Final Progress Report for:

The Washington State Occupational Safety and Health Surveillance Program

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List of Terms and Abbreviations

ANSI	American National Standards Institute
AOEC	Association of Occupational and Environmental Clinics
BLS	Bureau of Labor Statistics
BRFSS	Behavioral Risk Factor Surveillance System
CFOI	Census of Fatal Occupational Injury
CHARS	Comprehensive Hospital Abstract Reporting System
CIR	Claims Incidence Rate
COSS	Consortium of Occupational State-based Surveillance
CORE	Core Occupational Health Surveillance
CSTE	Council of State and Territorial Epidemiologists
CTS	Carpal Tunnel Syndrome
DOSH	Division of Occupational Health and Safety
FACE	Fatality Assessment and Control Evaluation Program
FTE	Full-time Equivalent
ICD	International Classification of Disease
IR	Incidence Rate
KOS	Kept On Salary
L&I	Washington State Department of Labor & Industries
LBD	Low Back Disorder
LINIIS	Labor and Industries' Industrial Insurance System
LNR	Labor Neighbor Radio
MSD	Musculoskeletal Disorder
NAICS	North American Industrial Classification System
NIOSH	National Institute for Occupational Safety and Health
OH	Occupational Health
OSHA	Occupational Safety and Health Administration
PI	Prevention Index
PNASH	Pacific Northwest Agriculture Safety and Health Center
PPE	Personal Protective Equipment
ROPS	Roll-over Protective Structures
SENSOR	Sentinel Event Notification System for Occupation Risk
SHARP	Safety and Health Assessment and Research for Prevention
SOC	Standard Occupational Classification system
SOII	Survey of Occupational Injury and Illness
TBSA	Total Body Surface Area Burned
TIRES	Trucking Injury Reduction Emphasis through Surveillance
WA	Washington State
WIC	Washington Industrial Classification System
WC	Washington State Workers' Compensation
WMSD	Work-related Musculoskeletal Disorders
WRRA	Washington Refuse and Recycling Association
WTA	Washington Trucking Associations

Abstract:

Every working day more than three million Washington State citizens work for one of Washington's 160,000 employers. On average, one Washington worker will die every five days from an occupational injury. Every hour, 100 Washington workers suffer an occupational injury or illness. Workplace illnesses and injuries have very significant direct and indirect costs, to workers, employers, and society at large. In 2008, Washington State paid more than 2.1 billion US dollars in workers' compensation benefits.

This five-year NIOSH Cooperative agreement, from July 1, 2005 – June 30, 2010, provided Washington State with the core capacity to track work injuries and illnesses through four main component programs. The systematic, ongoing, collection, and analysis of work injury and illness data allows Washington State citizens, business, and labor groups, and other policy makers to describe the burden of work injuries and illness, perform information based decision making, and assess improvement in the occupational health and safety of the Washington State workforce.

1) The Fundamental program, whose core function is to provide reliable occupational injury and illness data to Washington State citizens, workers, employers and other policymakers through the analysis of public health data sources, had several significant findings:

    - Work-related musculoskeletal disorders (WMSDs) account for 40% of all Washington State workers compensation claims resulting in 3 or more lost workdays and account for 44% of all workers compensation costs.

    - Workers with a hospitalized electrical burn are significantly more likely to have psychiatric sequelae, like post-traumatic stress disorder, than those with non-electrical hospitalized burns.

    - Nearly 40% of all medically treated work injuries reported by workers had a payment source other than workers' compensation, suggesting an underestimation of the burden of occupational injury through use of workers compensation data.

    - Standard methods to identify work-related amputations within administrative databases likely leads to a significant underestimation of the total number of injuries that result in the loss of a body part.

2) The Washington State Fatality Assessment and Control Evaluation (WA FACE) tracks work injury fatalities. Detailed surveillance data are collected on all work-related fatalities in Washington State and used to focus prevention efforts towards high risk work activities and high risk industries.

    - WA FACE documented a decrease in the number of work injury fatalities from 81 to a Washington State low of 64 for calendar years 2005 to 2009, respectively.

    - WA FACE data shows that the top three industry sectors with the highest numbers of work injury fatalities in Washington State are: agriculture, forestry, fishing, and hunting; construction; and transportation and warehousing.

    - WA FACE produced over 80 prevention publications which were directly distributed to over 40,000 individuals, are downloaded from a dedicated WA FACE website, and serve as the foundation for WA FACE personnel onsite trainings. Evaluations of FACE prevention outreach suggest those trained by FACE are likely to initiate change for a safer workplace.

3) The Trucking Injury Reduction Emphasis through Surveillance (TIRES) program focuses on reducing work-related injuries in the Washington State trucking industry, which has some of the highest costs and rates for work-related injuries.

   - Developed and implemented surveillance system with case follow-up interviews of injured workers in the trucking industry. Case follow-up interviews with injured workers led to the identification of four job tasks associated with most work injuries. They are: a) loading/unloading (and other manual handling), b) exit/entry from the cab or trailer, c) securing a load, and d) walking around the job site.

   - The majority of injuries in trucking occur at the customer site. This is another significant finding from the case follow-up interviews. This creates a challenge for outreach training as the employer doesn't have the ability to monitor work processes. The employer may be the cause of the lack of proper equipment or maintenance or may just lack the ability to exert safety controls over their independent workforce.

   - Formed the TIRES steering committee comprised of industry stakeholders including business, labor, insurance, truck driver training schools and independent owner/operators. Suggestions like the collaborative web site and on-line training tools came directly from the steering committee.

   - Developed a collaborative web site, www.KeepTruckingSafe.org, which is the first consolidated internet safety resource for the US and Washington State trucking industry. TIRES developed over 40 prevention materials through the website and over 85% of site users add the TIRES website to their favorites list.

4) Identifying preventable causes of pesticide-related illness among Agricultural workers.

   - The Pesticide program successfully developed new interview questions to identify risk factors for occupational pesticide-related illness and injury from pesticide drift and personal protective equipment failure.

   - The analysis of contributing factors over a six year period, (2003-2008) found that fifty-three percent (87/167) of pesticide handlers were missing at least one piece of required PPE or had an identified problem with their PPE at the time of their pesticide exposure.

   - Close proximity of workers to power sprayers was more commonly reported as a root cause in pesticide drift than were high winds or other adverse weather conditions. A key factor was lack of communication between spray crews and field crews on the same or on neighboring farms.

The findings from these four component programs can all be used in the workplace to help focus prevention efforts on high-risk injuries and industry sectors. Data dissemination efforts of the Washington State surveillance program have led to safer and healthier workplaces. The Washington State Occupational Surveillance program has become a resource for all of Washington workers and employers by maintaining a responsive expert staff, technical expertise in working with public health data sources, and an extensive web catalog of materials. In return, WA benefits from extensive support from the health and safety, employer, and worker communities.

Final Progress Report for:

The Washington State Occupational Safety and Health Surveillance Program - The Fundamental Program

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A component of the
'Washington Occupational Safety and Health Surveillance Program"
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Abstract:
Every working day more than three million Washington State citizens work for one of Washington's 160,000 employers. On average, one Washington worker will die every five days from an occupational injury. Every hour, 100 Washington workers suffer an occupational injury or illness. Workplace illnesses and injuries have very significant direct and indirect costs, to workers, employers, and society at large. In 2008, Washington State paid more than 2.1 billion US dollars in workers' compensation benefits. This five-year NIOSH Cooperative agreement, from July 1, 2005 – June 30, 2010, provided Washington State with the core capacity to track work injuries and illnesses. The systematic, ongoing collection and analysis of work injury and illness data allows Washington State citizens, business and labor groups, and other policy makers to describe the burden of work injuries and illness, perform information based decision making, and assess improvement in the occupational health and safety of the Washington State workforce.

During this five-year cooperative agreement, Washington State used Occupational Health indicators (OHI) to describe the burden of key occupational injuries and illnesses in Washington State. These measures were developed by the Council of State and Territorial Epidemiology (CSTE) Occupational Health (OH) workgroup, which includes Washington State representatives, and consist of 19 occupational health indicators. OHI trends from 1997 – 2007 suggest that Washington is experiencing a declining rate of non-fatal work injuries, declining work-injury fatality rates, decreases in occupational lead exposure, and declining rates of workers' compensation carpal tunnel syndrome claims but there was little change in the rate of work-related injury hospitalizations. Washington expanded its reporting of the OHI to include several additional state specific OHI for high cost, common injury types resulting in workers' compensation claims including: Falls from elevation, falls on the same level, 'caught in, under or between', 'struck by or against' injuries, and vehicle cr-ashes.

Believing that the indicators should evolve and expand to sustain stakeholder interest, Washington State proposed and subsequently developed the first new indicator for use by US states – the 'Hospitalization for Work-related Low Back Disorders.' Low back disorders account for one-third of work-related hospitalizations, are commonly identified by the public as representative of work injuries, and are costly. To facilitate the collection of the data, a 'how to guide' was developed which included model computer programs to standardized data collection across all states By consensus of the OH workgroup, all states will be collecting this indicator beginning in 2010.

Surveillance can inform potential policy decisions at the state and federal level. An expanded analysis of the two OHI for amputations indicates that the number of amputations is likely underestimated. Using medical record reviews and estimation methods, analysis of Washington workers' compensation data suggests that nearly 60% of amputation injuries are not identified as such in data reports. The amputations missed by tradition methods were both more severe and more costly. These observations should be considered for allocation of state OSHA prevention activities towards amputations injuries. Washington State also participates in the Consortium of Occupational State-based Surveillance (COSS) group. In this capacity, Washington State led efforts of a 10 state subgroup of the COSS to develop state-level occupational injury rate estimates through direct interviews with workers participating in CDC's Behavioral Risk Factor Surveillance System (BRFSS) survey. Additional questions were added to estimate the proportion of medically treated work-related injuries not paid for by workers compensation insurance suggesting that an alternative payment system was used. These results were subsequently published in CDC's Morbidity and Mortality Weekly Report.

As part of the fundamental program, Washington State maintained previously established occupational health surveillance systems for work-related musculoskeletal disorders, asthma and hospitalized burns. As the sole state conducting work-related MSD surveillance during this period, we provided data to identify high risk industries for WMSDs to state policymakers and private employers for prevention

efforts. This surveillance system is used to evaluate the implementation of Safe Patient Handling legislation in Washington State acute care hospitals. In response to public concerns, the state and federal resources dedicated to the work-related asthma program were used to identify workplaces using diacetyl, the butter flavoring associated with bronchiolitis obliterans. In addition to informing health care providers and high risk employers of this occupational hazard, we also responded to media reports regarding risks posed by inclusion of butter flavoring in cooking oils. Timely and immediate response led to production of a fact sheet which was distributed to cooks and restaurant owners. Additional efforts to identify cases of butter-flavoring induced lung disease did not yield cases in Washington State. These efforts led to praise for our occupational health program in the press. Finally, our hospitalized burns surveillance program targeted prevention messages to high risk industries based on our surveillance data – specifically to tar burns in roofers, scald burns in restaurants and concrete burns in construction. From an analysis of our surveillance data coupled with our workers' compensation data, we identified that workers with electrical burns were more at risk for psychiatric sequelae following a burn than those having a different type of burn.

Section 1.

Highlights and Significant Findings: The core function of this program is to provide reliable occupational injury and illness data to Washington State citizens, workers, employers and other policymakers. Multiple components of the Washington State Occupational Surveillance program accomplish this task and this information is presented in the scientific report attached. There are four significant findings from our surveillance data are notable for the current grant period.

1. Work-related musculoskeletal disorders (WMSDs) account for 40% of all Washington State workers compensation claims resulting in 3 or more lost workdays and account for 44% of all workers compensation costs.

2. Nearly 40% of all medically treated work injuries reported by workers had a payment source other than workers' compensation.

3. Workers with a hospitalized electrical burn are significantly more likely to have psychiatric sequelae, like post-traumatic stress disorder than those with non-electrical hospitalized burns.

4. Standard methods to identify work-related amputations within administrative databases likely leads to a significant underestimation of the total number of injuries that result in the loss of a body part.

