the suspended worker. The 2013 training materials were identical except for a change in the data collection method to permit a more rapid but not precisely comparable score. Nevertheless, the relative rankings of the selections in 2012 and 2013 remain comparable. There is general agreement for the "set-up" items ranked in the top three for the routine and emergency conditions by both years. Among the top three "use" items, there is much stronger evidence for a difference between the two years of classes. The change in data collection methods cannot be ruled out as one source of these differences. In both years, it is not unusual to see a major difference in rank between routine and emergency conditions on a single item. In an emergency, some participants stated: "It's go or no-go, right?" and "It's critical, or it doesn't matter." This study encouraged participation from construction workers who already work with the OSHA regulations. What are their perceptions regarding these regulations? The emergency scenario was created to assess these overall impressions. More important, what criteria should be emphasized as the most critical with respect to ladder safety? The data reflect agreement on some criteria and disagreement on other criteria. These results were then returned to each class for a brief summary and a 45-minute discussion. The goal of the discussion was to encourage each participant to re-evaluate his/her personal checklist of critical elements in ladder set-up and use. For example, one goal of this training is that every worker should check the ladder every time before he/she climbs or descends.

P16

Title: Evaluation of the NIOSH Online Healthcare Workplace Violence Prevention Course

Authors: [Marilyn Ridenour](#), [Daniel Hartley](#), [Terry Wassell](#)

Background: The Bureau of Labor Statistics' Survey of Occupational Injuries and Illnesses data indicate that healthcare workers account for over two-thirds of the nonfatal workplace violence related injuries that require days away from work. In 2013, the National Institute for Occupational Safety and Health launched a course on prevention of workplace violence. The course aims to educate nurses and healthcare workers on the scope, nature and prevention of workplace violence in healthcare settings. We describe the participants that completed the online course and their evaluations of the course.

Methods: We utilized R software for the descriptive analysis (frequencies) of the evaluations from participants that completed the course to earn continuing education units from August 2013 to November 2015.

Results: From 8/12/2013 through 11/30/2015, 14,518 individuals completed the NIOSH violence prevention in healthcare course, the evaluation, and obtained continuing education units. Eighty-five percent of the individuals were nurses. Ninety-three percent of the individuals that completed the training had some college (41%), completed college (35%), or an advanced degree (17%). Over half of the participants worked in a hospital and 68% were registered nurses working directly with patients. After completing the training, the participant's agreed or strongly agreed to the following course objectives: can identify institutional, environmental, and policy risk factors for workplace violence (96%); can recognize behavioral warning signs of violence in individuals (97%); can employ communication and teamwork skills to prevent and manage violence (96%); can identify appropriate resources to support injured nurses (95%); can take steps to implement a comprehensive workplace violence prevention program (90%). Ninety-four percent of participants reported that they had experienced verbal violence and 18% reported that they had experienced physical violence at work in the past 12 months.

Discussion: The evaluation of the participants that completed the Online Healthcare Workplace Violence Prevention Course indicated that participants reported

learning about workplace violence and prevention policies, warning signs for violence, violence prevention strategies, and follow-up to workplace violence events. An evaluation on the effectiveness of the online course materials when applied in the workplace is planned.

P17

Title: Steep Slope Machine Logging in Washington State: Hazard Assessment and Intervention

Authors: [Randy Clark](#), [Christina Rappin](#), [Todd Schoonover](#), [Travis Naillon](#)

Background: The goal of the Washington Fatality Assessment and Control Evaluation (WA FACE) program is to prevent work-related traumatic injuries and fatalities. Logging has historically been a dangerous industry, and it remains so today. According to the U.S. Bureau of Labor Statistics, in 2016, logging workers had the highest fatality rate of any occupation at nearly 136 deaths per 100,000 full-time workers, far exceeding the national rate across all occupations of 3.6. Within the logging industry, timber falling and choker setting are two of the most hazardous occupations. Advances in technology have led to the mechanization of timber falling in certain situations, reducing the need for manual timber falling. Mechanized logging operations are considered much less hazardous than non-mechanized logging, but they still present hazards. In Washington State, the recent introduction of steep slope machine (SSM) logging, also known as tethered logging, is proceeding at a rapid pace. In steep slope systems, a logging machine equipped with a cutting head is attached by wire rope to an anchor. The wire rope is winched to provide traction assistance to the SSM, allowing it to fall timber on steeper slopes than previously possible. SSMs are projected to further reduce the already declining number of workers involved in manual tree falling and cable logging. The primary objectives of this project were partnering with industry stakeholders to assess and characterize hazards associated with this emerging technology, and to develop and disseminate best management and operating practices and safety information to keep SSM operators and other workers safe while using these systems.

Methods: A WA FACE logging technical expert conducted informal interviews with a diverse group of logging industry stakeholders, including: land owners; logging

company owners; academic and technical experts; and SSM equipment manufacturers and operators. Site visits were made to SSM logging operations and manufacturers of SSMs. Injury claim and safety and health inspection information were obtained from the Washington State Department of Labor and Industries (L&I). An advisory committee reviewed and gave input during the development of best management and operating practices. Logging industry stakeholders were recruited to report and provide information on near-miss incidents that occurred during the project period. An injury root-cause analysis approach was used to identify the factors contributing to reported incidents and develop safety outreach materials.

Results: The scope of and hazards associated with the emerging use of SSM technology in Washington State were characterized. Best management and operating practices for steep slope machine logging were developed, and a system was created for ongoing update and review of these practices. Easy to understand one-page Hazard Briefs and Near Miss Alerts were issued. Outreach materials were disseminated by L&I and industry associations.

Discussion: The introduction of steep slope machine logging technology promises both increased production for the logging industry and safety for logging industry workers by eliminating most manual timber falling. But as a shift is made in how logging site operations are carried out, this new technology has been shown to have its own hazards. Continued surveillance of fatality and injury incidents and the safety aspects of this developing technology are warranted to ensure the safety of logging industry workers. The cooperation of stakeholders in this relatively small and hard-to-reach industry is integral to the effectiveness of this type of safety assessment and outreach project, and having a technical expert with industry connections was key to its success.

P18

Title: SW AgCrash: Leveraging Motor Vehicle Crash Data for Injury Surveillance and Research in AFF

Authors: [Eva Shipp](#), [Amber Trueblood](#), [Hye-Chung Kum](#), [Tanya Garcia](#), [Ashesh Pant](#), [Shubhangi Vasudeo](#), [Kim Jisung](#), [Das Subasish](#)

Background: Workers in the Agriculture, Forestry, and Fishing sector (AFF) experience substantially higher

motor vehicle related fatal injury rates compared to workers in other sectors. However, little is known about the magnitude of this problem and how to best address it specifically in the Southwest region (AR, LA, NM, OK, and TX). The objective of the Southwest Agricultural Crash Surveillance System (SW AgCrash) project is to inform the development of AFF injury surveillance systems while also identifying factors contributing to transportation-related injuries in AFF populations. In addition, crash narratives are free-text fields that are a rich source of data for identifying relevant crashes and illuminating causal factors. This resource has yet to be fully incorporated into surveillance and research in AFF or other sectors.

Methods: This three-year project began in 2016 and involves constructing a regional crash surveillance system for the Southwest region. The system is comprised of a crash database largely populated by state crash reports that police officers collect on-scene. It also includes data cleaning and analysis protocols including descriptive and inferential statistics and mechanisms for dissemination of information including via an advisory panel. In addition, it involves developing simple and complex methods for mining the crash narratives such as a Microsoft Excel-based tool and advanced computer science techniques (e.g., Natural-language processing, support vector machines).

Results: The database currently includes data on over 5 million crashes. Each state, at a minimum, contributed data for 2011-2015 with more recent years expected to be added as available. From 2012-2015, there were 2,084 crashes involving agricultural vehicles and 1,240 crashes involving logging vehicles. As expected based on population size and economic factors, the greatest number of crashes occurred in Louisiana and Texas. Analyses are currently underway to estimate crash rates for each state and identify contributing factors. Preliminary findings are available for logging-related crashes in Louisiana from 2010-2015 (n=368). In a multiple logistic regression model, behavioral factors associated ($p < 0.05$) with an injury among logging drivers involved in a single motor-vehicle crash included: no or improper seatbelt use (OR=3.12), careless operation of a vehicle (OR=3.19), and other non-behavioral factors. Most states do not have a structured data field to indicate which vehicle is at-fault. Analyzing the crash narratives along with the structured data allowed for developing a method for assigning fault to a specific vehicle. Among

the logging drivers involved in a crash with at least one other vehicle, approximately 46% were found to be at-fault for the crash. Additional findings are forthcoming with respect to this analysis and additional benefits of mining the crash narratives.

Discussion: Motor vehicle crash records are a credible and valuable source of data for monitoring injuries among agricultural and logging workers and producing data to support outreach and other interventions in the Southwest region. Structured data can provide information on injury frequency, severity, and contributing factors at the person, vehicle, crash, and environment levels. Narrative data can be mined to provide additional details and to assess the quality of the structured data. Both simple and complex data mining methods are useful to this end.

P19

Title: Occupational Immersion Deaths in Canada 1991-2014

Authors: [Peter Barss](#), [Yasmina Tehami](#)

Background: Occupational immersions represented 7% (731/11280) of submersion fatalities in Canada. Practically all involved persons over age 15, with 76% between 25 and 64 (n=556). Objective: Assess circumstances of occupational immersions, including, incidents, activities, personal, equipment, supervisory and environment factors.

