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Hester J. Lipscomb, Ashley L. Schoenfisch, Kirill S. Shishlov. *Non-fatal contact injuries among workers in the construction industry treated in U.S. emergency departments, 1998-2005. Pages 191-195.*

Problem: The National Occupational Research Agenda (NORA) for the construction industry calls for efforts to identify areas where guidance and regulation are needed to adequately prevent traumatic injuries resulting from a worker coming into contact with objects or equipment. **Method:** This descriptive study of work-related contact injuries in the construction industry that were treated in emergency departments (EDs) between 1998 and 2005 utilized records of work injuries captured through a national probability-based sample of U.S. hospitals with 24-hour ED services. **Results:** Contact injuries accounted for 54% of all construction ED-treated injuries. Hospitalizations were most common for injuries from contact with discharged nails from pneumatic nail guns, with hand held power saws, and fixed saws. Some injuries were proportionally more serious and sometimes involved multiple workers including trenching injuries and those resulting from collapse of buildings under construction, walls, roofs, and scaffolding. **Discussion and impact:** Given that nail gun use is limited primarily to wood frame construction, efforts are needed to control frequent serious injuries associated with these tools. Enforcement of existing trenching regulations is also needed.

- **Keywords:** Construction workers; Work-related injury; Contact injuries; Struck by; NEISS-Work

Todd Schoonover, David Bonauto, Barbara Silverstein, Darrin Adams, Randy Clark. *Prioritizing prevention opportunities in the Washington State construction industry, 2003-2007. Pages 197-202.*

Objective: This study compares construction industry groups in Washington State by injury severity and cost, and ranks industry groups according to potential for prevention. **Methods:** All Washington State workers' compensation compensable claims with date of injury between 2003 and 2007 were classified into North American Industrial Classification System (NAICS) industry groups. Claims were then aggregated by injury type and industry groups were ranked according to a prevention index (PI). The PI is the average of the rank orders of the claim count and the claim incidence rate. A lower PI indicates a higher need for prevention activities. The severity rate was calculated as the number of days of time loss per 10,000 full-time equivalents (FTEs). **Results:** For all injury types, construction industry groups occupy 7 of the top 15 PI ranks in Washington State. The severity rate among construction industry groups was twice that for non-

construction groups for all injury types. Foundation, structure, and building exterior contractors (NAICS 2381) ranked highest in prevention potential and severity among construction industry groups for most common injury types including falls from elevation, fall on same level, struck by/against, and musculo-skeletal disorders of the neck, back, and upper extremity (WMSDs). Median claim costs by injury type were generally higher among construction industry groups. **Conclusions:** The construction industry in Washington State has a high severity rate and potential for prevention. The methods used for characterizing these industry groups can be adapted for comparison within and between other industries and states. **Impact on Industry:** These data can be used by industry groups and employers to identify higher cost and higher severity injury types. Knowledge about the relative frequencies and costs associated with different injury types will help employers and construction industry associations make better informed decisions about where prevention efforts are most needed and may have the greatest impact. The results of this study can also be used by industry stakeholders to cooperatively focus on high cost and high severity injuries and explore best practices, interventions, and solutions as demonstrated by efforts to prevent musculoskeletal disorders in masonry (Entzel, Albers, & Welch, 2007). Initiating construction industry groups to focus on high cost and high severity injuries may also help prevent other types of injuries.

- **Keywords:** Construction industry; Workers' compensation; Injury prevention; Claims cost; Severity

Thomas G. Bobick, E.A. McKenzie Jr., Tsui-Ying Kau. *Evaluation of guardrail systems for preventing falls through roof and floor holes.* Pages 203-211.