Translation of Findings:

Work-related Musculoskeletal Disorders: The overwhelming burden of musculoskeletal disorders on workers' compensation insurers, employers, and workers cannot be overlooked. Washington State has a long established occupational injury and illness surveillance system for WMSDs of the neck, back and upper extremity. From the late 1990's until 2010, Washington State was the only state conducting surveillance on these conditions. State-based surveillance programs seeking to reduce disability and improve the health status of the workforce should consider developing WMSD surveillance programs. Efforts by Washington State to assist other states in developing some capacity for WMSD surveillance include creation of an Occupational Health indicator for work-related low back disorder hospitalizations.

Payment by Workers Compensation for Occupational Injury: Workers' compensation is a social insurance program to treat and provide wage replacement to injured workers. Exemptions to coverage and eligibility restrictions for workers compensation coverage significantly shift the burden of payment for occupational injury care to alternative health insurance systems, or directly onto workers or employers. The 40% of work injuries where treatment was not paid for by workers compensation suggest that workers' compensation data significantly underestimates the burden of occupational injury.

Psychiatric Sequelae following Burn Injuries Resulting in Hospitalization: Psychiatric sequelae following a burn injury are well recognized in the clinical community. Our surveillance and research suggests that hospitalized occupational burns with psychiatric sequelae have significantly higher medical costs and more days of time loss from work than those without these diagnoses. Identifying that workers with hospitalized electrical burns have significantly higher risk for these complications has not been previously recognized and identifies a high risk population for increased secondary and tertiary prevention efforts.

Can We Count Amputations? Amputations are a sentinel injury and often indicate lack of effective hazard controls in the workplace. Measures of trend and allocation of prevention resources depend on accurate surveillance data. In this expanded analysis of an occupational health indicator, we discovered

that reliance on a standard case classification system to identify amputations led to a significant undercount of amputation injuries, and missed proportionately more severe amputation injuries and those occurring to the lower extremity. Information such as this can enhance the focus of state OSHA compliance investigations to high hazard workplaces.

Outcomes, Relevance, and Impact:

Work-related Musculoskeletal Disorders: The WMSD surveillance program provides useful data to promote legislative action in Washington State. In 2006, Washington State WMSD surveillance data was used to promote and develop Safe Patient Handling legislation. Subsequently, the WMSD surveillance system is being used to evaluate the effectiveness of this legislation by tracking injuries to nursing aides, attendants and orderlies and other acute care hospital workers. Early results of this evaluation have been presented to the US Congress in congressional hearings over proposed federal safe patient handling legislations

The creation of occupational health measures for hospitalized 'Low-back Disorders' by Washington State will be implemented by states participating in the Occupational Health Indicators project with NIOSH in 2010. This new indicator gives each state an additional tool to measure the burden of musculoskeletal disorders and influence public policy makers.

Payment by Workers Compensation for Occupational Injury: There are very few measures of occupational injury reported by workers and almost none that can be systematically implemented across all US states. This research used a CDC sponsored survey administered in every US state to estimate the proportion of workers employed for wages who were work injured in the last 12 months. This injury estimate relied on worker self-reported injuries and not on reporting through employers, which may be prone to underreporting. The survey module is adaptable for use in all US states and can be use to provide national estimates as well.

The finding that medical treatment for nearly 40% of all worker-reported occupational injuries are not paid for by workers compensation suggests 'costs' are shifted to alternative payment systems. Evaluation of the workers' compensation insurance programs for surveillance and benefit adequacy should consider these findings. The impact of utilizing alternative payment sources for treatment of work-related injuries is relevant to policy considerations related to health care reform and insurance coverage.

Psychiatric Sequelae following Burn Injuries Resulting in Hospitalization: The surveillance and case follow-up of hospitalized electrical burn injuries in determining the presence or absence of post-injury psychiatric sequelae is new knowledge. Additional confirmatory studies are necessary to identify the risk factors associated with development of psychiatric disorders and their impact on return to work and mental health – yet workers, families and insurers should be cognizant of this high risk complication. Secondary and tertiary prevention efforts can be focused to minimize long term disability in this population and promote return to work.

Amputations Injury Surveillance: Reducing workplace amputations is a focus of state and federal workplace safety agencies. Accurate identification of these injuries allows allocation of prevention resources to the highest risk industries. If there is misclassification of these injuries, the ability to measure the effectiveness of interventions is compromised. The methods developed in this cooperative agreement should improve the measurement of these injuries in other surveillance systems and allow more accurate measurement of these sentinel injuries.

Section 2: Scientific Report

Background: Washington State Occupational Surveillance Program (2005-2010)

The Washington State Fundamental Occupational Surveillance Program exists to enhance comprehensive state-based occupational health surveillance in Washington State and to participate in state-based national occupational health surveillance.

Public health surveillance is the ongoing systematic collection, analysis, interpretation and dissemination of data regarding a health event for use in public health action to reduce morbidity and mortality and to improve health. Surveillance is fundamental to the prevention of work-related injuries, illnesses and hazards. Surveillance data are useful in estimating the magnitude of occupational health problems, establishing trend data, identifying priorities for intervention and evaluating efforts to reduce the burden of occupational injuries and illnesses.

The benefits of state-based surveillance programs are well recognized. State-based occupational surveillance programs are in a unique position to: 1) utilize state-specific data sources; 2) enact mandatory health care provider/laboratory reporting laws; 3) develop local partnerships with employers, industry associations, unions, and community groups; and 4) evaluate the utility of conventional data sources. Further, state level occupational health and safety surveillance programs that are actively linked to intervention efforts provide an opportunity to integrate occupational health into mainstream public health.

The 2008 NIOSH/CSTE guidelines for planning and developing state-based occupational health activities suggested that a state-based occupational health program should monitor injury and illness trends utilizing existing data sources (Stanbury M et al, 2008). The program should attempt to supplement existing data sources with additional data systems or through voluntary or mandatory reporting of occupational injury or illness (e.g. mandatory physician or laboratory reporting of disease, poison control systems). The goals of the state program are to: 1) describe the magnitude of occupational injury, illness or hazards in the state; 2) utilize occupation and industry coding to identify high risk occupations and industries for the condition under surveillance; 3) use personal identifiers to conduct follow back interviews to identify where causative exposures occur; 4) develop site specific interventions; and 5) implement primary prevention measures throughout the employers in the high risk industry. Surveillance activities should be linked to data dissemination, policy development and integrated with workplace intervention activities to prevent occupational injuries and illness.

Specific Aims: Washington State Occupational Surveillance Program (2005-2010)

There were six specific aims to the Washington Occupational Surveillance Program in the last 5 years.

1. Establish a dedicated Washington State Occupational Health and Safety Surveillance Advisory Committee.

2. Conduct population-based surveillance using the CSTE/NIOSH Occupational Indicators.

3. Develop, publish and disseminate an annual Washington State Occupational Indicator report.

4. Develop and publish a supplement to the indicator report that identifies industries at high risk for high cost, high frequency non-fatal acute traumatic occupational injuries.

5. Participate in the Consortium of Occupational State-based Surveillance (COSS).

6. Continue established Washington State occupational health surveillance systems for work-related musculoskeletal disorders, asthma and hospitalized burns.

Specific Aim #1: Establish a dedicated Washington State Occupational Health and Safety Surveillance Advisory Committee.

Specific Aim # 1: Background:

The Washington Occupational Surveillance Program is located within the Safety and Health Assessment and Research for Prevention (SHARP) program. SHARP is the primary occupational health surveillance and research program in Washington State. SHARP is a multidisciplinary, collaborative group of occupational health researchers and public health personnel including occupational epidemiologists, an occupational medicine physician, ergonomists, safety engineers, database managers, an organizational health psychologist, industrial hygienists, an economist, and administrative support staff. Like several other state programs, SHARP receives a combination of state and federal resources for its work.

SHARP is located within the Washington State Department of Labor and Industries (L&I), which also includes the state OSHA plan (the Division of Occupational Safety and Health - DOSH) and the state workers' compensation system (described below). SHARP's mission is the primary prevention of occupational injury and illness. SHARP performs occupational injury and illness surveillance, field studies to identify risk factors for injury or illness, and intervention effectiveness research. SHARP is administratively in L&I Insurance Services program. The placement of SHARP in the Insurance program helps to clarify that SHARP is not involved in DOSH enforcement activities, thereby reducing employer's concerns about participating in SHARP's research projects or surveillance worksite case investigations.

SHARP research, public health and surveillance reports provide information regarding hazards, occupational injuries and illnesses under surveillance as well as emerging hazards, occupational injuries and illnesses. Generally, report titles and executive summaries are listed on SHARP's Internet site (http://www.lni.wa.gov/Safety/Research/Pubs/); and full reports are available on request. Reports are published and distributed in hardcopy to a surveillance mailing list. The surveillance mailing list consists of present and past contacts with individual employers, employer groups, labor unions, government officials, academia, DOSH, local health departments, health care providers, and internal stakeholders. E-mail announcements about the availability of surveillance information are also disseminated. SHARP publishes a quarterly 'E-card' to provide updates of SHARP activities and to advertise new reports, surveillance findings and other notable publications. SHARP staff contribute to NIOSH's E-News. Informational updates containing surveillance data are provided to reporting physicians or hospitals participating in surveillance work. Submissions to peer-reviewed journal are also part of SHARP's research and surveillance activities.

Specific Aim # 1: Results: SHARP created a specific surveillance advisory group and it was quickly determined that it was redundant to the existing reporting structure for SHARP and its surveillance and research work. Following its initial meeting the surveillance advisory group was disbanded and reporting was continued to several existing stakeholder and advisory committees.

SHARP and the Washington State Occupational Surveillance Program report to three stakeholder and scientific advisory groups: the L&I DOSH Advisory Committee, the Washington State Labor Council's

DOSH/Industrial Insurance Monitoring Committee and the joint L&I and University of Washington Department of Environmental and Occupational Health Sciences Quarterly meetings. As much as these groups provide SHARP with some level of oversight, SHARP provides evidence-based input for policy development.

The L&I DOSH Advisory Committee is composed of four employer and four worker group representatives. This committee is chaired by the Assistant Director for DOSH Services (the director of our state OSHA). The DOSH Advisory Committee members provide input into the direction of SHARP research, surveillance and prevention activities. Most recently, input has been directed at the periodic evaluation of DOSH's enforcement activities on subsequent serious injuries, on surveillance of work-related musculoskeletal disorders (WMSDs), occupational fatalities, and other surveillance activities related specifically to DOSH activities (e.g. heat related illness surveillance, and workplace violence).

The DOSH/Industrial Insurance Monitoring Committee is under the auspices of the Washington State Labor Council and its 20 members facilitate the development of partnerships with labor and management groups for prevention activities. This committee also reviews SHARP's prevention and evaluation activities. This committee has emphasized research directed toward the undercount of occupational injuries and illnesses in WA data sources used for occupational injury and illness surveillance and emphasizes surveillance and research directed toward high risk workplaces.

The joint L&I and University of Washington Department of Environmental and Occupational Health Sciences Quarterly meetings link SHARP research and surveillance activities to our academic partners. Generally, updates are exchanged between the two groups. While there is some coordination and collaboration on research and prevention activities, these meetings also insure an efficient allocation of scarce occupational safety and health resources by preventing duplication of efforts.

Finally, while SHARP does not formally report to the Governor Christine Gregoire's 'Government Management Accountability and Performance (GMAP)' committee much of our occupational safety and health surveillance data has been used to inform discussions of the occupational health status of Washington State. These quarterly forums require the involvement of the entire senior leadership of L&I, and coordination of actuarial research, disability prevention research, primary prevention research (SHARP's focus), program evaluation research and economic modeling. The Governor GMAP has adopted one indicator measure – the occupational injury fatality rate – as the primary measure of Washington's occupational health status compared to the nation. The group also monitors the allocation of state OSHA resources, the non-fatal occupational injury rate from BLS, hospitalization data, workers' compensation injury rates, and costs. While these measures overlap with some of the CSTE Indicators, additional Washington data is used to augment these published indicators (i.e. FACE data presents more real-time number estimates for fatalities, use of our State DOSH inspection data for allocation of OSHA resources, etc.).