Methods: Using structured questionnaires, coroners' data were collected prospectively in 1991-2014 during national surveillance of water-related injury deaths. Population averaged 30 million.

Results: Between 1991 and 2014, there were 731 occupational immersion deaths. Provinces: Most deaths occurred in coastal provinces of British Columbia 21% (n= 151), Newfoundland/ Labrador 16% (n=117) and Nova Scotia 15% (n=107). This differs from non-occupational immersions, such as recreational, with greatest numbers in Ontario and Quebec. Activities: 37% occurred during commercial fishing (n=276), 58 in marine shipping, 29 during commercial diving and 22 were commercial pilots. Cause of death: 89% of occupational immersion victims died from drowning (n=656), while a smaller number died from cold/ hypothermia (n=22), Trauma of air crash into water, air embolism (n=11) or trauma of boating collision (n=10). Personal factors: 96% of immersion victims were males, 706 of 731 immer-

sions. 73% (n=535) were classified as non-indigenous and 10% (n=71) definitely or probably indigenous. Of 156 victims with known swimming ability, 43 were non-swimmers and 17 weak swimmers. 7% (n=49) of victims had alcohol levels above the legal limit, while 50% (n=361) had an alcohol reading of zero. 5% of victims (n=39) were found or suspected to have consumed an illegal drug. Environment/ built environment: Most deaths occurred in oceans (n=372), followed by Lakes or ponds (n=153), and river/ stream/ creek/ waterfall (n=106). 30% occurred while wave conditions were Choppy (n= 41), Rough (n=84) or Storm/ Gale force (n=91). 24% of deaths occurred at dawn (n=91) or during darkness (n=84).

Discussion: For occupational immersions, particular attention should be paid to maritime provinces with the highest number of deaths. Special attention should be made in training individuals who work near or in water to be proficient swimmers.

P20

Title: Trends in Injuries and Fatalities for Electric Power Workers

Authors: [Tiffani Ann Fordyce](#), [Megan Leonhard](#), [Ximena Vergara](#), [Eric Bauman](#)

Background: The Electric Power Research Institute (EPRI), as part of the Occupational Health and Safety Program, established an ongoing surveillance and research project in 1999, called the Occupational Health and Safety Database (OHSD), to provide information on the occurrence of workplace injury and illness among workers in the electric power industry. The OHSD includes 2,118,459 employee-years of follow-up and 64,903 observed lost time and recordable injury/ illness events among nineteen participating companies over a 22-year period (1995–2016).

Methods: Data were standardized into a consistent format to compare across different companies. Injury rates were calculated and primarily expressed in terms of the number of injuries per 100 employees during a year of follow-up except for rare injuries, which were expressed per 10,000 employees. Given the deviance and dispersion estimate criteria, 95% confidence (CI) intervals were calculated assuming an underlying Poisson distribution. Throughout the report, proportions and rates were examined by year groupings. Years 1999–2014 were broken into five year ranges and the remaining, most recent

years were combined (2015–2016). Tests for trend were calculated using the SAS GENMOD Type III procedure to approximate a Breslow Day test for trend.

Results: The average annual injury rate for all companies is 3.06 per 100 employee-years and there was a statistically significant decrease ($p < 0.001$) in injury rates in the overall cohort between 1995–2016, from a high in the 1995–1999 time period (4.18; 95% CI: 4.12–4.23) to the lowest reported rate occurring between 2015–2016 (1.59; 95% CI: 1.49–1.68). The fatality rate over the 22-year period is 0.32 per 10,000 employee-years based on 68 fatalities. By year range, the fatality rate in the most recent year range (2015–2016) (0.42 per 10,000 employee-years) is higher than all but the first five-year range of the OHSD (1995–1999) (0.48 per 10,000 employee-years). When examined by age, there was a marked increase in the injury rate for workers 20 or less from 2.67 per 100 employee-years for 1995–1990 to 29.36 per 100 employee-years for 2015–2016, and for workers aged 65 and older from 0.21 per 100 employee-years from 1995–1999 to 1.12 per 100 employee-years from 2015–2016. We tested for significance of trend increases over the 22-year range noting $p < 0.001$ for both workers aged 20 or less and for workers 65 and older. All other age groups showed significant decreasing trends over 22 years ($p < 0.011$). When examined by occupational group, many high-risk occupations (e.g., line workers, welders, mechanics, meter readers) experienced a decrease in injury rates over the 22-year period; however, machinists experienced an increase in injury rates in the present year group 2015–2016 (5.33; 95% CI: 1.45–13.66) over that of 2010–2014 (3.13; 95% CI: 2.30–4.16), although down from the highest reported rate in 1995–1999 (8.53; 95% CI: 7.57–9.45).

Discussion: One advantage of this type of analysis is that a stable representation of changes over time can be provided, since an anomaly seen in one year will have less of an effect on the results. In general, non-fatal injury rates have declined since the start of the OHSD in 1999 and continue to decline. Although fatalities remained below one per year over nearly a decade of the OHSD, the recent increase in fatalities warrants further analysis and review of prevention strategies. New patterns in the most recent year group (2015–2016) were discovered, including an increase in injury rates for machinists and the oldest and youngest age groups. While the 2015–2016 year range may be more influenced by outliers than the other groupings, surveillance of the

most recent date range may indicate areas of emerging concern, allowing for prompt interventions to prevent injuries amongst specific age and occupational groups.

P21

Title: Surveillance of Acute Nonfatal Occupational Inhalation Injuries Treated in U.S. Hospital Emergency Departments, 2014–2016

Authors: [Angela Javurek](#), [Larry Layne](#), [Patty Schleiff](#)

Background: Little is known regarding the burden of acute nonfatal occupational inhalation injuries. Various surveillance efforts to identify the prevalence of inhalational injuries have included using poison control centers, physician reports, and hospital emergency department (ED) records. It was previously reported that occupational inhalation prevalence rates from hospital ED in the U.S. during 1995–1996 were magnitudes higher than those from physician reports collected in Canada and the United Kingdom from the 1990s. This current effort reexamines three years of recent hospital ED data nearly two decades later.

Methods: National Electronic Injury Surveillance System (NEISS)-Work data were used to identify nonfatal civilian occupational inhalation injury cases treated in U.S. hospital ED from 2014–2016. NEISS-Work is a national stratified probability sample of 67 hospital ED in the U.S. and its territories. At each hospital, a trained coder is responsible for reviewing every ED medical record and abstracting essential NEISS-Work data elements. Data are not restricted by age, employer size, or type of employer or industry. A workers' compensation claim is not required for inclusion. Due to the lack of a coding structure that would identify all inhalation cases, a three-step process was used for case identification. First, cases that were coded with the Occupational Injury and Illness Classification System event/ exposure code Inhalation of Harmful Substance '552' were classified as 'inhalation positive'; second, all cases with the nature of injury coded as Anoxia '65' were manually reviewed by researchers; and third, a keyword search was performed on the narrative comment field of all remaining cases not identified in the two previous steps with manual review of all cases identified by the keyword search. The key words included terms such as fume, vapor, smoke, gas, aerosol, and particulate but excluded asthma, chronic obstructive pulmonary disease (COPD), allergy, wheeze, bronchitis, granuloma and others that

would bias the study towards exacerbation of illness. Estimates of the employed population for calculation of rates were derived from the Current Population Survey using the on-line Employed Labor Force query system. Rates are reported per 10,000 Full-Time Equivalent (FTE). SAS® 9.4 Proc Survey was used for calculation of 95% confidence intervals (CI) to incorporate the stratified sample design of NEISS-Work.

Results: There were approximately 88,900 (CI: 63,900–113,900) acute nonfatal occupational inhalation injury cases treated in U.S. hospital ED from 2014-2016. The overall rate was 2.1 per 10,000 FTE (CI: 1.5–2.6). Firefighters comprised 7% ($\pm 3\%$) of the total. By sex, males comprised 60% ($\pm 17\%$) of the injuries although the rates for males and females were similar at 2.2 (CI: 1.5–2.8) and 1.9 (CI: 1.4–2.5), respectively. Although workers 45-years and older accounted for the largest percentage of injuries (32%, $\pm 10\%$), those less than 25-years had the highest rate at 3.7 (CI: 2.6–4.8), and this pattern was consistent between the sexes. An examination of the leading sources of injury by sex (excluding firefighters) showed that chemicals were more prevalent for inhalation injuries among females (78%, $\pm 24\%$) compared to males (71%, $\pm 20\%$). Within chemicals, cosmetics and cleaners were more common among females (19%, $\pm 9\%$). In contrast, adverse environmental conditions, scrap and debris such as saw dust were prominent among males (14%, $\pm 6\%$).

Discussion: The results provide insight into the burden of acute nonfatal occupational inhalation injuries and an understanding of how injuries are distributed based on age and sex. While the inhalation injury rates declined 42% over the last two decades, it is unknown whether the observed decline is truly a reduced risk or related to changes in medical care such as the rise of urgent care facilities reducing the burden seen in hospital emergency departments.

P22

Title: Have Work-Related Injuries Become More Severe?