Introduction: Fall-related occupational injuries and fatalities are serious problems in the U.S. construction industry, especially incidents related to unguarded holes. The National Institute for Occupational Safety and Health, Division of Safety Research, Morgantown, WV conducted a project to evaluate the effectiveness of guardrail systems to prevent falls through roof and floor holes. **Methods:** Two commercial edge-protection products were evaluated when used as perimeter guarding around a roof hole. Installations of the commercial products were compared to job-built guardrails constructed of 2" x 4" construction-grade lumber. Occupational Safety and Health Administration (OSHA) regulations require that "a force of at least 200 pounds" must be supported by the top rail of a guardrail system "in any outward or downward direction at any point along the top edge." A laboratory testing system was developed to evaluate this requirement. A dynamic 200-lb force was generated against the top rail using a weighted manikin mounted on a hinged steel frame. Nine construction workers, who served as test subjects, each built five different guardrail configurations. **Results:** All 45 configurations met the 200-lb OSHA requirement. Installation time for one commercial product was 32% quicker than the job-built configuration (25.6 min vs. 37.9 min). **Impact on Industry:** This study: (a) indicates that the two edge-protection products can be used as perimeter guarding; (b) highlights the importance of using proper materials and fasteners to construct guardrails to protect workers from falling into unguarded roof and floor holes; and (c) discusses an overall-strength-testing methodology that can be used by fall-protection researchers.

- **Keywords:** Fall to lower level; Guardrail; Roofing; Residential construction; Force measurement

James R. Harris, John R. Powers Jr., Christopher S. Pan, Brad Boehler. *Fall arrest characteristics of a scissor lift.* Pages 213-220.

Problem: Census of Fatal Occupational Injuries (CFOI) data indicate 306 aerial lift fatalities between 1992-2003. Seventy-eight of these fatalities specifically involved

scissor lifts. Members of standards committees have requested that NIOSH conduct research to determine the effects of safety-control practices related to using fall-protection systems for scissor lifts. **Method:** This research examined the structural and dynamic stability of a scissor lift subjected to fall arrest forces. This was accomplished by conducting drop tests from a scissor lift. Anchorage locations evaluated included manufacturer-supplied anchorage points on the scissor lift platform as well as mid-rail and top-rail locations. **Results:** Preliminary drop tests determined that a 2400 lb maximum arrest force (MAF) could be generated by dropping 169 lb through a fall height of 36" using Nystron® rope as a lanyard. The scissor lift maintained structural and dynamic stability for all drop tests when fully extended and on an incline. **Discussion:** Anchoring a fall arrest system to either the mid-rail or top-rail is *not* a recommended practice by the scissor lift manufacturer. Anchor points are provided on the platform floor of the scissor lift for this purpose. However, our results demonstrate that the mid-rail and top-rail absorb substantial energy from an arrested fall and may have potential as appropriate anchorage points. **Impact to Industry:** Employers and workers should consider implementing fall arrest systems when using scissor lifts as part of their overall risk mitigation plan for fall injury prevention.

- **Keywords:** Scissor lift; Aerial lift; Fall arrest

Vicki Kaskutas, Ann Marie Dale, Hester Lipscomb, John Gaal, Mark Fuchs, Bradley Evanoff and the Carpenters' Joint Apprenticeship Program Instructor Team. *Changes in fall prevention training for apprentice carpenters based on a comprehensive needs assessment. Pages 221-227.*