Specific Aims #2/3/4: Using the CSTE/NIOSH Occupational Indicators for State-based Surveillance (Includes Specific Aim #2. Conduct population-based surveillance using the CSTE/NIOSH Occupational Indicators. Specific Aim #3. Develop, publish and disseminate an annual Washington State Occupational Indicator report and Specific Aim #4. Develop and publish a supplement to the indicator report that identifies industries at high risk for high cost, high frequency non-fatal acute traumatic occupational injuries).

Background: Specific Aims #2/3/4:
The NIOSH/CSTE Occupational Health Work Group developed the occupational health indicators (a.k.a. CSTE Indicators) as measures of the occupational health status of a population. The CSTE

Indicators were selected on the basis of the availability of population based data, the public health importance of the occupational injury or illness or exposure to be measured, and the potential for workplace intervention activities. Nineteen indicators were developed along with one employment profile.

The CSTE Indicators were piloted by the five states (CA, MA, MI, NY, and WA) with NIOSH Cooperative Agreements to conduct 'Core Occupational Health Surveillance' (CORE) volunteered to pilot test the indicators and develop simple 'how-to' guides for completing the indicators. With the last funding announcement the first thirteen indicators were required as a fundamental state based surveillance activity and currently 15 states conduct them annually. Washington State has been involved in the indicator project from its inception, contributed to the development and updates of the 'how to' document, and currently provides leadership specific to three indicators – Indicators 5 - Amputations filed with the state workers' compensation system, Indicator 8- Carpal tunnel syndrome cases filed with the state workers' compensation system and Indicator 17- Occupational safety and health professionals – answering technical questions from other states about tabulating data related to these indicators, and serving in a consultant capacity regarding use of state workers' compensation data.

Each indicator identifies the demographic group, a description of the numerator and denominator and the 'Measures of Frequency'. The typical indicator is the 'Measure of Frequency', which reports the numerator (case count) and the 'rate' of the selected health event. For example, Indicator 1 is the 'Non-fatal work related injuries and illnesses reported by employers,' which uses the BLS Survey of Occupational Injury and Illness (SOII) as the data source for the numerator measures (number of cases of work-related injuries and illnesses in the private sector) and the denominator (FTE estimates), to report 'Measures of Frequency' estimates for the total number of work-related injuries and illnesses and the annual total work-related injury and illness incidence rate per 100,000 FTEs. The population under study is employed persons in the private sector.

The indicator documents also identify the data sources used for the indicator, the limitations of the data resources and other available data which may be of use to state surveillance experts to provide additional information for their state based surveillance program. For example, Indicator 1 also recommends using information in the BLS SOII to describe injury data by industry, occupation, age, gender, ethnicity, nature of injury, body part, length of service and other measures for days away from work cases where this detail is available. Typically, this data is not reported to CSTE.

SHARP has significant expertise in the use of the CSTE Indicator data sources for uses other than the indicators and this relies on a firm understanding of these data. These data systems are: the Bureau of Labor Statistics' (BLS) Survey of Occupational Injury and Illness (SOII), BLS Census of Fatal Occupational Injury (CFOI), the Comprehensive Hospital Abstract Reporting System (CHARS) - hospital discharge data, Washington State Vital Records' Death Certificate System, the Washington State Cancer Registry, the registry for the ABLES system, and the BLS Current Population Survey. SHARP has created databases for surveillance systems which rely on workers' compensation data and physician/hospital reporting. SHARP's FACE program ascertains cases from workers' compensation data, DOSH, L&I's BLS group, DOH, public safety officials, newspapers, medical examiners/coroners, and other sources. Descriptions of most of the state and federal data sources used for CSTE Indicator surveillance have been developed for Washington State data. Each data source description provides an assessment of the strengths and limitations of that data source for surveillance.

Results: Specific Aims #2/3/4:

In the Washington Occupational Surveillance Program, WA State SHARP: 1) annually collects all 19 indicators and submits the indicator data to CSTE; 2) published model state-based indicator reports; 3) developed the first new indicator for states to use for non-traumatic low back disorder hospitalizations, and 4) conducted expanded analysis of the amputations indicator – amputations reported to workers compensation.

The fundamental program epidemiologist collects the indicator data in accordance with the CSTE 'how-to' guide and submits the data to the CSTE occupational health program lead. CSTE in partnership with states conducts some quality control and quality assurance on the data and the information is subsequently posted to the CSTE website.

Annual Data Collection and State-based Indicator Reports: During this program grant period, Washington State has created two separate types of state-based indicator reports.

Our first indicator report was developed with input from stakeholders who asked that the report be simple, short and focused on information used to assess the occupational health status of Washington State. The report provided a brief introduction to the indicator, then had a section entitled 'Information you could use' where measures of 'trend', and information about the injured population's age, gender, industry and occupation were summarized. An 'other useful information' category was included summarizing results from other data elements available within the data source– i.e. race and ethnicity data in the BLS survey, time loss duration for amputations in workers' compensation.

We included within this indicator report additional 'Washington State Indicators' which presented results on common 'types' of high cost occupational traumatic injuries types within the workers compensation data. From previous analyses, we had identified traumatic injuries from 'Fall from elevation', 'Fall on same level', 'Caught In/Under/Between,' 'Struck by/against', and 'Vehicle' injuries as representing a significant cost and injury burden to Washington State workers and their employers. The indicator report was distributed in hardcopy to business, labor and government stakeholders in the occupational health community and posted on the website.

A second report format was developed to provide the indicator data for years 2005, 2006, and 2007 via a web posting. Our current postings of indicator data match the CSTE submission schedule for data submission and quality control. We restrict these postings to match data provided to CSTE.

Constructive feedback from stakeholders suggests that more current data, more information related to specific prevention activities that might result from the CSTE Indicator data, more data on the cost of occupational injury and illness, and the limitations associated with comparing indicator data across states would be valuable. The current indicator processes at present are not able to meaningfully address these issues, and these recommendations reflect the rationale for some of our additional current and future activities.

Developing a New Indicator: Hospital Discharges for Non-traumatic Low Back Disorders.
The indicators must evolve in order to raise awareness of occupational health issues in the states and the nation. In 2007, WA suggested adding a new indicator for surgical and non-surgical non-traumatic low back disorders (LBD) hospitalizations with workers compensation as the expected payer. LBD hospitalizations account for more than 1/5th of all WA State workers compensation paid hospital discharges. WA State developed the indicator, piloted the how-to-guide with a small workgroup of other states (MI, MA, OK, KY, and LA) and generated a model SAS program for states to use in completing the indicator. The CSTE workgroup officially adopted the indicator at the June 2009 CSTE meeting for

voluntary completion by states. This is the only completely new CSTE occupational indicator adopted by workgroup. It is planned for implementation in 2010 with all states being asked to voluntarily submit data for the 2007 data collection year.

We've conducted some very preliminary analyses using the indicator. Trend data from the number of hospital discharges among 18-65 year olds patients paid for by WC and the number paid by non-workers compensation payers reveals divergent trends (Figure F1). The trend patterns remain divergent when LBD hospitalizations are stratified by surgical or non-surgical discharges. The distribution of principal ICD-9 codes for surgical and non-surgical admissions does not differ by payer (WC vs. non-workers' compensation). The principal ICD-9 codes for surgical admissions reveal increased growth of lumbar fusion in the non-workers compensation population but not in the WC population.

Population and employment growth during this time period were proportionately similar. Due to limitations in the availability of denominator data rates are currently limited to 1996 to 2007 but should not impact the observations (not presented). Lipscomb et al. observed similar patterns in outpatient health care utilization trends for musculoskeletal low back diagnoses in a cohort of union carpenters in WA State. Outpatient health care utilization through non-WC increased significantly from 1999 through 2003 whereas trends in WC utilization decreased. There are many potential hypotheses for these observations including cost shifting from WC to private insurance, and WC benefit limitations (non-coverage of palliative only treatment, and limited coverage for lumbar fusion procedures). Newer procedures for lumbar fusion have influenced surgical hospitalization rates in the non-WC population. We plan further analysis of this newly developed indicator.

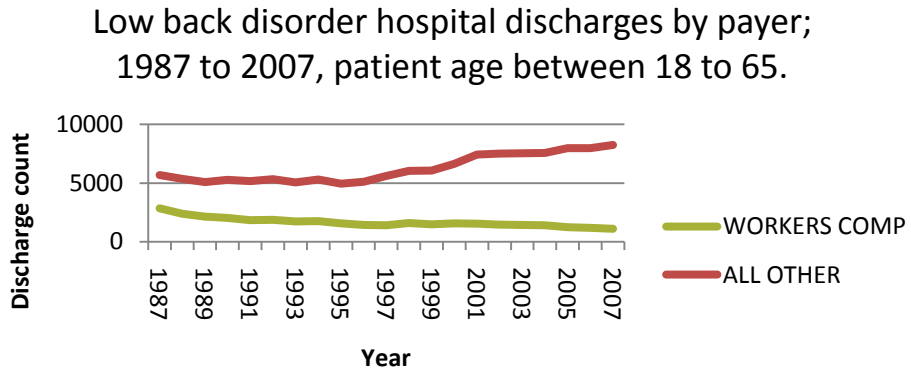


Figure F1: Number of low back disorder hospital discharges (surgical and non-surgical) for patients aged 18-65 by expected payer from CY 1987-2007. (Source: WA State Comprehensive Hospital Abstract Reporting System)

Expanded analysis of indicators – Amputations reported to workers compensation
Work-related amputations are a preventable serious injury. Two CSTE indicators characterize the burden of amputations by using state workers' compensation data and US Bureau of Labor Statistics (BLS) Survey of Occupational Injury and Illness (SOII) data. According to the 2006 BLS SOII, there were an estimated 7,990 amputations in the US and 140 in Washington State, or 9 per 100,000 FTE for the US and 8 per 100,000 FTE in Washington State. From the 2006 Washington State workers compensation data there were 238 amputations. In Washington, the average duration of time lost from work for an amputation case is more than 100 days and average medical costs exceeding $30,000.

In the Washington Occupational Surveillance program, we realized that improvements in population based non fatal traumatic occupational injury surveillance were necessary. Amputations were selected according to SHARP's project selection criteria as a sentinel occupational injury for surveillance due to

the seriousness of the injury, the availability of prevention technology (e.g. machine guarding), and significant cost associated with the injury. Employer, employee and governmental groups also readily accept the need for activities related to amputation prevention.

Our experience in developing the workers' compensation indicator led to several observations related to capturing cases of amputations within our data systems and overall understanding of occupational public health surveillance. While the data elements and general structure of the Washington workers' compensation system are described above, we will review several aspects of how amputation cases are traditionally identified in surveillance datasets and how SHARP now uses an alternative approach to identify amputation cases.

Briefly, most datasets used for occupational injury and illness surveillance describe the injury or illness at one point in time (hospital discharge data at the time of discharge, emergency department data at the time of the ED visit, BLS data as a case reported on an OSHA log, state workers' compensation data at the time when a case is reported by an employer to the state agency mandated to collect data, death certificate data at the time of death and so on). The CSTE Indicator #5 relies on the OIICS or ANSI code assigned to the workers compensation case at the time of claim reporting (by the employer's insurer or the employer) to the state agency which collects the workers compensation data.

Washington State is one of four US states where the state is the exclusive provider of workers' compensation insurance to all employers. Since the Washington State insurance records includes forms necessary for claim adjudication (e.g. claim forms), billing records from health care providers, and medical records over the entire time period from injury until the claim is resolved, a rich dataset exists for case identification of specific injuries over time. In other words, data from the time of injury, hospital visit, emergency department visit, outpatient visits, disability determinations and payments, and during the rehabilitation process are available for review and identification of cases within the same data system. Moreover, cases are classified at different points with different coding systems that are useful in identifying cases – from the injury narratives and other information on the insurance claim form ANSI injury classification codes are assigned; medical bills from hospitals, EDs, outpatient providers include CPT and ICD-9 disease and procedure codes. Since medical records are available for each claim, use of different 'case' coding systems ability to identify an amputation case can be verified by reviewing the medical records for clinical confirmation. Therefore, using Washington workers compensation insurance records with the many available methods to identify amputation cases enhances our ability to ascertain cases.