Author: [Brooks Pierce](#)

Background: Factors related to injury treatment, reporting, and classification are widely understood to act as filters to injury surveillance. Examples include incentives via workers' compensation systems, barriers to health care service utilization, case management

policies by employers, and reluctance by employees to report on-the-job injuries. Such factors adversely affect the ability to measure changes over time in true occupational injury risk. Because these factors seem most relevant for less severe injuries, there is in particular a worry that relatively minor injuries are increasingly omitted from surveillance systems. One potential solution to this measurement problem is to record trends in occupational injury risk, stratified by case severity. Stratifying by severity, or alternatively documenting trends for the most severe injuries, is an attempt to hold case mix fixed in comparisons across time. While there has been interest and success in developing severity measures in other data sources, including Workers' Compensation data, there appear to have been few prior attempts at deriving such measures in Survey of Occupational Injuries and Illnesses (SOII) data. For a variety of reasons, comparisons over time in SOII median injury duration are difficult to interpret. Developing alternative severity measures for SOII data could aid in comparisons over time for a broad population of injury and illness incidents.

Methods: This work derives additional measures of case severity in the SOII, a large ongoing national survey. The measures rely on identifying case characteristics, as captured under the OIICS coding structure, that correlate with injury duration and emergency room visit. Injuries and illnesses with characteristics that indicate higher likelihood of emergency room visit, or alternatively higher likelihood of a long duration case, are deemed to be more severe. The paper presents trends in injury rates stratified by the derived severity measures. It also discusses the strengths and weaknesses of such measures for trend comparisons.

Results: Injury rates for the least severe SOII cases have fallen more over time than have injury rates for the most severe SOII cases. This differential improvement accumulates steadily over the 1992-2010 time frame. It is most apparent for measures derived from emergency room visit data. The results suggest that the reported SOII case mix has become modestly more severe over time.

Discussion: Further scrutiny of the derived severity measures is warranted. Emergency room visit information is a relatively new SOII data element. Furthermore, the results should be analyzed with reference to well-known series breaks in SOII data. Extensions of the methods shown here to include measures related to

fatalities, and to describe 2011-2016 data, are feasible. Extensions to describe variation across geography (for example, across states, or across counties within states) also seems feasible and of fundamental interest to the surveillance community.

P23

Title: Restaurant Inspection Reports as a Proxy Measure for Occupational Health and Safety: South Asian Restaurant Workers in New York City

Authors: [Hasanat Alamgir](#), [Ismail Nabeel](#)

Background: Restaurants can be hazardous workplaces for the nature of business, materials handled and tasks completed. Working with hot equipment and oil, sharp knives, lifting heavy objects, working in hot work areas for a long period of time and on slippery floors or floors cluttered with objects may result in muscle strains, sprains, and tears; cuts and lacerations; and burns and scalds.

Methods: We have explored using restaurant inspection grade as a proxy measure for employee safety and working conditions. We have compiled inspection data on Indian, Pakistani and Bangladeshi restaurants in NYC. We have used 1) overall restaurant grade and 2) specific violations as means of assessing workplace health and safety.

Results: These overall grade findings suggest that 19% of the Indian, 26% of Bangladeshi, and 15% of Pakistani restaurants did not achieve grade A in these inspections. These suggest that workers in about 20% of these restaurants more than likely work in a relatively hazardous or unhygienic working conditions. We also present a list of possible violations and its implication on worker health and safety such as live roaches present in facility's food and/or non-food areas and evidence of mice or live mice present in facility's food and/or non-food areas.

Discussion: We need to further validate this proposed alternative surveillance tool as this grading system has evolved over the last several years. There appears to be better understanding and appreciation of the grading system now since its implementation in 2011 and there has been a continuous effort to improve the accuracy of this system. Incorporating a few worker health and safety measures in the current grading system can be a very

useful next-step. There is a great need to develop workplace health and safety surveillance systems for small businesses to systematically understand the cause, nature and severity of injuries and illness. Surveillance data would identify high risk worker groups within these restaurants, and allow looking at time trends and help in evaluating interventions.

P24

Title: Modernization of the National Occupational Mortality Surveillance Program and Future Opportunities

Authors: [Andrea Steege](#), [Pamela Schumacher](#), [Susan Nowlin](#), [Jeffrey Purdin](#)

Background: Since 1985, NIOSH has maintained the National Occupational Mortality Surveillance (NOMS) system to study patterns in mortality among workers according to the industry and occupation of their usual (longest-held) job, as indicated on their death certificate. As the largest source of data linking mortality and industry and occupation, NOMS data have been analyzed for at least 87 peer-reviewed journal articles with 151 authors. These have appeared in 22 journals. Study types include proportional mortality ratio (PMR), proportionate cancer mortality ratio, case-control, and others. Health outcomes studied range from silicosis to hepatitis B and Parkinson's Disease. Over 30 occupations and industries have been studied. NOMS data have recently been analyzed to gain an understanding of how drug-related deaths vary by occupation as well as suicide in law enforcement workers. In addition, our web-based PMR query system is utilized by researchers, journalists, insurance executives, students and lawyers. A limitation of the NOMS is that it has historically included a limited set of jurisdictions partially due to the resources required to manually code the industry and occupation (I/O) of decedents. Another limitation of the current process is the 5-year time lag in assembling and coding data.

Findings/Discussion: Two recent developments have resulted in an opportunity for NOMS to be expanded and improved. These are adoption of Electronic Death Registration Systems (EDRSs) and development of the NIOSH Industry and Occupation Computerized Coding System (NIOCCS). EDRSs have been adopted in almost all US jurisdictions allowing collection of digital I/O narratives. NIOCCS assigns standardized Census I/O

codes to free text I/O data. A recent NIOCCS update has improved the I/O auto-coding rate to 85% for death certificate data. NIOSH-trained coders code the remaining narratives efficiently using a NIOCCS utility. This year the NOMS modernization project will expand formal collaboration with the National Center for Health Statistics (NCHS) and jurisdiction vital statistics offices. Although 47 jurisdictions currently submit I/O narratives to NCHS, it does not have an agreement in place to share them with any other entity. During this time, NIOSH will streamline the process to accommodate larger volumes of I/O narratives. This will be done in addition to fulfilling all CDC requirements for setting up this mechanism, including ensuring data security. The first phase will also include work with NCHS to develop, test, and use a mechanism to electronically transfer I/O text data in death certificates from NCHS to NIOSH for coding with NIOCCS, then to transfer the I/O codes back to NCHS, to be returned to the jurisdictions. NCHS will return I/O Census codes to jurisdictions within 3 months after narratives are submitted. When data are finalized, I/O Census codes will be made available as

part of the National Vital Statistics System (NVSS)'s public use mortality data, as well as through NCHS's Research Data Centers.

In 2019, a pilot test with 10 jurisdictions will be conducted to test data flow. In 2020, NIOSH will include all other jurisdictions who agree to participate. This project will enhance the NOMS system, thus providing NIOSH, jurisdiction partners, and others the capacity to more effectively and rapidly monitor trends and generate hypotheses regarding associations between occupational risk factors and specific health outcomes, including drug overdose and injury related-deaths as well as chronic diseases. NOMS data can also be used to inform policy and direct prevention efforts to specific I/O groups with the greatest burden of disease. This will be done by integrating coded I/O data into the NCHS NVSS, a CDC system that obtains real-time data from all jurisdictions. Leveraging this system will expand NOMS from 17 to as many as 57 jurisdictions and will eliminate the 5-year delay in data processing.

Day 3: Thursday, October 18, 2018

Session H1

Title: Integration of Safety Culture into the Incident Command System to Enhance Fire Fighter Safety

Moderator: Murrey Loflin

The inherent risk factors of firefighting and emergency operations are recognized and simply accepted as unavoidable occupational hazards. The culture of unsafe practices may be so deeply ingrained that efforts to change are viewed as challenges to fundamental beliefs, while other unsafe practices are created by the culture of the fire and emergency service as a whole. As has been shown for other occupational safety problems, the true root causes of many fire fighter fatalities may be traceable back to basic cultural attributes. Fireground operations are categorically the most dangerous location in which fire fighters operate, in terms of both fatalities and serious injury. Fire fighter fatalities are closely linked to unsafe practices and a fire and emergency service culture that is not fully committed to safety. In order to effectively manage an emergency incident, the incident command system (ICS) was developed. The incident command system addresses problems related to establishing operational command and control of emergency incidents. The ICS structure can expand and contract as needed to meet the changing conditions of an incident. In 2011, an analysis of 189 National Institute for Occupational Safety and Health fire fighter fatality reports for the time period 2004 – 2009 found that there were four higher-order causes of fire fighter death and injury: 1) insufficient resources, 2) inadequate preparation, 3) insufficient incident command structure, and 4) suboptimal personnel readiness. The incident command system (ICS) is the dominant operational system for all firefighting organizations, and regulatory and legislative actions at the federal level have made the ICS a requirement for a broad array of emergency response organizations. The National Fallen Fire Fighters Foundation (NFFF) Life Safety Initiative #1 states, "Define and advocate the need for a cultural change within the fire service relating to safety; incorporating leadership, management, supervision, accountability and personal responsibility." Life Safety Initiative #3 states, "Focus greater attention on the integration of risk management with incident management at all levels, including

strategic, tactical and planning responsibilities." These two initiatives serve as the foundation of this session. This session will explore research and interventions in the incident management system that demonstrate the interdependence of safety culture/ safety climate with safe work policies and practices in the fire service related to the ICS/IMS.