Problem: Falls from heights in residential construction are common, especially among inexperienced workers. **Methods:** We conducted a comprehensive needs assessment to determine gaps in the school-based apprentice carpenters' fall prevention training. A team of carpenter instructors and researchers revised the fall prevention training to fill these gaps. Apprentice evaluation and feedback guided ongoing curricular improvements. **Results:** Most apprentice carpenters performed work tasks at heights prior to training and fall protection techniques were not commonly used at residential construction sites. Priorities of the revised school-based training included safe ladder habits, truss setting, scaffold use, guarding floor openings, and using personal fall arrest systems. New apprentices were targeted to ensure training prior to exposure at the workplace. We used adult learning principles to emphasize hands-on experiences. A framed portion of a residential construction site was fabricated to practice fall protection behaviors in a realistic setting. The revised curriculum has been delivered consistently and apprentice feedback has been very favorable. **Conclusions:** Integration of needs assessment results was invaluable in revising the school-based carpenters apprentice fall prevention curriculum. Working closely with the instructors to tailor learning experiences has provided preliminary positive results. **Impact on Industry:** The fall safety of the residential construction industry continues to lag behind commercial construction and industrial settings. The National Occupational Research Agenda includes a Strategic Goal to strengthen and extend the reach of quality training and education in the construction industry via mechanisms such as construction safety and health training needs assessments. This study demonstrates how a structured process can be used to identify and remedy gaps and improve training effectiveness. We encourage others to take steps to assess and increase the impact of training efforts directed at all residential construction professionals; including both union and non-union workers. The implications are even greater in the non-union sector where most U.S. residential work is done.

- **Keywords:** safety and health; construction safety; injury prevention; training; apprenticeship; Construction

Shengke Zeng, John R. Powers, Bradley H. Newbraugh. *Effectiveness of a worker-worn electric-field sensor to detect power-line proximity and electrical-contact.* Pages 229-239.

Problem: Construction workers suffer the most electrocutions among all industries. Currently, there are no electrical contact warning devices on the market to protect workers. This paper proposes a worker-worn electric-field sensor. As the worker is in proximity to, or in contact with, a live power-circuit, the sensor sets off an audible/visual warning alarm. The sensor also has the potential to wirelessly trip a wireless-capable circuit breaker, and to trigger a wireless transmitter to notify emergency response of an electrical contact. **Methods:** An experiment was conducted to measure electric-field variation on simulated human-wrists (10 defrosted hog-legs) in various proximities and in electrical-contact to a simulated power-circuit. The purpose of these tests was to determine the feasibility of developing a worker-worn electric-field detection sensor for use in protecting workers from contact with energized electrical conductors. **Results:** This study observed a significant electric-field-magnitude increase as a hog-leg approaches the live-circuit, and the distinct electric-field-magnitude jump as the leg contacts with the live-circuit. The observation indicates that this sensor can be an effective device to warn the workers of electrical hazards. Additionally, the sensor has the potential to wirelessly trip a wireless-capable circuit-breaker and trigger a wireless transmitter (such as a cell phone) to notify an emergency response. The prompt notification prevents the worker from further injury caused by postponed medical-care. **Impact on Industry:** Widespread use of this sensor could lower electrocution and electrically related injury rates in the construction industry.

- **Keywords:** Electric Field; Sensor; Proximity; Powerline; Electrical-contact

Hester J. Lipscomb, James Nolan, Dennis Patterson, John M. Dement. *Continued progress in the prevention of nail gun injuries among apprentice carpenters: What will it take to see wider spread injury reductions?* Pages 241-245.

Problem: Nail guns are a common source of acute, and potentially serious, injury in residential construction. **Method:** Data on nail gun injuries, hours worked and hours of tool use were collected in 2008 from union apprentice carpenters (n = 464) through classroom surveys; this completed four years of serial cross-sectional data collection from apprentices. A predictive model of injury risk was constructed using Poisson regression. **Results:** Injury rates declined 55% from baseline measures in 2005 with early training and increased use of tools with sequential actuation. Injury rates declined among users of tools with both actuation systems, but the rates of injury were consistently twice as high among those using tools with contact trip triggers. **Discussion and impact:** Nail gun injuries can be reduced markedly through early training and use of tools with sequential actuation. These successful efforts need to be diffused broadly, including to the non-union sector.

- **Keywords:** Nail Gun; Injury; Work-Related; Residential Construction; Injury Prevention; Injury Intervention

David Rempel, Demetra Star, Alan Barr, Ira Janowitz. *Overhead dribbling : comparing three bases for aligning a drilling jig to vertical.* Pages 247-251.