We therefore conducted a study using Washington State Fund workers' compensation data, for claims filed with a date of injury from 1997 – 2005. We identified cases using ICD-9 diagnosis amputation codes, CPT codes for treatment of an amputation, ICD-9 Surgical Procedure codes for treatment of an amputation and DRG codes consistent with the case being an amputation. We then sampled the cases by the coding system with which they were identified and reviewed the medical record to confirm that the injury identified using this alternative approach had indeed resulted in the loss of a body part. By using this alternative approach, we identified 150% more amputation cases than could be identified using the usual ANSI nature code assigned at the time of claim filing. (Many injuries that resulted in the loss of protruding body part had an ANSI nature code assigned as 'cut,' 'contusion' or 'multiple injuries' rather than 'amputation'.) Several significant differences were observed, in the types of amputation cases identified, notably, that the amputation identified by the alternative methods were more likely to be more proximal upper extremity (non-fingertip), toe and more proximal lower extremity amputations. Likewise for those cases that led to more than 3 lost workdays, the cases identified by the alternative definition were more severe in terms of cost and time loss measures (Table F1).

Table F1: Selected results for WA State Fund workers' compensation amputation cases from 1997 - 2005; by case identification method.			
	ANSI Nature = 100 Amputations	Alternative Method; Added Amputation Cases*	p value
	N = 2,528	N = 3,912	
Body Part Amputated			
Finger(s) Only	2,421 (95.8)	3,309 (84.6)	<0.001**
Upper Extremity	45 (1.8)	274 (7.0)	<0.001
Toe(s) Only	21 (0.8)	77 (2.0)	<0.001
Lower Extremity	22 (0.9)	190 (4.9)	<0.001
Other	19 (0.8)	62 (1.6)	0.003
Compensable Claims Only	n= 1,905	n = 2,819	
Mean Claim Cost ($)	32,457	45,861	<0.0001†
95% Confidence Interval	(29,172 - 35,922)	(41,510 - 50,213)	
Mean # Time Loss Days (CI)	105 (92-118)	163 (147 - 178)	<0.0001†
* Cases are identified by use of ICD-9 diagnosis or procedure codes; CPT or DRG codes on medical bills submitted to WA WC and on claims administrative coding. ** Chi-square test; † t-test.			

Using the ANSI Z 16 Nature 100 code for 'amputations', the standard approach used for indicator data, trends suggested that the number of amputations had increased from 2002 through 2005. However, when all amputation cases were combined (the alternative method and the ANSI method) the trend in the number of cases for 2002-2005 was level (Figure F2). We wonder if variations in descriptions of injury augment our trend data for many other sentinel injuries within our datasets.

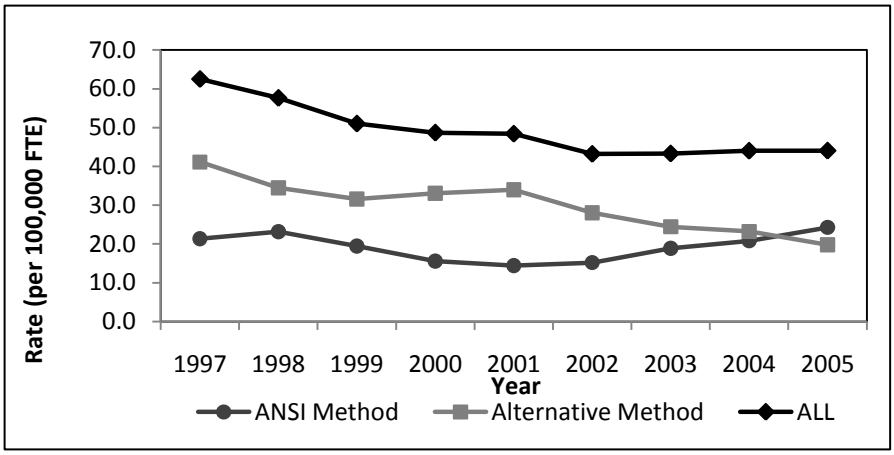


Figure F2: Claims incidence rate for accepted work-related amputations identified in Washington state fund workers' compensation claims, 1997-2005 by case identification method.

Age, gender, marital status, employer size, medical only claim costs, the source of the amputations (e.g. machine related), and industries noted to be at higher risk (by amputation rate per 100,000 FTE) were not meaningfully different between the two groups of amputation cases. The information generated can be used to assign prevention efforts to industries (NAICS 5 digit) at high risk for occupational amputations (Table F2). We have proposed a model previously to allocate state research and prevention resources toward industries based on a prevention index (PI). The ranking by

prevention index identifies industries with a combination of high claim counts and high claim rates. This is included as part of Table F2 and is discussed above.

We have submitted an article to a peer-reviewed medical journal which is currently undergoing revisions. We believe there is significant importance to maximizing use of the data available for public health surveillance. The current OSHA national emphasis program targets establishments by SIC code with machinery or equipment associated with amputation injuries. State program and area OSHA offices were to augment the list of establishments inspected by using IMIS accident data and, if available, workers' compensation data, OSHA 200 and OSHA 300 data, NIOSH data, and other reliable sources of information. WA State's OSHA program, DOSH, did not adopt this emphasis program. Instead, Washington State's OSHA program uses WA workers compensation cases to identify workplaces for inspection using the ANSI code within the system. We propose to conduct additional analyses of employer data to broaden and possibly increase the effectiveness of our state OSHA program for amputation prevention.

Table F2: Accepted Washington State Fund Claims for Amputations from 1997-2005 by North American Industrial Classification System Ranked by Prevention Index (PI).

NAICS	Industry Name	Count	Count Rank	Claim Rate*	Rate Rank	PI	% Compensable
33711	Wood Kitchen Cabinet & Countertop Mfg.	121	7.0	515.2	2.0	4.5	83.5
32191	Millwork	124	6.0	414.8	5.0	5.5	79.0
23813	Framing Contractors	259	3.0	293.3	10.0	6.5	84.2
32199	All Other Wood Product Mfg.	83	14.0	516.7	1.0	7.5	91.6
32111	Sawmills & Wood Preservation	96	11.0	418.8	4.0	7.5	89.6
11331	Logging	91	12.0	280.8	11.0	11.5	89.0
23611	Residential Building Construction	288	2.0	182.0	21.0	11.5	81.6
33231	Plate Work & Fab. Structural Product Mfg.	68	17.5	341.4	7.0	12.3	85.3
32121	Veneer, Plywood, & Eng. Wood Prod. Mfg.	74	16.0	310.9	9.0	12.5	83.8
33712	Household & Institutional Furniture Mfg.	62	21.0	353.7	6.0	13.5	75.8
56173	Landscaping Services	117	8.0	171.6	24.0	16.0	84.6
33232	Ornamental & Arch. Metal Products Mfg.	66	19.0	228.4	14.0	16.5	80.3
33299	All Other Fabricated Metal Product Mfg.	60	23.0	234.3	13.0	18.0	70.0
32619	Other Plastics Product Mfg.	64	20.0	192.0	19.0	19.5	84.4
31171	Seafood Product Prep.& Packaging	55	24.0	217.4	16.0	20.0	76.4
72211	Full Service Restaurants	354	1.0	83.0	46.0	23.5	30.2
44511	Supermarkets & Other Grocery (except convenience)	114	9.0	97.4	39.0	24.0	57.0
31161	Animal Slaughtering & Processing	48	31.0	186.8	20.0	25.5	81.3
32192	Wood Container & Pallet Mfg.	33	43.5	316.4	8.0	25.8	72.7
56132	Temporary Help Services	151	5.0	67.4	48.0	26.5	80.1
72221	Limited-Service Eating Places	189	4.0	52.7	55.0	29.5	31.7
32212	Paper Mills	26	59.0	437.9	3.0	31.0	92.3

* Rate per 100,000 FTEs; Industries were included in PI calculations if they had $\geq$ 25 claims over the study time period. Industries in the Top 5 by Count or Rate Rank (Grey Shade) but not in the Top 20 by Prevention Index.

Specific Aim #5. Participate in the Consortium of Occupational State-based Surveillance (COSS).

Specific Aim #5. Background:

The Consortium of Occupational State-based Surveillance (COSS) was established by NIOSH to foster collaboration across the states receiving fundamental state based surveillance grants. Washington State attended the COSS meeting and subsequently led a collaborative research effort to develop a state-level population based estimate of work injuries requiring medical attention through the Behavioral Risk Factor Surveillance System (BRFSS).

Only the Bureau of Labor Statistics Survey of Occupational Injury and Illness (SOII) provides state-level non-fatal occupational injury and illness incidence rates for most US States. The BLS Survey of Occupational Injury and Illness relies on employer documentation of recordable injuries and illnesses on an OSHA 300 log. BLS samples establishments which in turn provide the data from their OSHA logs and additional detail on cases with days away from work, restricted work activities or with job transfer.

Two recent capture-recapture studies using BLS SOII data and WC data suggest significant underreporting of occupational injury and illness on the BLS Survey and to WC. One study by Boden and Ozonoff, used Washington WC data provided by SHARP. In this study SOII captured about 56% of cases in WA WC and WA WC captured 96.9 percent of cases in SOII. Overall, Washington WC was estimated to capture nearly 95% of all occupational injuries that resulted in more than three days of lost work time and were considered to be eligible for WC.

There is however a relative dearth of population based measures at the state level related to the incidence of work-related injury and illness that do not rely on employer reporting or workers' compensation data. In 2002, SHARP initiated the inclusion of a state-added module about occupational injury and illness on the Washington State Behavioral Risk Factor Surveillance System (BRFSS). BRFSS is a CDC sponsored population based computer assisted telephone interview survey used to assess trends in health behaviors in the United States. In additional to the CDC core questions, CDC allows each state to augment their survey to include state added modules. Our 2002 module, asked those respondents who were employed for wages whether they had been injured at work or had been told by a health care provider that they had an occupational illness over the preceding 12 months. A follow-up question asked about whether the medical care provided for their injury or illness was paid for by workers' compensation insurance.

Specific Aim #5 Results: The results of this collaboration and surveillance project were published in CDC's MMWR on July 30, 2010. Washington State's PI was the lead author. From our 2007 BRFSS survey, the self-reported rate of occupational injury in the preceding 12 months was 6.1% (95%CI 5.2; 6.7). Among those with a work-related injury or illness, 61% (95% CI: 55; 67) filed a workers' compensation claim.

Specific Aim #5 Conclusions: Conclusions: Obtaining a population based estimate of self-reported occupational injury rates via the CDC's BRFSS survey is feasible. The proportion of workers without payment for work injuries by workers compensation is nearly 40%. Efforts to understand the rationale and use of alternative payment sources should be explored. Possible implementation of the BRFSS module onto the CDC core may be of value for national occupational injury and illness surveillance.

Specific Aim# 6. Continue established Washington State occupational health surveillance systems for work-related asthma, work-related musculoskeletal disorders, and hospitalized burns.

Background: Work-related Asthma

Nationally, asthma prevalence has been increasing since 1980. The lifetime prevalence estimate for adults in 2008 was 13.6%, higher than in 2000 (10.6%). In Washington State, adult lifetime prevalence for asthma increased from 11.9% in 2000 to 14.9% in 2008. Washington State's estimates for lifetime prevalence and current prevalence are both higher than national estimates.

The proportion of adult asthma attributed to occupational exposures has been estimated to be between 10-25%. Further, work-related asthma is the most commonly diagnosed occupational lung disease within occupational medicine clinics. In Washington State, an analysis of workers' compensation claims data demonstrated that rates for filed claims increased by approximately 7% per year from 1995-2002; while the rate for accepted claims increased (non-significantly) almost 4% per year. The average work-related asthma claim cost nearly $11,000. Additionally, each year the workers' compensation state fund reimbursed workers for nearly 10,000 lost workdays due to work-related asthma. Work-related asthma has been identified as a national priority for surveillance. Work-related asthma was included in a list of 13 conditions identified by the NIOSH-CSTE Surveillance Planning Work Group as priorities for surveillance, based several criteria, including magnitude, severity, preventability, emergent concern, public concern, economic impact, and feasibility. Work-related asthma surveillance is also a priority in Washington State. SHARP has been conducting surveillance for work-related asthma since September 2000. The overall purpose of SHARP's work-related asthma surveillance system is to identify high-risk worksites, industries, occupations, and hazards at high risk for targeting prevention efforts.