H1.1

Title: Developing and Assessing a Measure for Incident Command Operational Effectiveness in Firefighter Safety Research

Authors: [Todd Smith](#), [David DeJoy](#), [Aimee Dyal](#)

Background: The importance of effective incident command is generally understood throughout fire and emergency service organizations and deficiencies in incident command have been linked to firefighter injuries and fatalities. Despite this knowledge, incident command has not been fully studied, particularly in the context of safety culture/ climate within the fire service. Generally, safety climate research focuses on shared perceptions about safety, but there was no discernible measure associated with perceptions of incident command effectiveness. Further, our preliminary and qualitative research efforts to study safety climate in the fire service indicated a need to emphasize incident command. Thus, we sought to develop a valid and reliable measure of incident command to incorporate into firefighter safety climate research and to explore whether perceptions of incident command effectiveness would be associated with firefighter safety outcomes.

Methods: Our study used a multi-stage, mixed methods approach to examine firefighter safety climate and relationships with safety outcomes. Qualitative studies included cognitive interviews with firefighters (n=86) and 10 focus group meetings (n=86) with two large metropolitan fire departments including one in the eastern US and one in the western US. Quantitative data analyses included two pilot studies. Data were collected from firefighters completing training at a fire training center (n=206) and firefighters from a city department (n=208). A final survey was administered to 994 firefighters in the two metropolitan fire departments noted above. Preliminary analyses of qualitative data resulted in the inclusion of incident command in our model

development and survey development activities. Item and scale development activities were completed to develop a measure of incident command. Psychometric and confirmatory analyses were completed to ensure a valid and reliable measure of incident command. This scale was incorporated into various safety climate studies for the overall Firefighter Safety @ Work project, including a structural equation modeling analysis that examined relationships between organizational safety climate, incident command and fireground safety behaviors.

Results: As a result of our preliminary, qualitative and quantitative analyses, a valid and reliable measure of incident command was derived ($\alpha = .90$). A summary of this process and outcomes leading to the measure will be presented. For the main purposes of this presentation, we will present the results of a structural equation modeling study that examined the relationships between organizational safety climate (as a higher order factor derived from factors including management commitment, safety policies and programs and human resources practices), incident command and fireground safety behaviors, which included behaviors such as following SOPs, participating in rehab during the fire-fight and following personnel accountability systems. Organizational safety climate positively predicted incident command ($p < .01$) and incident command positively predicted safety performance on the fireground and in emergency operations ($p < .01$).

Discussion: Previous gaps existed in firefighter safety research as there was no discernible measure for assessing perceptions of incident command effectiveness within firefighter safety climate studies. The research team developed a valid and reliable measure for incident command, which can be used by researchers and practitioners to assess incident command operational effectiveness perceptions. Beyond development of the measure, it has been determined that incident command effectiveness, as a performance outcome of safety climate, positively impacts firefighter performance on the fireground and in emergency operations, illustrating the importance of this as a leading indicator and predictor of firefighter safety performance.

H1.2

Title: Safety Culture and the Incident Command System

Author: [Murrey Loflin](#)

Background: Fireground operations are categorically the most dangerous location that fire fighters operate, in terms of fatalities and serious injury. In order to effectively manage an emergency incident, the Incident Command System (ICS) was developed. The Incident Command System addresses problems related to establishing operational command and control of emergency incidents. The ICS structure can expand and contract as needed to meet the changing conditions of an incident. This presentation will show how the proper use of the Incident Command System is a practical example of an occupational health and safety management system (OHSMS) and improves the safety culture of the organization.

Methods: The NIOSH Fire Fighter Fatality Investigation and Prevention Program (FFFIPP) investigates fire fighter line of duty deaths (LODD) and significant injuries to identify contributory factors and formulate prevention strategies. One of the most common denominators relating to fire fighter fatalities is the lack of use or inadequate use of the Incident Command System. During an LODD investigation, NIOSH FFFIPP investigators utilize a safety culture questionnaire to capture a snapshot of the fire department's perception of its culture on the fireground. The Incident Commander, company officers, and fire fighters are asked to discuss their philosophy and views of the incident management system utilized and the outcome of the incident.

Results: From 2012 – 2016, an average of 76 fire fighters died annually. During this same period, the National Institute for Occupational Safety and Health (NIOSH) Fire Fighter Fatality Investigation and Prevention Program investigated 29 incidents, which resulted in 38 fire fighter fatalities and 40 fire fighter injuries. During each of these incidents, the Incident Commander failed to utilize or fully implement the Incident Command System. The Incident Commander is the person who drives ICS towards that end. The Incident Commander is responsible for building an ICS organization that matches the organizational needs of the incident to achieve the completion of the tactical priorities for the incident. While the Incident Commander's decisions establish a theoretical level of acceptable risk that applies to every

individual involved in an incident, it often occurs that individual fire fighters knowingly or unknowingly expose themselves to higher levels of risk than the Incident Commander has deemed acceptable. This is a particular problem when individual perceptions of acceptable risk are different from the Incident Commander's perceptions.

Discussion: The focus on culture as a factor in fire fighter fatalities is not new in that various fire service organizations have called for culture change in fire-fighting operations. While the ICS provides for effective command and control of any size incident, ensuring the safety of fire fighters is the primary tactical objective. The FFFIPP investigation results show that non-use or inappropriate use of the ICS continues to contribute to fire fighter death and serious injury. This data indicates that changes need to continue to improve the safety culture in the fire service, especially the proper use of the Incident Command System.

H1.3

Title: Beyond the Sixteen, How to Reduce Fire Fighter Fatalities on the Fireground

Author: [Dennis Rubin](#)

Background: This presentation will focus on leadership strategies and tactics for decreasing fire fighter line of duty deaths on the fireground. Since the advent in 1987 of the National Fire Protection Association (NFPA) 1500, Standard on Fire Department Occupational Safety, Health, and Wellness Program, the fire service has attempted to enhance the safety culture of fire department operations. This process has continued through the standards making process as well as through other avenues. At the 2004 Fire Fighter Safety Summit, the National Fallen Fire Fighter Foundation (NFFF) instituted the 16 Fire Fighter Life Safety Initiatives, which were jointly developed by representatives of the major fire service organizations, including representatives from the NIOSH Fire Fighter Fatality Investigation and Prevention Program (FFFIPP). The 16 Fire Fighter Safety Initiatives were developed based on actual fire fighter research; scientific or quantitative testing reports; published academic studies/ articles from professional journals; published academic papers from professional conference presentations industry reports and studies, including investigations of fire fighter fatalities and injuries; and comprehensive lessons-learned fire reports. At that time, the NFFF was tasked with disseminating and utilizing these Initiatives throughout the fire service to

develop a safety culture to reduce fatalities and occupational injury and illness rates of fire fighters.

Findings: From 2006 – 2015, 810 fire fighters died, which averages to 81 fire fighters deaths a year. This is a decrease of fire fighter fatalities from an average of 100 fire fighter fatalities annually. This decrease indicates that the fire service is making efforts to continually reduced fire fighter fatalities. In 2011, NFFF personnel reviewed 1252 firefighter line-of-duty death reports for fatalities that occurred between 1999 and 2010. Ineffective Decision Making was the most common root cause among the fatality reports reviewed, and was identified in 766 of the 1252 cases, or 61%. While not every poor decision has a negative outcome, many do. For example, those with a “traditional” outlook often expressed disagreement with the emphasis toward “acceptable risks” and “rules of engagement,” claiming that they promote nonaggressive and ineffective operations. In 2011, an analysis of 189 NIOSH FFFIPP reports for the time period 2004-2009 found that there were four higher-order causes of firefighter death and injury: insufficient resources, inadequate preparation, insufficient incident command structure, and suboptimal personnel readiness.

Discussion: Although the NFPA data for 2006-2015 show that the average number of deaths is lower than previously seen, there are still too many deaths. The NIOSH FFFIPP reports indicated that fire fighter safety climate perceptions and ultimately fire fighter safety behaviors can be enhanced through safety-specific transformational leadership tactics. These reports include recommendations (lessons learned and/or reinforced), with each report intended to assist fire departments from making the same or similar mistakes in the future by breaking the chain of poor performance at emergency events. To enhance fire fighter safety and health and to possibly curtail fire fighter injuries and fatalities through enhanced safety behaviors, the fire service should seek to integrate safety-specific transformational leadership strategies and tactics into their daily operations to bolster safety climate perceptions. This could be accomplished by promoting safety practices, illustrating concern for fire service personnel and by focusing on the overall health, safety and wellness of department members. Fire departments should also convey safety as a fundamental value through communication, action, personal behaviors, and through a sustained commitment to safety. A clear and concise

safety vision focused on injury and fatality prevention and fire fighter health and well-being should be developed and communicated within a fire department. Beyond the tactics noted above, leadership could intervene and address deficiencies commonly associated with fire fighter injuries and fatalities such as under-resourcing, inadequate preparation, and ineffective adoption and use of incident command procedures, while also ensuring personnel readiness. While the principles of the 16 Fire Fighter Life Safety Initiatives have been mostly embraced by the fire service in America, debates about the “culture of safety vs the culture of suppression” continue. This presentation will explore additional strategies for continually decreasing fire fighter line of duty deaths on the fireground.