Problem: Drilling overhead into concrete or metal ceilings is a strenuous task done by construction workers to hang ductwork, piping, and electrical equipment. The task is associated with upper body pain and musculoskeletal disorders. Previously, we described a field usability evaluation of a foot lever and inverted drill press intervention devices

that were compared to the usual method for overhead drilling. Both interventions were rated as inferior to the usual method based on poor setup time and mobility. **Method:** Three new interventions, which differed on the design used for aligning the drilling column to vertical, were compared to the usual method for overhead drilling by commercial construction workers (n = 16). **Results:** The usual method was associated with the highest levels of regional body fatigue and the poorest usability ratings when compared to the three interventions. **Conclusion:** Overall, the 'Collar Base' intervention design received the best usability ratings. **Impact on Industry:** Intervention designs developed for overhead drilling may reduce shoulder fatigue and prevent subsequent musculoskeletal disorders. These designs may also be useful for other overhead work such as lifting and supporting materials (e.g., piping, ducts) that are installed near the ceiling. Workplace health and safety interventions may require multiple rounds of field-testing prior to achieving acceptable usability ratings by the end users.

- **Keywords:** Construction; Overhead; Drilling; Shoulder; Ergonomics; Musculoskeletal

Quintin Williams Jr., Michele Ochsner, Elizabeth Marshall, Louis Kimmel, Carmen Martino. *The impact of a peer-led participatory health and safety training program for Latino day laborers in construction.* Pages 253-261.

Background: Immigrant Latino day laborers working in residential construction are at particularly high risk of fatal and non-fatal traumatic injury and benefit from targeted training. **Objective:** To understand the impact of a participatory, peer-facilitated health and safety awareness training customized to the needs of Latino day laborers. **Methods:** Baseline surveys exploring exposures, PPE use, attitudes, work practices and work-related injuries were collected from more than 300 New Jersey Latino day laborers in construction prior to their participation in a one day (minimum of six hour) Spanish language health and safety training class. The classes, led by trained worker trainers, engaged participants in a series of tasks requiring teamwork and active problem solving focused on applying safe practices to situations they encounter at their worksites. Follow-up surveys were difficult to obtain among mobile day laborers, and were collected from 70 men (22% response rate) 2-6 months following training. Chi-square analysis was used to compare pre- and post-intervention PPE use, self protective actions, and self-reported injury rates. Focus groups and in-depth interviews addressing similar issues provided a context for discussing the survey findings. **Results:** At baseline, the majority of day laborers who participated in this study reported great concern about the hazards of their work and were receptive to learning about health and safety despite limited influence over employers. Changes from baseline to follow-up revealed statistically significant differences in the use of certain types of PPE (hard hats, work boots with steel toes, safety harnesses, and visible safety vests), and in the frequency of self-protective work practices (e.g., trying to find out more about job hazards on your own). There was also a suggestive decrease in self-reported injuries (receiving an injury at work serious enough that you had to stop working for the rest of the day) post-training based on small numbers. Sixty-six percent of workers surveyed post-training reported sharing information from their safety workbook with friends and co-workers. Focus groups and interview results generally confirmed the quantitative findings. **Conclusions:** Participatory, peer led training tailored to the needs of construction day laborers may have a positive effect on Latino immigrant workers' attitudes, work practices, and self reported injury rates, but major changes would require employer engagement. **Impact on Industry:** Health and safety researchers have identified reducing the number of traumatic injuries among the immigrant construction workforce as an increasingly important priority. This project provides one model for collaboration between university-based researchers, a union, and a community-based organization. The specific elements of this project—participatory curriculum customized to the needs of day laborers in residential construction, training day laborers to facilitate training classes, and involving peer leaders in outreach and research—could be adapted by other organizations. The

findings of this study suggest that the Latino day laborers have a strong interest in and some ability to act on health and safety information. Widespread implementation of this type of training, especially if supported with cooperation from residential contractors, could lead to reduced rates of traumatic injury in the residential construction industry.