Methodology: Work-related Asthma

SHARP's work-related asthma surveillance system relies on two data sources for case ascertainment. First, workers' compensation claims, identified by using a text word search for "asthma" are extracted from the workers' compensation database on a monthly basis. Claim information, such as employer, occupation, industry, nature of injury, accident type, and body part codes are collected for each case. Second, physicians report cases of work-related asthma directly to SHARP (work-related asthma is a reportable condition to the SHARP program through the Washington State Department of Health (Washington Administrative Code - 246-101). Case follow-up interviews are attempted with all workers identified through the surveillance system to collect additional information, such as the relevant exposure source(s), employment history, personal and family medical history, personal protective equipment use, smoking history.

SHARP's work-related asthma surveillance system uses the SENSOR case definition: (1) a health care professional's diagnosis consistent with asthma, and (2) an association between asthma symptoms and work. Additionally, case follow-up interviews are conducted and information collected are used to classify cases as work-aggravated asthma, occupational asthma, or Reactive Airways Dysfunction Syndrome (RADS), according to the SENSOR case classification criteria for work-related asthma.

Results and Discussion: Work-related Asthma

There were 566 asthma claims identified by the SHARP work-related asthma surveillance system between July 2006 and June 2010. Of these, 193 completed an asthma follow-up interview.

The number of asthma claims varied by industry sector and major occupational group, and are summarized below (Table F3 and F4) (the data is cumulative from the beginning of our surveillance data through April 2008 [to allow for claim maturity], further analysis and complete sector breakdown will be available in a technical report this year).

Table F3: Work-related Asthma Washington Workers' Compensation State Fund Claims by Industry Sector, 2000-2008.

Number of Claims by 2-Digit NAICS Industry Sector		
Industry Sector	#	%
11 – Agriculture, Forestry, Fishing and Hunting	61	4.69
21 – Mining	1	<1
22 – Utilities	4	<1
23 – Construction	86	6.61
31-33 – Manufacturing	210	16.13
42 – Wholesale Trade	47	3.61
44-45 – Retail Trade	110	8.45
48-49 – Transportation and Warehousing	36	2.76
51 – Information	16	1.23
52 – Finance and Insurance	31	2.38
53 – Real Estate and Rental and Leasing	24	1.84
54 – Professional, Scientific, and Technical Services	29	2.23
56 – Administrative and Support and Waste Management and Remediation Services	96	7.37
61 – Educational Services	131	10.06
62 – Health Care and Social Assistance	189	14.52
71 – Arts, Entertainment, and Recreation	9	<1
72 – Accommodation and Food Services	53	4.07
81 – Other Services (except Public Administration)	38	2.92
92 – Public Administration	131	10.06
TOTAL	1302	100

An additional 41 claims had no industry information reported. One industry sector, NAICS 55 – Management of Companies and Enterprises, did not appear in our data.

Table F4: Work-related Asthma Washington Workers' Compensation State Fund Claims by Occupation, 2000-2008.

Number of Claims by Major Occupational Group	Frequency	Percent
Management	31	2.73
Business & Financial Operations	18	1.59
Computer & Mathematical	4	0.35
Architecture & Engineering	8	0.70
Life, Physical, & Social Sciences	9	0.79
Community & Social Services	15	1.32
Legal	3	0.26
Education, Training & Library	27	2.38
Arts, Design, Entertainment, Sports & Media	6	0.53
Healthcare Practitioners & Technical	82	7.22
Healthcare Support	45	3.96
Protective Service	34	3.00
Food Preparation & Serving Related	33	2.91
Building & Grounds Cleaning & Maintenance	54	4.76
Personal Care & Service	25	2.20
Sales & Related	59	5.20
Office & Administrative Support	145	12.78
Farming, Fishing & Forestry	44	3.88
Construction & Extraction	80	7.05
Installation, Maintenance & Repair	50	4.41
Production	156	13.74
Transportation & Material Moving	95	8.37
999999	112	9.87

Frequency Missing = 208

Work-related Asthma Exposure Sources

Claims were assigned agents using Association of Occupational and Environmental Clinics (AOEC) coding, which groups exposures in a hierarchical system and is intended to aid in the systematic identification of asthma exposure sources. Exposure source information is gathered from the asthma follow-up interviews, and where that is unavailable, from the claim medical record. Exposure source agents are assigned to each claim after interview and/or medical record review, as well as review by epidemiologist, industrial hygienist, and medical director.

The most common sources by major groups were "320 – Miscellaneous Chemicals and Materials, Referenced by Use" which includes various chemicals and cleaning products, followed by "010 –

Mineral and Inorganic Dusts," and are summarized below (Table F5) (the data is cumulative from the beginning of our surveillance data through April 2008 [to allow for claim maturity], further analysis and complete sector and agent breakdown will be available in a technical report this year). Common individual sources included dust, mold, indoor air pollutants, perfume, and other indoor air quality exposures; chemicals; paint; wood dusts; and cleaning materials, among others. Claims may report multiple sources, or none at all.

Table F5: Work-related Asthma Washington Workers' Compensation State Fund Claims by Suspected Agents grouped by 3-digit level AOEC code, 2000-2008.

	AOEC Code - Description	All primary sources
1.	320 – Miscellaneous Chemicals and Materials, Referenced By Use *(includes cleaning products)*	495
2.	010 – Mineral and Inorganic Dusts	182
3.	370 – Plant Material	164
4.	390 – Microorganisms	142
5.	330 – Pyrolysis Products	111
6.	170 – Hydrocarbons, Not Otherwise Specified	85
7.	020 – Metals and Metalloids	49
8.	380 – Animal Material	48
9.	060 – Aliphatic and Alicyclic Hydrocarbons	44
10.	360 – Ergonomic Factors (*i.e. exercise)*	36
11.	050 – Acids, Bases, and Oxidizing Agents	27
12.	220 – Isocyanates	27
13.	040 – Miscellaneous Inorganic Compounds	24
14.	270 – Polymers	23
15.	130 – Ketones	18
16.	030 - Halogens (Inorganic)	16
17.	350 – Physical Factors	14
18.	160 – Aromatic Hydrocarbons	11
19.	110 – Epoxy Compounds	9
20.	120 – Aldehydes and Acetals	9
21.	070 - Alcohols	6
22.	190 – Halogenated Aliphatic Hydrocarbons (except Organochlorine Pesticides)	4
23.	140 - Esters	3
24.	090 – Glycol Ethers	2
25.	180 – Phenols and Phenolic Compounds	2
26.	080 - Glycols	1
27.	150 – Carboxylic Acids and Anhydrides	1
28.	250 – Aromatic Nitro and Amino Compounds (including Heterocyclic)	1
29.	310 – Organic Sulfur Compounds	1
Grand Total		1,555

Occupational Respiratory Hazards – Flavorings

In addition to continuing surveillance and characterization of industries and exposure sources, our surveillance program also maintains the capacity to respond to emerging hazards and public requests for information from our surveillance databases. Our program responded to press reports of possible hazards associated with diacetyl exposures from use of butter flavored oils by providing health care providers and targeted employers and workers with information to guide medical evaluations and work

practices. We produced English and Spanish informational materials for restaurant owners and cooks about possible diacetyl exposures from butter flavored oils, and we have conducted outreach to physicians and other health care providers about cases of food flavoring lung disease. We also conducted a health hazard evaluation of a restaurant-like facility; although we were unable to find meaningful diacetyl exposures or respiratory disease. The considerable favorable press attention to our program about this issue has increased visibility for our surveillance programs. By providing information and increasing awareness of this exposure, possible harmful exposures have likely been averted.

Conclusions: Work-related Asthma

Work-related asthma (WRA) occurs in a very large number of industries, as a result of a diverse array of exposures, and carries high costs. Information gathered as to the specific industries, agents involved and situations encountered is used as part of an overall surveillance system to identify high-risk industries and workplace hazards to focus resources for prevention.

In Washington State, continued exposures to indoor air, isocyanates, wood dusts, cleaning materials, and other chemicals have been noted; with high numbers of claims in the Manufacturing and Health Care and Social Assistance industry sectors.

While Washington State is not funded for an expanded program for work-related asthma, the capacity to provide some data as well as respond to emerging hazards should assure the public of Washington State's capacity to track and respond to issues of concern to the general public.

Work-Related Asthma Surveillance - Publications

Bonauto DK, et al: [2006] Diagnosing Work-Related Asthma. SHARP publication #64-1-2006. Continuing Medical Education Activity for physicians.

Bonauto DK: [2006] Physician's Post Activity Evaluation. CME Evaluation Form

SHARP: [2006] Letter to Employers Regarding Food Flavorings. SHARP publication #64-8-2006. Information and links to resources for employers about diacetyl vapors and dust hazards.

SHARP: [2006] Safety and Health Alert for Flavorings and Flavoring Ingredients. Technical Report #64-8-2006. Safety and health alert about diacetyl, describing the hazard, symptoms, and available resources.

Bonauto DK: [2006] Letter to Physicians Regarding Food Flavorings. SHARP publication #64-9-2006. Information for physicians regarding the diacetyl hazard; occupational history, symptoms and medical evaluation information.

SHARP: [2008] New Information for Restaurant Owners and Workers about Diacetyl. Technical Report #64-10-2008. Information for cooks and restaurant workers about diacetyl, health concerns, how to reduce exposures, and available resources.

SHARP: [2008] Cocina usted con aceitas de sabor artificial a mantiquilla o sustitutos de mantequilla. Technical Report #64-11-2008(s). Spanish version of "Information for Restaurant Owners and Workers about Diacetyl.

Bonauto DK: [2008] Letter to Physicians Regarding Food Flavorings. SHARP Publication #64-12-2008. Letter to encourage physician recognition and reporting of food flavoring lung disease.

Program Director/Principal Investigator (Last, First, Middle): Bonauto, David Keith

Inclusion Enrollment Report

This report format should NOT be used for data collection from study participants.

Study Title: Washington State Work-Related Asthma Surveillance

Total Enrollment: 193 **Protocol Number:**

Grant Number: 5 U60 OH008487-05

PART A. TOTAL ENROLLMENT REPORT: Number of Subjects Enrolled to Date (Cumulative) by Ethnicity and Race

Ethnic Category	Females	Males	Sex/Gender Unknown or Not Reported	Total
Hispanic or Latino	16	12	0	28 **
Not Hispanic or Latino	96	59	0	155
Unknown (individuals not reporting ethnicity)	7	3	0	10
Ethnic Category: Total of All Subjects*	119	74	0	193 *
Racial Categories				
American Indian/Alaska Native	6	1	0	7
Asian	1	4	0	5
Native Hawaiian or Other Pacific Islander	1	2	0	3
Black or African American	6	3	0	9
White	90	53	0	143
More Than One Race	6	7	0	13
Unknown or Not Reported	9	4	0	13
Racial Categories: Total of All Subjects*	119	74	0	193 *

PART B. HISPANIC ENROLLMENT REPORT: Number of Hispanics or Latinos Enrolled to Date (Cumulative)

Racial Categories	Females	Males	Sex/Gender Unknown or Not Reported	Total
American Indian or Alaska Native	2	0	0	2
Asian	0	0	0	0
Native Hawaiian or Other Pacific Islander	0	1	0	1
Black or African American	1	0	0	1
White	5	3	0	8
More Than One Race	6	7	0	13
Unknown or Not Reported	2	1	0	3
Racial Categories: Total of Hispanics or Latinos**	16	12	0	28 **

* These totals must agree. ** These totals must agree.

Work-Related Asthma Surveillance - Materials available for other investigators

Technical reports that summarize our data and research methodology, as well as materials for prevention (such as injury narratives and hazard alerts) are periodically published on the SHARP website and available to other investigators and the public.

Background: Hospitalized Work-Related Burns

Nationally, more than one million burn injuries occur each year, resulting in an estimated 700,000 emergency department visits and 45,000 hospitalizations. Published estimates of the proportion of hospitalized burns that are work-related have ranged from 20-30%. One study that assessed return to work after burn injury found that almost 47% of patients admitted to two regional burn centers in Washington State and Texas were burned while at work. In another study of both inpatient and outpatient burn injuries, 22% were found to be work-related.