H1.4

Title: Finding FOCUS on a Safer Fire Service Climate

Authors: [Jennifer Taylor](#), [Andrea Davis](#)

Background: Every fire department in the United States is vulnerable to the impact negative organizational culture has on safety. Even fire departments that have a positive safety culture need objective data to show they are performing at the highest levels – and to set targets for maintenance.

Methods: In 2004, the fire service released 16 Fire Fighter Life Safety Initiatives for occupational safety and health. FSLI #1 read, “Define and advocate the need for a cultural change within the fire service relating to safety; incorporating leadership, management, supervision, accountability and personal responsibility”. The Firefighter Organizational Culture of Safety (FOCUS) survey was developed to create a fire service-specific safety climate assessment tool to measure FLSI #1. A mixed methods sequential design generated a psychometrically valid tool that measures behaviors, decision-making, and organizational safety factors. The language of the survey captures firefighters’ behaviors, decision-making, and attitudes towards safety. FOCUS was developed through interviews and focus groups with 120 firefighters across 12 US departments. The survey was then validated with 130 career and volunteer fire departments from a geographically stratified random sample of all 10 FEMA regions (approx. 800 stations and 10,000 firefighters). FOCUS baseline assessment empowers fire departments to plan interventions that are then evaluated in a post-test fashion with the same tool.

Results: A validation study showed for every 10-point increase in FOCUS score, there was on average: a 6% decrease in Firefighter Injury Rate, a 2.5-point decrease in Burnout, an 8-point increase in Morale, and a 7-point increase in Work Engagement. The survey detects differences in perceptions between leadership and rank-and-file. When asked, “Decision-makers in this department listen carefully to members’ concerns about safety”, leaders positively agreed at 54%, while firefighters agreed at 37%. A difference of 17 on a 100-point scale. When asked, “We have all the gear we need to do our job safely.” Leaders positively agreed at 79%, but firefighters agreed at 57%. Both examples show opportunities for improving perceptions among leadership and firefighters (getting closer to 100), as well as a diminution of the differences between their perceptions.

Discussion: FOCUS is a valid and reliable fire service tool to assess predictors of injury, burnout, morale, and engagement. To date, approximately 500 departments have assessed with FOCUS. Participants reflections on having these data include: “Change is the hardest thing for people to accept. Trying to implement some change has to be well thought of and with this kind of data, it helps. This is scientific data we could use to try to identify some of those pitfalls and we can fix them.” “The fire service needs to realize that they can take care of everybody else but now it’s time to start taking care of ourselves in so many different ways – it’s not just safer equipment, it’s also safety procedures and the problem is that we have to deal with the stress... You’ve given us tools that can help us move forward in safety culture in the fire service.” “...In my heart, I believe that we promote a safe culture..., but it was gratifying to see that others in our organization believe this to be true also... I like the fact that I can now put actual numbers to what has previously been a ‘gut feeling.’” FOCUS dissemination is growing through a research-to-practice partnership with the Fire Department Safety Officers Association. To date, approximately 500 departments have assessed with FOCUS.

Session H2

Title: Reducing Occupational Safety and Health Risk Among Maritime Workers

Moderator: [Jennifer M. Lincoln](#)

Maritime workers face a higher risk of fatality, injury, and illness than the average American worker. To help identify and reduce the risks associated with maritime

workplaces, the National Institute for Occupational Safety and Health (NIOSH) recently created the Center for Maritime Safety and Health Studies (CMSHS) to coordinate research and intervention studies across NIOSH and its intramural and extramural scientists. Currently, the Center includes research in six maritime industries: shipyards, marine terminals, marine transportation, seafood processing, commercial fishing, and aquaculture. NIOSH scientists have worked with the commercial fishing industry for decades and our research has led to a measurable decrease in fatalities in the US. These successes were possible through partnerships with industry, fishing associations, professional organizations, other federal and state agencies, and academia. This work has focused on identifying and reducing risk factors for injuries, fatalities, and vessel casualties. Once our epidemiologic research has identified hazards, we collaborated with these partners to design, test, and improve interventions that decrease or control those hazards. The establishment of the NIOSH CMSHS is an ideal opportunity to broaden this approach to other maritime industries. In this session, we describe research findings from four maritime industries. A short introduction describing the burden of injuries in the maritime workplace will be followed by a series of talks covering maritime industries and highlighting progress towards the prevention of injuries, as well as persistent challenges, in this important but often overlooked workforce.

H2.1

Title: Fatal Falls Overboard in Commercial Fishing: Using Surveillance Data to Identify Practical Solutions

Authors: [Samantha Case](#), [Jennifer Lincoln](#), [Devin Lucas](#)

Background: Commercial fishermen work on vessels with numerous hazards, including falling overboard. Although preventing deaths from falls overboard has frequently been identified as a priority area in fishing safety, drownings from these events remain the second leading cause of fatalities in the industry after vessel sinkings. This study used surveillance data on fatal falls overboard in the US to identify gaps in the use of primary, secondary, and tertiary prevention strategies.

Methods: For this study, a case was defined as an unintentional fatal fall overboard from a commercial fishing vessel in the US during 2000-2016. Cases were

identified from NIOSH's Commercial Fishing Incident Database, a national surveillance system containing detailed information on all work-related fatalities in the fishing industry. A descriptive analysis was used to explore characteristics of the falls overboard and rescue attempts, and identify areas for potential interventions.

Results: During 2000-2016, 755 work-related deaths occurred in the US commercial fishing industry, with 204 (27.0%) attributed to unintentionally falling overboard. Fishing fleets with the highest number of fall overboard fatalities were Gulf of Mexico shrimp (n=34), East Coast lobster (n=18), and Alaska salmon drift gillnet (n=16). None of the workers wore a personal flotation device (PFD) when they died. The leading causes of falls were losing balance (48; 23.5%), tripping or slipping (47, 23.0%), and becoming entangled in fishing gear (31; 15.2%). Nearly half (99; 48.5%) of falls occurred while victims were on deck alone. Many falls occurred while the victims were working with fishing gear, including setting gear (35; 17.2%) and hauling gear onboard (20; 9.8%). Falls also occurred while crewmembers were on deck while off duty (34; 16.7%). Thirty crewmembers (14.7%) who fell overboard were recovered from the water shortly after entering the water; however, resuscitation was unsuccessful.

Discussion: Falls overboard are a persistent yet preventable issue in the fishing industry. By better understanding the circumstances of the falls and the subsequent rescue attempts, targeted solutions can be identified and implemented to prevent future fatalities. Designing enclosed workspaces where appropriate and using engineering controls to reduce entanglement hazards could help prevent workers from falling from vessels. Enhanced use of PFDs and man-overboard alarms could improve chances of survival should a fall overboard occur. The ability of other crewmembers to perform CPR and properly treat cold-water immersion victims once recovered from the water may also save lives. Future research should include efforts to increase awareness and adoption of drowning prevention strategies, particularly in high-risk fisheries, as well as evaluating the efficacy of interventions.

H2.2

Title: Maritime Worker Safety Beyond the Horizon: Risks Associated with Vessel Casualties and Disasters

Authors: [Alice Shumate](#), Benjamin Sinclair, Jennifer Lincoln

Background: Maritime workers aboard vessels face a variety of occupational hazards. The isolated nature of their work environment creates additional risk when a vessel experiences a catastrophic incident such as a collision, fire, capsizing, or sinking. This study uses National Transportation Safety Board (NTSB) maritime investigations to understand the types of catastrophic vessel incidents that occur, the contributing factors that cause and exacerbate these incidents, and the implications for maritime worker safety.

Methods: Data were abstracted from all NTSB maritime investigations for incidents that occurred in the years 2005–2014. NTSB investigations are completed for major maritime incidents, including vessel casualties such as collisions, and vessel disasters such as fires, capsizings and sinkings. Abstracted data included information about the circumstances of the incident, vessel(s) involved, injuries and fatalities, and probable causal and contributing factors identified by NTSB investigators. Descriptive statistics for causal factors and injury outcomes were calculated at both an incident and vessel level.

Results: The NTSB completed 101 maritime investigations during the study period. One investigation involving a private vessel and no worker exposures was excluded from our analyses, resulting in a dataset of 100 incidents involving 153 vessels. Of the 153 vessels, tug and tow vessels were the most common (n=36 [24%]), followed by cargo vessels (27 [18%]), fishing vessels (24 [16%]), passenger vessels (23 [15%]), barges (18 [12%]), and other specialized vessels (25 [16%]) such as military, law enforcement, and oil and gas support vessels. Of the 100 incidents, 70 (70%) involved a single vessel, 16 (16%) involved 2 vessels, and 14 (14%) involved 3 or more vessels. Vessel outcomes varied, with 41 incidents (41%) resulting in at least one vessel sinking, 4 (4%) resulting in a vessel grounding, 16 (16%) resulting in at least one vessel burned but afloat, 38 (38%) resulting in at least one vessel damaged but afloat, and one incident with no reported vessel damage. Fatalities and/or non-fatal injuries were reported in 40% of the incidents, with

69 fatalities and 600 non-fatal injuries reported in total. Nineteen incidents (19%) resulted in at least one fatality, with a median of two fatalities per incident (range 1–20). Thirty-four incidents (34%) resulted in at least one non-fatal injury, with a median of 3 non-fatal injuries per incident (range 1–298). In their probable cause analysis, the NTSB identified 71 incidents (71%) in which at least one human factor was a contributing cause. Contributing human factors included navigational error (21 [21%]); lack of company oversight (20 [20%]); communication issues (19 [19%]); failure to follow appropriate safety and/or emergency procedures (19 [19%]); and poor decision making (18 [18%]). Non-human contributing factors were identified in 47 incidents (47%), and included problems related to maintenance (22 [22%]), weather (19 [19%]), and vessel design or lack of stability (10 [10%]).