- **Keywords:** Latino day laborer; Immigrant laborer; Hispanic construction worker; Construction injury

Janie L. Gittleman, Paige C. Gardner, Elizabeth Haile, Julie M. Sampson, Konstantin P. Cigularov, Erica D. Ermann, Pete Stafford, Peter Y. Chen. *CityCenter and Cosmopolitan Construction Projects, Las Vegas, Nevada: Lessons learned from the use of multiple sources and mixed methods in a safety needs assessment : case study. Pages 263-281.*

Problem: The present study describes a response to eight tragic deaths over an eighteen month times span on a fast track construction project on the largest commercial development project in U.S. history. **Methods:** Four versions of a survey were distributed to workers, foremen, superintendents, and senior management. In addition to standard Likert-scale safety climate scale items, an open-ended item was included at the end of the survey. **Results:** Safety climate perceptions differed by job level. Specifically, management perceived a more positive safety climate as compared to workers. Content analysis of the open-ended item was used to identify important safety and health concerns which might have been overlooked with the qualitative portion of the survey. **Discussion:** The surveys were conducted to understand workforce issues of concern with the aim of improving site safety conditions. Such efforts can require minimal investment of resources and time and result in critical feedback for developing interventions affecting organizational structure, management processes, and communication. **Summary:** The most important lesson learned was that gauging differences in perception about site safety can provide critical feedback at all levels of a construction organization. **Impact on the Industry:** Implementation of multi-level organizational perception surveys can identify major safety issues of concern. Feedback, if acted upon, can potentially result in fewer injuries and fatal events.

- **Keywords:** Construction; Safety; Occupational; Survey; Needs Assessment

Matt Gillen. *The NIOSH Construction Program : research to practice, impact, and developing a National Construction Agenda. Pages 289-299.*

The U.S. National Institute for Occupational Safety and Health (NIOSH) conducts research to improve and protect the health and safety of workers. This paper describes the experience of the NIOSH Construction Program with two recent program planning initiatives intended to improve the program: (a) an independent external review of work over the past decade and (b) the development of strategic goals organized into a "National Construction Agenda" to guide a decade of future work. These goals, developed with input from construction industry stakeholders and researchers, are a part of the NIOSH National Occupational Research Agenda (NORA) initiative. The NORA goals are intended to provide an ambitious set of goals for all construction stakeholders to work together on. Both efforts relate to insuring the relevance and impact of research, reflecting an emerging policy perspective that research programs should be judged not just by the quality and quantity of science produced, but by the industry impact and tangible benefit resulting from the research. This paper describes how views on research planning have evolved to incorporate lessons learned about how research leads to improved safety and health for workers. It also describes the process used to develop the goals and the resulting strategic and intermediate goals that comprise the National Construction Agenda.

- **Keywords:** Construction; Research to Practice (r2p); National Construction Agenda; Strategic planning; Research Impact

Matt Gillen, Janie L. Gittleman. *Path forward : emerging issues and challenges*. Pages 301-306.

The NIOSH Construction Program worked with industry stakeholders to develop a National Occupational Safety and Health Construction Agenda to target future research and activities. The Program and its partners are also cognizant that new developments can emerge over time and that research can play an important role in helping to understand and address these emerging issues. Examples of emerging issues relevant to construction safety and health are described. These include: (a) climate change and energy considerations; (b) green construction developments and opportunities; (c) new materials; (d) changes in industry structure and practice; (e) workforce developments and disparities; (f) injury underreporting and cost and risk shifting; and (g) increased interest in addressing root causes. Responding to emerging issues while maintaining a focus on fundamental longstanding issues represents an ongoing challenge for researchers and industry organizations. Additional research to understand the diffusion and adoption of research by the industry is also needed. Research accomplished to date provides a strong foundation for addressing future industry needs and trends.

- **Keywords:** Emerging Issues; Construction Industry changes; Research challenges; NORA National Construction Agenda; Green construction