Burn injuries are serious, costly and often result in considerable job disruption. One study reported that two years after burn injury, only 37% of patients had returned to their same employer and job without needing special accommodations. In Washington State, costs incurred by the state-run industrial insurance system for all work-related burn injuries averaged over $5 million each year.

Hospitalized burn injuries, which typically make up only a small fraction of burn injury cases - accounting for less than 2% of all work-related burn claims, cost over $2.7 million per year. In the Washington State workers' compensation system accepted State Fund between January 1, 2001 and April 30, 2008, there were almost 20,000 burn claims, but only 329 of these were hospitalized burns. While hospitalized burns were just 1.7% of all burns cases within workers' compensation during that time, they accounted for 51% of the workers' compensation claim costs for work-related burns. The average hospitalized burn claim during that time period resulted in 132 lost workdays. Hospitalized work-related burns can also lead to devastating long-term sequelae including physical complaints such as scarring, economic consequences like delayed return-to-work, and psychiatric diagnoses such as Post-Traumatic Stress Disorder, Depression, and Anxiety disorders.

Due to the public health importance of hospitalized work-related burns, their preventability, and the availability of data, they were selected by the CSTE-NIOSH Occupational Health Surveillance Workgroup for inclusion in the minimum set of occupational health surveillance indicators. Similarly, surveillance for hospitalized work-related burn injuries has been identified as a priority for surveillance in Washington State. SHARP has been conducting surveillance for work-related burn injuries requiring hospitalization since September 2000.

The purpose of the hospitalized work-related burn surveillance system is to identify worksites, industries, occupations, and hazards at high risk for hospitalized burns. Identifying common sources of burn injury and industries at high risk for burn injuries can help target prevention efforts.

Methodology: Hospitalized Work-Related Burns

SHARP's work-related burn surveillance system relies on two primary data sources for case ascertainment. First, workers' compensation claims are extracted from L&I's industrial insurance database on a monthly basis. Claim information such as employer, occupation, industry, nature of injury, accident type, and body part codes are collected for each case. Second, SHARP has developed voluntary reporting agreements with both the burn centers in Oregon and Washington. Hospitals report cases directly to SHARP. Additionally, SHARP conducts surveillance for work-related traumatic fatal injuries through its Fatality Assessment Control and Evaluation (FACE) Program. The FACE program reports any fatality where the victim was either killed by a fatal burn or received a severe burn in the fatal incident.

SHARP collects all cases of work-related thermal, chemical, electrical, friction or radiation burns affecting workers employed in Washington State that result in inpatient hospitalization either for the initial burn treatment or any subsequent skin graft surgery.

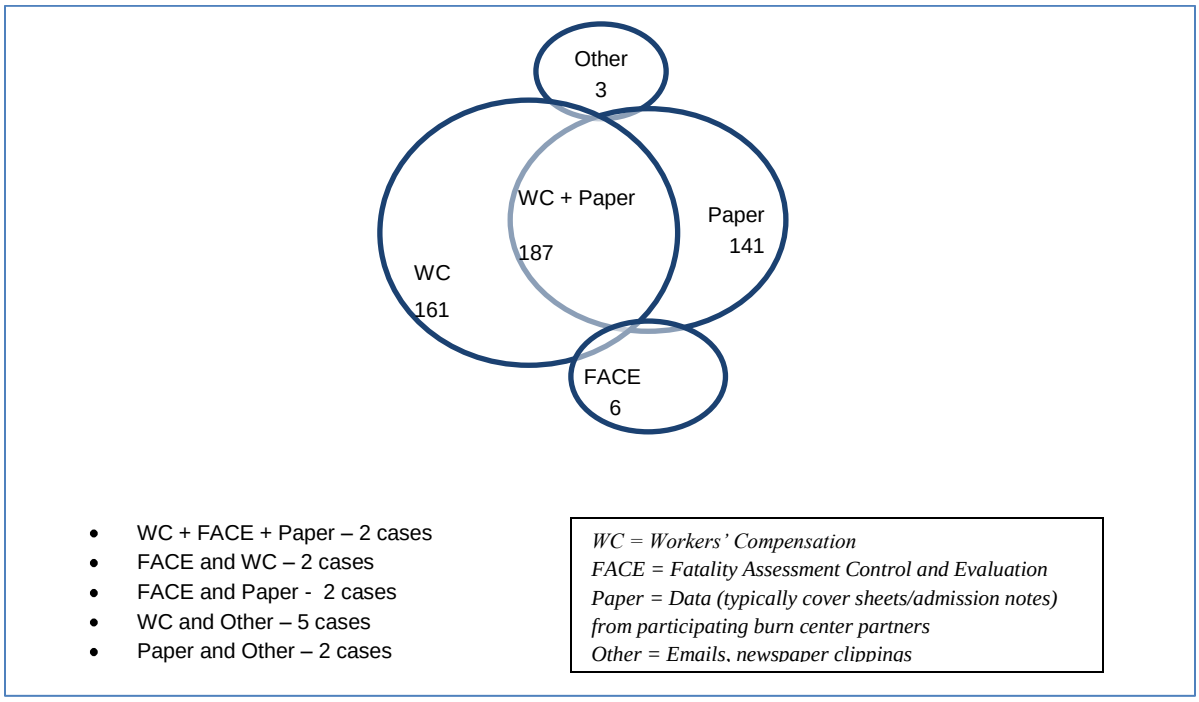
The collected cases are entered into the hospitalized occupational burns surveillance system database, which is updated monthly with all claims that meet the following criteria –

(1) The nature of the injury was coded as a heat burn, chemical burn, non-ionizing radiation, or welders flash; AND
(2) The claimant was identified as an inpatient from a hospital bill
OR
(1) The nature of injury was coded as an electric shock, AND
(2) The claimant was identified as an inpatient from a hospital bill, AND
(3) At least one diagnosis code from the hospital bill was consistent with a burn injury.

Results and Discussion: Hospitalized Work-Related Burns

During the grant period there were 271 unique burn claims. Burn reports came from a variety of sources, including workers' compensation (the majority of cases), as well as from participating burn centers, doctors' referrals, and other sources. Figure F3 summarizes the contributions from each data source during the years 2000-2007 (because SHARP has been continuously collecting data since 2000, data provided may include previous years; additionally, more recent claims may not be included, to allow for a standard of claim maturity). Burns cases were overwhelmingly male (86%), with a median age of 37 years.

Figure F3. Hospitalized Work-Related Burn Cases by Data Source, Washington State, 2000-2007 (n=511).



Sources: While the source of burn injuries varied, the majority (19%) were from flame/fire/smoke, followed by hot water and electrical apparatus (see Table F6). Other sources of interest were cooking oils, chemicals and asphalt/road oil.

Industry: Cases of hosptalized work-related burns also varied by industry (see Table F7).

Total Body Surface Area Burned (TBSA, %): Hospitalized work-related burn claims had TBSA ranging from 1% (n=20) to 77% (n=1), with most (57%) having a TBSA ≤10%.

Costs: For claims between July 1, 2006 and June 30, 2010, the median incurred cost for a hospitalized work-related burn was $16,378. The total cost for hospitalized work-related burns claims in WA during that time was approximately $16.5 million dollars.

Time Loss: During the grant period (in compensable claims) there was an average of 160 days of time loss, median 35 days.

Fatalities: During the grant period, there were three reported fatalities associated with hospitalized work-related burns claims.

Table F6. Commonly Reported Sources of Hospitalized Work-Related Burn Injuries (n=511)

Source	Frequency	Percent
Flame, Fire, and Smoke	98	19.2
Hot Water	50	9.8
Electrical Apparatus (not elsewhere classified or specified)	43	8.4
Cooking Oils	40	7.8
Chemicals (not elsewhere classified or specified)	24	4.7
Asphalt and Road Oil	20	3.9
Conductors	13	2.5
Liquids (not elsewhere classified or specified)	13	2.5
Molten Metal	12	2.3
Switches and Fuses	8	1.6
Steam	7	1.4
Heating Equipment	7	1.4
Sulfuric Acid	6	1.2
Gas and Liquid Compounds	5	1.0
Welding Equipment	5	1.0
Crude and Fuel Oil	5	1.0
Hydrocarbon Gas	5	1.0
Hydrofluoric Acid	5	1.0
Machines (not elsewhere classified or specified)	5	1.0
Metal Items (not elsewhere classified or specified)	5	1.0

- Only sources associated with at least 5 cases are shown. Twenty-eight cases did not have enough information to describe the source of injury (unknown, unidentified, and miscellaneous). An additional 25 were blank for source of injury.

Table F7. Counts and Average Annual Rates for Hospitalized Work-Related Burns by two-digit NAICS Industry Sector. Ranked by the Prevention Index, Washington State, January 1, 2000 - December 31, 2007.

Industry Sector*	Sector Description	FTEs	Count	Count Rank	Claim Rate**	Rate Rank	PI Rank
23	Construction	1133741	126	1	11.11	1	1
31-33	Manufacturing	2006042	76	2	3.79	6	4
72	Accommodation & Food Service	1091755	75	3	6.87	4	3.5
42	Wholesale Trade	827427	33	4	3.99	5	4.5
44-45	Retail Trade	2206563	30	5	1.36	10	7.5
11	Agriculture, Forestry, Fishing, & Hunting	558748	18	6	3.22	7	6.5
81	Other Services (except Public Administration)	662825	15	7	2.26	9	8
48-49	Transportation and Warehousing	513464	12	8	2.34	8	8
56	Admin & Support & Waste Management	866718	10	9	1.15	12	10.5
92	Public Administration	1028541	9	10	0.88	14	12
54	Professional, Scientific, and Technical Services	962642	9	10	0.93	13	11.5
22	Utilities	90881	8	11	8.80	3	7
62	Health Care and Social Assistance	1781974	7	12	0.39	17	14.5
61	Educational Services	1296790	6	13	0.46	16	14.5
53	Real Estate and Rental and Leasing	418697	5	14	1.19	11	12.5
21	Mining	31084	3	15	9.65	2	8.5
52	Finance and Insurance	692899	1	16	0.14	18	17
71	Arts, Entertainment & Recreation	170596	1	16	0.59	15	15.5
51	Information	644714	0	--	--	--	--
55	Management of Companies and Enterprises	6672	0	--	--	--	--
Blank / NA			67	--	--	--	--
TOTAL		17027213	511	--	3.0		

* Industry Sectors with >5 claims

** Rate per 100,000 FTEs

Outreach: SHARP also produces burn narratives, hazard alerts and fact sheets (see Publications), such as those for restaurant burns - one such burn narrative has been published in the Washington Restaurant Association's trade journal *Front Burner*.

Psychiatric Sequelae: In addition to generally characterizing hospitalized work-related burns in Washington State, SHARP also undertook an examination of the psychiatric sequelae of hospitalized work-related burn injuries using workers' compensation data. During 2001-2008, there were 329 cases of hospitalized work-related burns in WA workers' compensation. Of these, we identified 62 (18.9%) that had a psychiatric diagnosis of interest (post-traumatic stress disorder (PTSD), depression, other anxiety disorders – see publication for complete methodology).

These workers were primarily male (90%), aged 25-54 (61.7%), came from employers with less than 50 FTE (66.3%), and had a median 545 days on the job. There was no significant difference in sex, age, employer size or number of days on the job between claims with psychiatric diagnoses and those claims without psychiatric diagnoses.

However, there were some differences. There were differences in marital status, average yearly wage, body part, type of burn, percentage total body surface are burned (TBSA), costs and time loss. More of those with psychiatric diagnoses were married than those claims without psychiatric diagnoses. In wage, more claims with psychiatric diagnoses made over $50,000/year than claims without psychiatric diagnoses. Body part was significant, though "Multiple" was the most common reported body part burned for hospitalized work-related burns in WA, body part - of all workers who had "Head/Face" burns, 27.7% had a psychiatric diagnosis, followed by 25.7% of those with "Multiple." The type of burn also proved significant, with 57.1% of electrical burns leading to psychiatric diagnosis though making up

only 8.5% of the burns; whereas in thermal burns, by far the most common type of burn overall (80.2% of all), only 13.6% received a psychiatric diagnosis. Burns with greater than 10% TBSA also showed an increased proportion of psychiatric sequelae; of cases where TBSA was available in the records (n=227), 30% of all burns with >10% TBSA had a psychiatric diagnosis, making up 67% of all cases with psychiatric diagnosis.