Discussion: Catastrophic vessel incidents are an important cause of fatal and non-fatal injuries in maritime workers aboard vessels. These incidents affect a wide variety of vessel types, and workers must be prepared to respond to fires, flooding, capsizing and sinking, sometimes entirely without off-vessel support. This analysis finds preventable human factors associated with the majority of these incidents, either contributing to the causation of the incident or exacerbating the risk of injury or fatality. Based on the findings of this study, it will be possible to begin developing and testing interventions to improve the safety of maritime workers.

H2.3

Title: Injury and Illness in Alaska's Onshore Seafood Processing Industry: An Analysis of Workers' Compensation Claims, 2014-2015

Authors: [Laura Syron](#), Laurel Kincl, Viktor Bovbjerg, Devin Lucas

Background: Seafood processing operations in Alaska are characterized by difficult working conditions, including strenuous and repetitive physical labor, long work hours for extended periods, and proximity to hazardous machinery and equipment. There is evidence from the Survey of Occupational Injuries and Illnesses that these workers are at high risk for nonfatal injuries and illnesses. Likewise, state regulators have designated Alaska's onshore seafood processing industry as highly-hazardous. The worker population is vulnerable, including low-wage earners and minority groups (e.g.,

non-resident, limited- or no-English language skills). Although the industry is vitally important to Alaska's economy, limited research has investigated occupational safety and health in onshore factories. This study's objectives were to use Alaska worker's compensation claims to estimate the risk of nonfatal injuries and illnesses, determine injury and illness patterns, and identify modifiable hazards.

Methods: Accepted workers' compensation claims data from 2014–2015 were manually reviewed and coded with: the Occupational Injury and Illness Classification System; the work activity that was associated with the injury or illness; geographic region; and the Standard Occupational Classification System. Workforce data were utilized to calculate claim rates per 1,000 workers.

Results: During the two-year study period, 2,889 claims were accepted for nonfatal injuries and illnesses in Alaska's onshore seafood processing industry. The average annual claim rate was 63 per 1,000 workers. This rate was significantly higher than the all-industry rate of 44 claims per 1,000 workers (rate ratio = 1.42, 95% CI = 1.37 – 1.48). In the onshore seafood processing industry, the most frequently occurring injuries and illnesses were: sprains, strains, and tears (993, 36%); bruises (490, 18%); and lacerations, punctures, and amputations (349, 13%). Most injuries and illnesses affected workers' shoulders, arms, and hands (1,212, 43%), as well as their backs, chests, and abdomens (578, 20%). The most common events and exposures that were associated with workers' injuries and illnesses included: being struck by objects and equipment (562, 21%); lifting, lowering, pushing and pulling objects and equipment (529, 19%); slips, trips, and falls (448, 16%); and exposure to harmful substances (201, 7%). Injuries and illnesses associated with line production activities (n=818) frequently involved: repetitive motion; overexertion while handling pans, fish, and buckets; and coming into contact with fish, pans, and processing machinery. Injuries and illnesses associated with material handling activities (n=495) frequently involved: overexertion while handling boxes, cartons, and bags; repetitive motion; and slips, trips, and falls.

Discussion: Preventing sprains, strains, and tears – especially to workers' shoulders, arms, and hands – is important for improving occupational safety and health in this industry. Hazard control measures should target: (a) repetitive motion, overexertion, and contact with equipment during line production; (b) overexertion due

to manual material handling; and (c) slips, trips, and falls. The seafood processing industry faces similar hazards and challenges as other high-risk food manufacturing industries, such as poultry and meat processing, and likewise merits attention, support, and resource investments. Industry members, occupational safety practitioners, and researchers could collaborate on designing, testing, and evaluating injury and illness prevention strategies in order to improve worker safety.

H2.4

Title: Occupational Safety in the Emerging Marine Aquaculture Sector: Assessing Current Knowledge and Regulations

Author: [Jillian Fry](#)

Background: Half of the world's edible seafood now comes from aquaculture, and the U.S. government and other stakeholders are working to expand the domestic marine aquaculture industry in near- and off-shore settings. Marine aquaculture is a diverse sector in terms of species, production methods, and distance from the coast. It combines elements of commercial fishing and agriculture, two of the most hazardous occupations in the U.S. Almost all marine aquaculture in the U.S. currently takes place in near-shore settings; siting production further offshore may involve additional hazards. The purpose of this study was to i) describe current knowledge of occupational risks in marine aquaculture and ii) identify and analyze state and federal laws relevant to marine aquaculture and occupational safety and health.

Methods: A literature review and policy analysis were performed to assess current knowledge of risks to marine aquaculture workers and existing oversight and potential regulatory gaps relevant to worker safety and health in marine aquaculture production settings. The literature review was expanded to include other high-income countries to learn from other countries where the marine aquaculture sector may be larger or have existed longer, while maximizing relevance to the U.S. The policy analysis focused only on the U.S.

Results: Marine aquaculture workers face a range of safety and health risks including drowning, electrical shock, slips, trips, falls, sprains and strains, machinery accidents, exposure to chemicals, fires, explosions, and exposure to infectious pathogens and therapeutants. The current U.S. marine aquaculture sector is largely

regulated at the state level. A potentially critical regulatory gap was identified regarding oversight of marine aquaculture workers in federal waters (i.e., offshore settings) due to current geographic and other limits impacting U.S. federal agencies with occupational safety and health mandates.

Discussion: Given the emerging nature of the marine aquaculture sector in the U.S., numerous occupational risks, and jurisdictional issues in federal waters, state and federal agencies should work collaboratively to ensure that comprehensive and functional regulatory structures and monitoring systems are established that will ensure worker safety in near- and offshore production settings.

Session H3

Title: Worker Safety in the Military

Moderator: Christina Socias-Morales

H3.1

Title: A Systematic Approach to Injury Prevention at Army Installations

Authors: [Michelle Canham-Chervak](#), [Anna Schuh-Renner](#), [Bruce Jones](#)

Background: Active duty Army personnel sustain over 1 million medical encounters affecting more than 275,000 Soldiers on an annual basis. Exposures, environments, and personnel vary across Army units, making it impossible to offer a “one size fits all” solution. To address this large and complex health issue, a systematic approach was needed.

Methods: In September 2015, the U.S. Army Medical Command published a policy to create Injury Prevention (IP) Teams at each Army installation, to support and enhance existing Community Health Promotion Councils (CHPCs). Teams included a variety of subject matter experts from medical and public health disciplines. Team members possess a breadth of skills in program development and analysis of population-based data that could be applied to the prevention of military and civilian occupational injuries. The public health approach was used to define IP Team objectives, beginning with the use of surveillance data to establish installation injury priorities. The first year consisted of a pilot phase with 7 Army installations. Lessons learned were captured, the policy modified, and a second year of execution was approved. Process metrics were captured in a survey of

Team leads at the start and end of the second year. For installations that participated for two years (i.e., pilot sites), linear trends in monthly injury rates before and after participation were analyzed using Minitab 17.1.0.

Results: During its second year of execution, 24 installations participated, 7 of which also participated during the first year as pilot sites. Installation IP Teams averaged 6 members (± 4) across multiple disciplines; 78% were led by preventive medicine or public health nursing personnel. On average, teams met 3 times (± 1.4) during the 6-month execution period. At the end of the second year, injury reduction was added to CHPC strategic plans at 8 installations (33%). IP teams presented to their CHPC, on average, 2.5 times (± 1.7) during the 6-month execution period, and 16 installations (67%) produced reports summarizing data, outlining existing injury reduction programs, and providing short and long-term installation-specific injury prevention recommendations for their respective CHPC. Among installations in their first year of execution, 75% reported capturing metrics for injury prevention programs at the end of the 6-month execution period, compared to 17% at the beginning. Five of seven sites (71%) in their second year of execution showed decreasing injury rates following participation, with reductions ranging from 7.3 to 40.4 injuries per 1,000 per month.

Discussion: This policy provided the necessary structure and steps toward effective installation injury prevention, resulting in documented progress in IP Team development, data-driven prevention planning and program evaluation, and promising injury trends. Year 3 execution will build on this foundation, involving additional installations, data, and partnerships.

H3.2

Title: Accuracy of Self-Reported Acute Traumatic and Cumulative Micro-Traumatic Injuries Compared to Medical Record Data

Authors: [Anna Schuh-Renner](#), [Michelle Canham-Chervak](#), [Tyson Grier](#), [Veronique Hauschild](#), [Bruce Jones](#)

Background: Self-reported injury data are frequently used in epidemiologic investigations. These data provide useful information about the activities and mechanisms of injuries because injury cause-coding is not required for outpatient medical visits. The purpose of this evaluation was to determine the accuracy of

self-reported military injuries when compared to injuries in outpatient medical records.

Methods: Injuries reported by survey were compared to diagnoses for injuries (International Classification of Diseases (ICD-9-CM 800-999)) and cumulative micro-traumatic injury-related musculoskeletal conditions (selected ICD-9-CM 710-739) obtained from medical records. Self-reported injury responses from military personnel are matched to diagnoses by date and body part.

Results: Infantry Soldiers (n=5,490) completed surveys that requested details about their most recent injury. About one-quarter (24%, n=1,336) reported injuries on the survey and had an injury diagnosis in their medical record in a six month period. Seventy-five percent of the self-reported injuries (n=996 of 1,336) were confirmed by medical records with a date match within 3 months and an identical or proximate body part. Common self-reported injuries were ankle sprains (10%), knee sprains (9%), lower back strains (4%), shoulder strains (3%), and lower back pain (3%). Nearly two-thirds (65%) of matched self-reported injuries had a medical diagnoses for a musculoskeletal condition (selected ICD-9-CM 710-739), not an acute injury.

Discussion: A high percentage of self-reported injuries match diagnoses in the medical records, substantiating the use of survey data for the evaluation of injury outcomes. Because a majority are musculoskeletal conditions, this also corroborates the need to include cumulative microtraumatic injuries in injury surveillance definitions. This is the first effort to validate self-reported injuries and musculoskeletal disorders with medical records in a large military population.

H3.3

Title: The Impact of the United States Air Force Fall Injury Prevention Program

Authors: [Christina Socias-Morales](#), [Bruce Burnham](#), [Joshua Franklin](#), [Jim Collins](#), [Cammie Chaumont Menéndez](#), [Terry Wassell](#), [David Stuever](#)

Background: Fall injuries are the second leading cause of traumatic injury and death for US workers. Since 2014, the Occupational Safety and Health Administration (OSHA) has coordinated the National Falls Prevention Campaign to bring awareness of fall injury prevention for construction and other industry

workers. The US Air Force (USAF) has participated in the Campaign as part of the annual Stand Down and has implemented a broad, comprehensive falls prevention program across all areas of the USAF. The purpose of this study is to document the impact of fall prevention efforts using mishap data from 2008-2018 to estimate the reduction in work-related falls across the USAF.

Methods: All military and work-related civilian injuries are reported on-line using the USAF Safety Automated System (AFSAS) by local safety offices. These electronic reports include a narrative description of the mishap, as well as demographic, work information, and other structured details allowing analysis by both local safety professionals and epidemiologists at the USAF Safety Center (AFSEC). The USAF has agreed to share data with NIOSH researchers for collaborative analysis. Falls were identified by the internal AFSEC mishap tiered coding scheme. Rates of fall injuries were calculated for the years 2008-2016 using aggregate military and civilian annual population numbers. We used Poisson Regression to calculate rate confidence intervals (CIs) and the Mann-Kendall nonparametric test for trend analysis of rates. In 2017-2018, NIOSH collaborated with the AFSEC to visit three Air Force bases to observe and document overall safety policies and procedures, maintenance activities, and onsite fall prevention solutions for several different aircraft with a variety of fall hazards.

Results: Fall-related mishaps are the third most common on-duty, non-combat injury. Fall-related mishaps decreased from 1,358 fall mishaps in 2008 to 776 fall mishaps in 2016. In the same years, the rate of fall mishaps decreased significantly ($p<0.05$) from 2.8 (95%CI: 2.6–2.9) per 1,000 USAF workers to 1.7 (95%CI: 1.6–1.9) per 1,000 USAF workers. Roughly, 65%-74% of falls were falls on the same level. All USAF bases have AFSEC-trained civilian and rotating officer and enlisted military safety personnel onsite. Extensive fall protection initiatives have been undertaken at all bases but vary based on the type of aircraft, age and construction of hangars, tasks performed and worker input on procedures. One major tool used at two bases is the Federal OSHA Voluntary Protection Program that involves safety beyond the safety office, which engages workers from all levels using job safety analyses, and emphasizes direct communication of safety issues to leadership. These two bases were primarily comprised of civilian workers who performed maintenance on large cargo aircraft. While fall prevention was a high priority, workers were

encouraged to address any safety issue, no matter how small. The third base was comprised of mostly military personnel performing a variety of tasks, including aircraft maintenance, telecommunication tower repair, logistics planning, refueling, tactical operations, and other activities. Several examples emerged as innovative solutions to reduce falls from heights.

Discussion: The number and rate of fall mishaps substantially decreased throughout the USAF from 2008-2016. Three bases were visited to document safety policies and procedures and to observe innovative solutions to reduce falls. Open communication and buy-in from all stakeholders is vital to improving safety. Documenting the processes and effectiveness of the USAF's falls prevention best practices will be helpful for translating these findings to improve fall prevention efforts in other sectors of the military and other high-risk industries in the private sector, such as construction.

H3.4

Title: Measuring Effectiveness Without Good Denominators

Authors: [Bruce Burnham](#), [David Stuever](#)

Background: Effectiveness of safety countermeasures is often measured using changes in injury rates. When a particular exposure is widespread or very common, the population total can be used. However, when exposure is uncommon or difficult to obtain, rates, particularly over time, may be less useful. Furthermore, injury surveillance is often criticized for underreporting and therefore not accurately determining the true burden of injury or the effectiveness of interventions. Finally, exposure rates may change over time. This study presents ranking of activities by raw injury numbers to estimate relative importance of injury types for prioritization, and estimating effectiveness, which are key to injury prevention efforts.

Methods: For this study, sports and recreation injuries were used for the following reasons: United States Air Force (USAF) personnel are young, active and have requirements to stay fit; injuries sustained still affect readiness regardless of duty status; the department of defense mandates reporting of off-duty injuries and it is inefficient to collect data and not act upon it. This study reviewed the top five injury-producing USAF sports and

recreation activities during the period 1998 to 2017. Activities were ranked by raw number of injuries reported each year over the 20-year period. Sliding injuries were analyzed separately from total softball injuries. Rates were determined using total USAF active-duty airmen.

Results: Softball-related injuries decreased significantly from approximately 100 to 40 per year during this period, while the annual rate decreased from 2.8 to 1.2 injuries per 10,000 active duty airmen. Sliding injuries decreased from 21 to 9 during this period, and the rate decreased from 5.7 to 2.6 per 10,000 airmen. Using raw number rankings, basketball and football were virtually unchanged during this period; running and weightlifting injuries significantly increased.

Discussion: This method of ranking produced visual trends which matched and confirmed our assumptions regarding cause and effect for all five activities. No prevention efforts were introduced for basketball and football, and injury patterns (and resulting injury rankings) for these activities were unchanged. Five countermeasures were instituted in January 2006 in an effort to reduce softball-related injuries, and injuries decreased thereafter. One of these countermeasures was related to sliding injuries, which also significantly decreased after implementation. The USAF fitness test switched from cycle ergometer to running in Jan 2004 and running injuries immediately increased. The increase in weightlifting injuries is in part explained by the growth of austere deployments and more free time for fitness. Numbers of participants for activities are unknown and may change over time, and therefore other methods of analysis are needed. In this application, ranking of relative injury numbers follows general trends found in rates, but is graphically smoother. Most importantly, it provides clear information regarding changing priorities for injury prevention.

Session H4

Title: Musculoskeletal Symptoms and Disorders

Moderator: Bradley Evanoff

H4.1

Title: Findings from the NIOSH Upper Extremity Musculoskeletal Disorder Consortium and Implications for the Revised TLF for Hand Activity

Authors: [Bradley Evanoff](#), [Fred Gerr](#), [Susan Burt](#), [Kurt Hegmann](#), [Barbara Silverstein](#), [Jay Kapellusch](#), [Arun Garg](#), [Ellen Eisen](#), [Stephen Bao](#), [Carisa Harris-Adamson](#), [Matthew These](#), [Alysha Meyers](#), [Ann Marie Dale](#), [David Rempel](#)

Background: Starting in the late 1990s, NIOSH recognized that a large-scale effort was needed to fund and conduct rigorous research to study upper limb musculoskeletal disorders (MSD). Starting in 2001, six U.S. research groups were supported by NIOSH to perform large, prospective epidemiologic studies examining associations between workplace physical risk factors and upper limb MSD. All research groups collected 1) detailed measured job physical risk factors (e.g. forceful hand exertions, repetitive hand motions, postures), 2) personal factors, 3) psychosocial factors, 4) clinical examinations, and 5) electrodiagnostic studies for carpal tunnel syndrome (CTS). Associations between physical risk factors and CTS are reported here.

Methods: The pooled Consortium cohort includes data from 4321 workers at 55 employers across a variety of hand-intensive industries, who were followed for up to six years between 2001 and 2010. Individual workplace exposure data included direct observation and video analysis. Health data included self-reported, clinical examination, and electrodiagnostic measures. The case definition of CTS required both characteristic symptoms and electrophysiological abnormalities. Associations between work exposures and CTS were estimated while controlling for personal factors (age, body mass index, gender, co-morbid diseases) and non-overlapping physical exposures (i.e., force, posture, repetition).

Results: We found no independent effects of wrist posture or total repetition rate on the incidence of CTS. In contrast, strong dose-dependent associations were found between incident CTS and peak hand force (Borg CR10 > 3), forceful repetition rate (> 3 exertions per

minute of > 9N pinch force or 45N power grip), and the proportion of time spent in forceful exertion (>11%). We also found that the ACGIH Threshold Limit Value for Hand Activity (TLV for HAL) was prospectively associated with CTS, and that modifying the TLV for HAL calculation to increase the contribution of force better predicted incident CTS. Importantly, exposures below the TLV for HAL "Action Limit" were associated with increased risk of CTS.