The total medical cost of all 329 hospitalized burns was $11,872,089 Hospitalized burn cases with psychiatric diagnoses (n = 62) made up 48% of the total cost ($5,720,194). Costs and time loss also differed significantly between claims with and without psychiatric diagnoses.
Medical costs were significantly different (p = 0.0001) between claims with and without psychiatric diagnosis at both levels of TBSA, with those with greater than 10% TBSA and a psychiatric diagnosis having a median medical cost 7 times that of those without psychiatric diagnosis. Days of time loss from work were significant (p = 0.0001) at the greater than 10% TBSA level, with claims with psychiatric diagnosis having median time loss 10 times longer (median 300 days) than that of those without psychiatric diagnosis (median 32 days).

By industry sector and major occupational group, Construction (NAICS 23) and Construction and Extraction Occupations (SOC 47) (notably Electricians, 47-2111) had the highest percentage of burns, both with and without psychiatric diagnoses.

One of the key findings of this study was of the significance of the type of burn, with electrical and chemical burns having a higher proportion of psychiatric diagnoses than thermal burns. This was most noticeable in electrical burns, where 57.1% of electrical burns had psychiatric diagnoses, whereas in thermal burns, only 13.6% had psychiatric diagnoses. Electrical burns also made up 25.8% of all the psychiatric diagnoses though making up only 8.5% of the 329 hospitalized burns.

The odds ratio for having a psychiatric diagnosis for electrical burns vs. all other types of burns was 7.391 ($p<0.0001$), demonstrating that an electrical burn carries a significantly increased risk of psychiatric sequelae. Electrical burns should be a target for further study and prevention, and clinicians should be aware of the increased likelihood of psychiatric sequelae with electrical burns.

Even the small number of claims in this analysis accounted for a substantial amount of money and time loss, as well as a devastating personal impact on the workers involved. Targeting resources towards preventing these injuries, such as burns of an electric nature, could produce substantial impact.

Conclusions: Hospitalized Work-Related Burns

Hospitalized work-related burns are a small but significant group of occupational injuries. Ongoing and systematic surveillance provides the data necessary to describe the burden of these injuries, set priorities for intervention and research, and facilitates evaluation of the effectiveness of prevention efforts over time.

In Washington State, burn prevention needs to focus on industry sectors with high claim counts and rates (such as Construction, Manufacturing, and Accommodation and Food Services) and targeting common types and sources of burns in those industries. Based on further analysis of claims with psychiatric diagnoses, targeting resources towards the prevention of burns of an electrical nature would also be worthwhile.

Given the heavy economic burden (and personal costs) of hospitalized work-related burns, any reduction in these injuries could have a substantial impact.

Hospitalized Work-Related Burns – Publications

SHARP: [2006] Roofer Seriously Burned While Lowering a Bucket of Hot Tar. Technical Report #85-6-2006. Burn injury narrative describing a WA worker's experience and injury prevention tips.

SHARP: [2006] Un techador sufrió quemaduras serias mientras bajaba un balde de asfalto caliente. Technical Report 85-6a-2006(s). Spanish version of "Roofer Seriously Burned While Lowering a Bucket of Hot Tar."

SHARP: [2006] Burn Injury Facts: Arc Flash/Blast. Technical Report #86-1-2006. Hazard alert providing information and prevention tips.

Curwick CC: [2006] Hospitalized Work-related Burns in Washington State. Technical Report #86-2-2006. Technical Report summarizing claims data; provides results of descriptive analysis of hospitalized work-related burns claims in Washington State; identifies high-risk industries for targeted prevention; compares relative contributions of hospital reporting and workers' compensation data.

SHARP: [2006] Burn Injury Facts: Hot Tar Burns in Roofing. Technical Report #86-3-2006. Hazard alert providing information and prevention tips.

SHARP: [2006] Datos De Quemaduras: Quemaduras Por Asfalto En La Industria Del Techado. Technical Report #86-3a-2006(s). Spanish version of "Burn Injury Facts: Hot Tar Burns in Roofing."

SHARP: [2008] Restaurant Worker Burned While Cleaning Deep Fat Fryer. Technical Report #86-4-2008. Burn injury narrative describing a WA worker's experience and injury prevention tips.

SHARP: [2008] Young Cook Seriously Burned by Boiling Water. Technical Report #86-5-2008. Burn injury narrative describing a WA worker's experience and tips to prevent a similar injury.

SHARP: [2008] Un joven se quemó limpiando una friedora.. Technical Report #86-6-2008. Spanish version of "Restaurant Worker Burned While Cleaning Deep Fat Fryer."

SHARP: [2009] Burn Injury Facts: Scald Burn Injuries to Restaurant Workers. Technical Report #86-7-2009. Hazard alert providing information and prevention tips.

SHARP: [2008] Concrete Burns in Construction. Technical Report #86-8-2009. Burn injury narrative describing a WA worker's experience and injury prevention tips.

Anderson NJ, Bonauto DK, Adams D: [2010] Psychiatric diagnoses following hospitalized work-related burn injuries in Washington State. Journal of Burn Care & Research, in press.

Inclusion of gender and minority study subjects: Information collected on hospitalized work-related burns does not contain systematic collected race and/or ethnicity data for subjects nor are subjects interviewed to ascertain this data.

Program Director/Principal Investigator (Last, First, Middle): Bonauto, David Keith

Inclusion Enrollment Report

This report format should NOT be used for data collection from study participants.

Study Title: Washington State Hosptilazed Work-Related Burns Surveillance

Total Enrollment: 193 **Protocol Number:**

Grant Number: 5 U60 OH008487-05

PART A. TOTAL ENROLLMENT REPORT: Number of Subjects Enrolled to Date (Cumulative) by Ethnicity and Race

Ethnic Category	Females	Males	Sex/Gender Unknown or Not Reported	Total
Hispanic or Latino				**
Not Hispanic or Latino				
Unknown (individuals not reporting ethnicity)	37	226	8	271
Ethnic Category: Total of All Subjects*	37	226	8	271 *
Racial Categories				
American Indian/Alaska Native				
Asian				
Native Hawaiian or Other Pacific Islander				
Black or African American				
White				
More Than One Race				
Unknown or Not Reported	37	226	8	271
Racial Categories: Total of All Subjects*	37	226	8	271 *

PART B. HISPANIC ENROLLMENT REPORT: Number of Hispanics or Latinos Enrolled to Date (Cumulative)

Racial Categories	Females	Males	Sex/Gender Unknown or Not Reported	Total
American Indian or Alaska Native				
Asian				
Native Hawaiian or Other Pacific Islander				
Black or African American				
White				
More Than One Race				
Unknown or Not Reported				
Racial Categories: Total of Hispanics or Latinos**				

* These totals must agree. ** These totals must agree.

Hospitalized Work-Related Burns - Materials available for other investigators

Technical reports that summarize our data and research methodology, as well as materials for prevention (such as injury narratives and hazard alerts) are periodically published on the SHARP website and available to other investigators and the public.

Background: Work-related Musculoskeletal Disorders

WMSDs are soft-tissue disorders of non-traumatic origin that are caused or exacerbated by interaction with the work environment. For 2007, the Bureau of Labor Statistics (BLS) reported 333,760 WMSDs in private industry in the United States -- an annual incidence rate (IR) of 35 per 10,000 workers, WMSDs accounted for 29 percent of all injuries and illnesses. On average, they resulted in a median of 9 days away from work. The service and manufacturing sectors accounted for about one-half of all WMSD cases. Nursing aides and orderlies had the highest IR (252 cases per 10,000 workers), followed by laborers and freight handlers (IR = 149) and light-truck and delivery-truck drivers (IR = 117). Changes in BLS case definitions may have affected national data collection on WMSDs, likely accounting for more underestimation of true occurrence of these disorders. The current BLS definition of musculoskeletal disorders includes cases where "the nature of the injury or illness is a sprain, strain, or tear; back pain, hurt back; soreness, pain, or hurt, except the back; carpal tunnel syndrome; a hernia; or a musculoskeletal-system or connective-tissue disease or disorder, when the event or exposure leading to it was bodily reaction/bending, climbing, crawling, reaching, or twisting; overexertion; or repetition. Cases of Raynaud's phenomenon, tarsal tunnel syndrome, and herniated spinal discs are not included. *Although they may be considered MSDs, the survey classifies these injuries and illnesses in categories that also include non-MSD cases [injury].*

The most commonly reported body areas affected are the low back and the upper extremity. There is increasing evidence of work-relatedness for some common hip and knee disorders. Tendonitis and tenosynovitis, the most commonly diagnosed WMSDs, are inflammations of the tendon or tendon sheath. Examples include rotator cuff tendonitis, epicondylitis, extensor and flexor tendonitis in the wrist, and peripatellar tendonitis in the knee. Carpal tunnel syndrome is the most common nerve entrapment. WMSDs can result in severe debilitating pain, burning, numbness, or tingling that, in turn, results in lost work time and less productivity while at work. Symptoms can initially be intermittent and mild, but in the absence of treatment may progress to become more frequent and severe.

Estimated annual workers' compensation costs for WMSDs in the United States vary between $13 and $20 billion in direct costs [2]. Estimated annual costs of "overexertion injuries" at work in the United States are now $9.8 billion, having decreased about 5 percent between 1998 and 2007. Estimated annual costs of repetitive motion injuries are now $2.1 billion, having decreased about 35.3% during the same time period.

Methods: Work-related Musculoskeletal Disorders

(The following methods were adapted from Silverstein BA [2008] and represent the methods from the last summary report published in 2008. Due to the conversion from the American National Standards Institute injury classification system to the BLS Occupational Injury and Illness Classification System in 2005, the case identification methods have changed. This conversion required additional resources provided by Washington State – and as such development of the first WMSD report using the new algorithms will not occur until late 2010.)

The Washington State workers' compensation data allow determination of injury and illness rates in a well-defined population – workers employed for wages in Washington State and covered by workers compensation. Access to the medical record and ICD-9 coding allows comparisons of data to surveillance systems based on medical case definitions. Employee work hours provide for a measure of exposure and for use in rate calculations by industry and by employer account. Data are available on the direct costs of work-related injury and illness to the workers' compensation system, (although some are estimated by actuarial methods). Workers' compensation claims data can be matched by employer and by worker to other state administrative databases (e.g. unemployment insurance data can provide measures of return to work, and employee turnover).

Washington Workers' Compensation System

In Washington State, employers (except the self-employed) are required to obtain workers' compensation insurance through the Department of Labor and Industries' (L&I) industrial insurance system unless they are able to self-insure. L&I's State Fund covers approximately two-thirds of the workers in Washington State (the remainder works chiefly for the approximately 400 largest employers and is covered by their self-insured employers). US Department of Energy claims (Hanford) have been included in the Self-Insured section since roughly 2000. Washington is the only state in which workers contribute monetarily to the medical aid portion of the State Fund.

Claims Management Data Base

Workers' compensation claims data and employment data for the years 1997-2005 were obtained from L&I's files. The L&I claims management database consists of two major data processing systems. The Medical Information and Payment System (MIPS) receives all billing information generated by provider medical bills. This system records such relevant items as dates of service, all associated procedure and treatment (CPT) codes, and physician diagnosis by International Classification of Disease (ICD), version 9, code for each provider visit. The Labor and Industries' Industrial Insurance System (LINIIS) contains all data necessary for the administration of State Fund claims (e.g., claim type and nature, occupation, employer information, status, progress). Only those Self-Insured compensable claims resulting in 4 or more days of lost time are coded in the LINIIS system. Rarely are there ICD9 codes or medical billing information in the MIPS database for the Self-Insured claims. Thus, the Self-Insured data in this report is not comparable to the State Fund data in terms of magnitude or cost.

Definition of Outcome

We used accepted State-Fund claims (for the 1997-2005 period) approximately 9% of the State Fund claims were rejected.

Medical treatment and diagnosis records were extracted from the MIPS database when the claim had either authorized or allowed CPT codes, or both. In addition, we extracted records for wrist or hand conditions (or both) from the claim history dataset by using the ANSI z16.2 code for body area (see Table F8 and F9).