Discussion: Study findings suggest that efforts to reduce workplace exposures should focus on jobs requiring high hand force and repeated or prolonged forceful exertions. Our study found that the TLV for HAL and other pragmatic assessment methods are useful tools for those engaging in workplace prevention efforts. However, similar to another large prospective study of CTS, our results indicated that the current "action limit" was too high to adequately protect workers. Results from these studies have driven recent revisions to the ACGIH TLV for HAL, and to the Strain Index. The revised TLV and Action Limits emphasize forceful hand activity, markedly lowering the TLV and Action Limit. The revised Strain Index modified force, duration and frequency multipliers to reduce the penalty for exertions with high frequency but very low force.

H4.2

Title: Musculoskeletal Symptoms among Masonry Apprentices Indicate an Opportunity for Ergonomic Intervention

Authors: [Laurel Kincl](#), [Dan Anton](#), [Matthew Bray](#), [Jennifer Hess](#), [Douglas Weeks](#)

Background: Work-related musculoskeletal disorders (MSDs) are common in the construction industry, and brick/ block masons (masons) are among the most affected due to the demanding physical nature of their work. Through concerted efforts in construction health and safety, rates of MSDs among masons have dropped over the last 25 years. However, masonry crafts still rank first among construction trades for back injuries with time away from work, and second for overexertion injuries. Our research team, working with a Masonry Research to Practice (r2p) Partnership, developed an ergonomic training intervention, called SAFETY Voice for Ergonomics (SAVE). The SAVE Program integrates ergonomic training and safety problem-solving skills ("safety voice") into masonry apprenticeship training and is

currently being evaluated at masonry apprenticeship training centers across the US. Previous studies indicate that musculoskeletal symptoms among journey-level masons are most prevalent in the low back, shoulder, and wrists and hands. However, little is known about symptoms among masonry apprentices as they enter the trade. Since MSDs are cumulative in nature, it is paramount to reduce exposures and risk of injury among apprentices before symptoms are prevalent. The purpose of this study is to report the distribution of musculoskeletal symptoms among masonry apprentices.

Methods: Masonry apprentices participated in this study as part of a larger national randomized controlled trial evaluating the SAVE program. Part of the evaluation includes measuring musculoskeletal symptoms via self-report. Among other questionnaires, participants completed demographic inventories and the Modified Nordic questionnaire (MNQ) assessing musculoskeletal symptoms. The MNQ is a validated questionnaire that asked apprentices about current work-related musculoskeletal symptoms in specific body regions, whether they saw a physician for the symptoms, and if they missed work in the last week due to the symptoms.

Results: One hundred forty masonry apprentices with a mean (SD) age of 29 (7.2) participated in this study. The majority were in their first year of the apprenticeship program (45%), were male (97%), and Caucasian (57%). Some apprentices had OSHA 10 training (68%), previous ergonomics training (16%), and stretch and flex training (27%). The most common body regions with musculoskeletal symptoms were the low back (56%), wrist/hand (46%), knee (34%), upper back (33%), and shoulder (31%). The mean (SD) number of regions (out of 9 regions asked about) with work related symptoms across all apprentices was 2.7 (2.1) regions. Although many apprentices reported musculoskeletal symptoms, most did not miss work or consult a healthcare practitioner. Consistent with previous studies of journey-level masons, low back pain was most prevalent, yet only 4% of apprentices accessed healthcare in this study compared to 34% in previous research of journey-level masons.

Discussion: These findings suggest that the level of musculoskeletal symptoms early in their careers are minimal and that the frequency of symptoms and seeking healthcare increases with time in the masonry trade. Further analysis of musculoskeletal symptoms among apprentice masons will occur prospectively through the SAVE project. These apprentice symptom responses indicate that effective ergonomic interventions have the

potential to reduce musculoskeletal symptoms and are essential for reducing MSDs as they progress through their careers.

H4.3

Title: Comparison of Productivity, Vibration, Dust, and Noise Between Pneumatic Rock Drill and an Electric Rotary Drill

Authors: David Rempel, Eileen Betit, Andrea Antonucci, Alan Barr, Michael Cooper, Barnard Martin, Richard Neitzel

Background: Both pneumatic rock drills and new electric rotary hammer drills are used for drilling large holes (e.g., 10 to 20 mm diameter) into concrete for structural upgrades to buildings, highways, bridges, and airport tarmacs. However, little is known about the differences in productivity, and exposures to noise, handle vibration, and dust between the two types of drills. The aim of this study was to compare these outcomes with similar mass electric rotary and pneumatic rock drills drilling into concrete block on a test bench system.

Methods: Three experiments were conducted on a test bench system to compare an electric (8.3 kg) and pneumatic drill (8.6 kg) on (1) noise and handle vibration, (2) respirable silica dust, and (3) drilling productivity. The test bench system repeatedly drilled 13 mm diameter x 100 mm depth holes into cured concrete block while the respective exposure levels were measured following ISO standards.

Results: Productivity levels were similar between the electric and the pneumatic drill (9.09 mm/s vs. 8.69 mm/s ROP; $p=0.15$). However, peak noise (LPeak: 117.7 vs. 139.4 dBC; $p=0.001$), weighted total handle vibration (ahw: 7.15 vs. 39.14 m/s²; $p=0.002$), and respirable silica dust levels (0.55 vs. 22.23 mg/m³; $p=0.003$) were significantly lower for the electric than the pneumatic drill.

Discussion: While there were no differences in drilling productivity between an electric and pneumatic drill of similar mass, there were substantial differences in exposure levels of noise, handle vibration, and respirable silica dust. Structural contractors should consider switching from pneumatic rock drills to electric rotary hammer drills for structural drilling into concrete in order to reduce worker exposures to the hazards of noise, hand vibration, and silica dust.

H4.4

Title: Do Whole Body Vibration Exposure Thresholds Minimize for Acute Sensorimotor and Cognitive Effects?

Authors: [Marcus Yung](#), [Stephan Milosavljevic](#), [Catherine Trask](#)

Background: Agricultural, mining, construction, and transportation workers commonly experience whole body vibration (WBV), an accepted risk factor for many chronic health conditions including low back pain. Occupational WBV may also negatively affect human performance, leading to fatal and non-fatal occupational injuries and accidents, including equipment-related falls and vehicle collisions. Current international WBV exposure guidelines were designed to prevent long-term development of musculoskeletal disorders and discomfort; however, it is uncertain whether these standards protect workers from short-term effects. Evaluating current WBV standards for their suitability in minimizing the risk of acute accidents, errors, and injury will require understanding of the relationship between WBV and human performance.

Methods: Eighteen participants were recruited to undergo realistic agricultural-based all-terrain vehicle (ATV)-derived WBV, simulated with a 6-degree of freedom rotopod platform at three different vibration conditions. Conditions were randomized and were performed at least 24 hours apart. Two conditions were based on European Directive (2002) guideline thresholds for long-term health: "Exposure Action Value" (EAV) and the "Exposure Limit Value" (ELV). If vibration exposure exceeds the EAV, guidelines advise the employer to reduce the exposure to a minimum by introducing technical and organizational measures. If vibration exposure exceeds ELV, employers are advised to take immediate action to reduce WBV. During the third condition (Control), participants were seated on the stationary ATV simulator with no vibration. Before and

after each 60-minute condition, a cognitive, sensorimotor, and physical measurement battery was collected. This abstract will focus on a sub-set of measures: rating of headache/ discomfort using a visual analogue scale, postural sway in the anterior and posterior direction, and psychomotor vigilance task (PVT). Pre- and post-differences for each condition were analyzed using either a paired t-test (parametric) or Wilcoxon signed-rank test (non-parametric). To determine differences between conditions, normalized pre/post changes were subjected to a one-way repeated measures ANOVA and Tukey-Kramer post hoc test (parametric), or Friedman's test and Wilcoxon signed-rank post hoc test (non-parametric).

Results: We observed significantly higher ratings for headache or head discomfort after EAV-level vibration ($t=-2.44$, $p=0.03$) and ELV-level vibration ($t=-2.91$, $p=0.01$). PVT mean reaction time ($t=-3.27$, $p=0.005$) and median number of lapses ($S=-42.5$, $p=0.002$) were significantly greater after ELV-level vibration. Postural sway significantly increased after EAV-level vibration ($t=-2.88$, $p=0.01$) and ELV-level vibration ($t=-2.57$, $p=0.02$) conditions. Differences between conditions were limited to PVT median number of lapses, where pre/ post changes were significantly higher during the ELV-level vibration condition compared to Control ($F=2.58$ $p=0.05$, Control vs. ELV: $p=0.037$).

Discussion: Our simulated whole body vibration did not induce acute effects any more than quiet sitting without WBV; thus, WBV may not be fully responsible for the observed acute sensorimotor or cognitive effects. However, effects increased with vibration intensity, with sensorimotor effects observed even after lower intensity vibration (EAV). Therefore, current threshold guidelines might not fully protect workers from the risk of acute WBV effects leading to accidents, errors, or injury. Further research on the effects of exposure intensity and duration is required to support these findings.

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