Similar methods were used to identify claims for general back, elbow and shoulder disorders. The specific disorders were defined as accepted claims based on claims with ANSI codes and/or CPT procedure codes (see Table F8 for codes).

Since a workers' compensation claim in Washington State may include disorders in more than one body part, only the primary site is assigned a z16.2 code. When specific disorders (like CTS for hand/wrist disorders) were examined in detail to determine type of onset, disorders were required to match the appropriate body area code (since type and nature of disorder are only specified for the primary site of disorder)(see Table F9).

Information collected for each claim included: claim status (compensable lost time claim of 4 or more days or medical treatment claim only codes); z16.2 codes for body area; nature and type of disorder; 4-digit Washington Industrial Code (WIC); 6-digit North American Industrial Classification System (NAICS) code; claim identification number; social security number; date of injury; birth date; gender; total cost of claim; lost time days; dollar amount of time loss payments; and dollar amount of medical aid payments. Using first date of injury allows us to estimate claims incidence. For example, if in LINIIS, a first date of injury year is 1996 and recorded for body area of hand/wrist, but the first MIPS allowed bill with a CTS code is in 1998, for purposes of this analysis, this is a 1997 CTS claim.

We categorized non-traumatic and traumatic onset to differentiate *cumulative* trauma exposures from acute exposure, such as falls. A combination of body part and nature and type was required. Non-traumatic onset, type codes (z16.2 code) included: rubbed or abraded, further restricted to disorders caused by leaning, kneeling, or sitting on objects (not vibrating) (081), those caused by objects being handled (not vibrating) (082), those caused by vibrating objects (083), those caused by repetition of pressure (085) and those caused by repetitive motion (086); overexertion (120-124, 129); bodily reaction (100); and unknown (899-999) -primarily strain, muscle soreness, pain with lifting etc.

These type codes were combined with the following nature codes: dislocation or herniation (190 for neck and back only); inflammation or irritation of the joints, tendons or muscles (260), including bursitis, tendonitis, synovitis and tenosynovitis; sprains and strains (310); multiple injuries (400 for upper extremity only); diseases of the nervous system (560), nerves and peripheral ganglia (562); symptoms and ill-defined conditions (580, 995 NOC); and unclassified (999). Disorders not fulfilling the criteria for non-traumatic onset were considered traumatic (e.g., type was slips, trips, falls, and struck by).

Data were extracted from L&I databases as of July 16, 2007. Claim costs reported here reflect actual totals for closed claims. For State Fund claims that were not closed, costs reflect actual totals to this date *plus* the additional case reserve as estimated by agency staff. Costs are expected to develop further for the most recent years. For example, as of August 2007, approximately 5% of all 2001 carpal tunnel syndrome claims, 11% of 2003, and 23% of 2005 carpal tunnel syndrome claims were still open. For WMSDs, approximately 7% of 2005 claims were still open compared to 4% of all claims. Lost time days for compensable claims were averaged from 1997-2005.

For Self-Insured compensable closed claims, we abstracted body part, nature, and type. We are less confident about the distinction between non-traumatic and traumatic onset status with the self-insured data because of more incomplete information in these data. Costs and time loss were also incomplete for these data.

Time loss days are paid on a 7-day workweek (20 days of time loss would be reflective of 3 calendar weeks, not 4). While the initial pension reserve is included as part of the total incurred costs, L&I stops counting time loss days as of the date a worker is moved to the pension roles. Lost workdays are not reflected as time loss days when an employee is kept on salary (KOS).

Costs: All bills were adjusted using the Consumer Price Index for Urban Wage Earners and Clerical Workers for Seattle-Tacoma-Bremerton, WA, not seasonally adjusted, annual figures. Bills were adjusted on a simplified basis using the date of injury as the “payment” date for all bills. Time loss payments occur over time and in some case stretch over years. Some open claims have future anticipated expenditures assigned. Incurred Medical costs were adjusted using the Medical Care Series (id CWURA423SAM, CWUSA423SAM), while all other costs were adjusted using All Items except Medical Care Series (id CWURA423SA0L5, CWUSA423SA0L5).

Payroll Hours: By Risk Class (WIC) we are excluding professional athletes (football, hockey, baseball, basketball, jockeys, and car/boat racers).

Using 2000 hours as the FTE basis may present a bias against the very industries we’ve identified as the “worst.” L&I offers two reporting options: actual hours worked, or a simplified 1920 hours/year, 480/quarter, 160/month…to allow for ease/consistency in payroll, etc. There is no field to indicate whether an employer chose the actual or simplified reporting. Simplified reporting is cost beneficial to those employers who have steady/regular work. It is possible we are underestimating the CIR for those

using simplified and overestimating for those using actual hours. It is possible that the actual exposure is 2000 hours even for those reported at 1920.

Validity of Case Codes

For the year 2000 report, numerous medical records abstraction exercises were conducted to evaluate the coding schemes used for both onset type (traumatic or non-traumatic) and specific diagnosis of upper extremity claims. In the first exercise, we took a random sample of 96 Washington State Fund compensable claims coded as CTS (N=56), epicondylitis (N=15) and rotator cuff disorders (N=25). One of the three diagnoses was recorded in each of the medical records.

This exercise demonstrated that the physician's statement on the medical records is fairly accurately translated into the coding system of the L&I claims management database. In an extract of 20 tendonitis claims, 18 (90%) were coded correctly. We also observed that CTS and epicondylitis are often mentioned together in a single claim, and that CTS is usually filed as the main disorder. Thus, the incidence of "elbow" disorders would be underestimated because the epicondylitis case would be identified under "hand/wrist."

Additionally, the cost information for that epicondylitis case would be lost because we required body part be elbow and diagnosis be epicondylitis in order to avoid overestimation of costs for specific conditions.

Electrodiagnostic studies were used to confirm the diagnosis of CTS in 100% of cases.

We also checked whether our definition for a traumatic or non-traumatic onset disorder, based on our selected codes, agreed with information from the medical records, in which it was very clear whether the onset was traumatic or non-traumatic. There was 76% agreement for the hand/wrist, 77% for elbow disorders, and 64% for the shoulder disorders.

The second exercise involved abstracting medical records from 100 random claims from 1995 that were coded *traumatic carpal tunnel syndrome* and 98 *non-traumatic onset hand/wrist disorders*. The case definition for carpal tunnel syndrome included symptoms in the median nerve distribution, and one of the following: positive electrodiagnostic study, carpal tunnel release surgery, or positive physical examination.

Eighty-one percent of the first group met the case definition for carpal tunnel syndrome and 43% of the second group met the case definition for CTS. All of those coded as non-traumatic onset met the definition of non-traumatic onset. Of those that were coded traumatic onset, 64% were actually non-traumatic onset. This suggests that the incidence rate for non-traumatic onset hand/wrist disorders may be underestimated. For rotator cuff disorders, about 30% of the claims coded as traumatic were non-traumatic.

Of the traumatic onset upper extremity claims, 51% were due to being struck against or struck by, whereas 42% of the traumatic onset back disorders were coded as fall related.

In addition to low back and upper extremity disorders, we reviewed neck and lower extremity disorders. For this purpose, the validity of the codes for nature and type was scrutinized. The purpose was to see whether a distinction could be made between non-traumatic soft tissue disorders and other musculoskeletal disorders.

For the neck disorders, the nature coding was in agreement with the information in the medical files in 86% of the cases. Of the types, 88% of the codes were in agreement. The most common neck disorders were sprain and strain (in 43% of bills), cervicalgia (6%), dislocation (7%), displacement of intervertebral disc (3%), and radicular syndrome or radiculitis (3%). Of these diagnostic groups, radicular syndrome or radiculitis differed from the others in that about half of the cases were non-traumatic, whereas the proportion of non-traumatic cases for the other neck disorders was about 30%. The too small number of cases consistently diagnosed with radiculitis precluded, however, the consideration of this diagnostic group separately in the analysis.

Washington State Employment by Industry and Region

Employment information is reported to L&I by State Fund employers as the number of hours worked by employees. However, hours by age and gender are not available.

Numbers of employees working per year were calculated assuming that each full-time employee works 2,000 hours per year (40 hours per week for 50 weeks per year). Hours were converted to full time equivalent workers (FTEs) as: Total Hours Reported / 2,000.

In those industries where there are high proportions of part-time workers, the denominator may be an underestimate, making the incidence rate higher than it would be if they were all full-time workers. An industrial classification is a grouping of industries that share similar workplace exposures. Washington Industrial Classifications (WIC) are more specific than the North American Industrial Classification System (NAICS) because employers must sub classify their employees based on type of work. We used converted risk classes for WIC to take into account some sub sectors moving around during the study period.

This year we used claims charged to the account as the primary determinate of the NAICS, secondary determinate was the NAICS code assigned most frequently to the account's business locations by the Department of Labor and Industries, tertiary was NAICS assignment to the Universal Business Identifier by the Department of Employment Security. This year, we consolidated the WIC discounted and undiscounted wallboard classes (current and past) as well as those historical classes that were absorbed by the current into "Wallboard Installation" because there was no difference in the work they performed.

To eliminate unstable rates, only those NAICS codes with an average of 50 FTEs per year or more and those WIC codes with an average of 50 employees per year over the 9-year period were included in the industry analyses.

Self-Insured compensable claims are not received and coded by L&I until they have been closed, thus this long lag time underestimates the number of claims in more recent years.

Because claims data is incomplete for the Self-Insured due to a high proportion of open claims, we used year 2001 claims for the trends analysis.

L&I does not have denominator data by gender and age. Therefore, in order to estimate rates by age and gender, we used Quarterly Workforce Indicators from the U.S. Census Bureau to determine the number of employees rather than FTEs in the denominator.

We included body mass index (BMI) in the demographic data because of some evidence of an association between higher BMI and some WMSDs. Height and weight are self-reported on the initial claim report and were reported for approximately 72% of State Fund compensable claims. BMI was calculated according to CDC as: [Weight (lbs) / height $(in)^2$] * 703.

Statistical Analysis

Descriptive analyses included a summary of claims by year, direct workers' compensation costs, age and gender. Claim incidence rates were calculated by year and industry class, and are expressed as number of claims per 10,000 FTEs.

Each industry code specific rate was compared to the industry-wide rate and a crude incident rate ratio or relative risk was calculated. Test for trend of incidence rates over time was performed using a Poisson regression analysis in SAS Software (SAS Proprietary Software Version 9.1, SAS Institute Inc. Cary, NC, USA 2001). Differences between rates were tested by Poisson regression with an interaction term for the compared rates.

WMSD claims were compared to all claims, excluding WMSDs. The different categories within WMSDs were compared to all claims WMSDs.

To prioritize industries for intervention purposes, frequencies of claims within an industry as well as the relative risk compared to all industries are important considerations. We combined the rank orders of both frequency and relative risk to create a "Prevention Index" (PI). PI = (Frequency Rank + Incidence Rank)/2.

Table F8. WA State Fund ICD-(and Procedure Codes (CPT) Used to Extract Claims with Specific Diagnoses

Condition	ICD9	Diagnosis Description	CPT	Procedure Description
Rotator Cuff	726.1	Rotator Cuff Syndrome	23410	Repair Ruptured Rotator Cuff-Acute
	726.10	Rotator Cuff, Supraspinatus Syndrome	23412	Repair Ruptured Rotator Cuff-Chronic
	727.61	Complete Rupture of Rotator Cuff	23415	Coracoacromial Ligament Release-Chronic Ruptured Rotator Cuff
	840.4	Sprains and Strains of Rotator Cuff Capsule	23420	Repair of Complete Rotator Cuff Avulsion, Chronic
Epicondylitis	726.31	Medial Epicondylitis	24350	Lateral or Medial Fasciotomy
	726.32	Lateral Epicondylitis		
Tenosynovitis/Tendinitis (Hand/Wrist)	727.03	Trigger Finger		
	727.04	DeQuervain's Disease		
	727.05	Other Tenosynovitis of Hand and Wrist		
	727.4	Ganglion & Cyst of Synovium, Bursa, Tendon		
	727.42	Ganglion of the Tendon Sheath		
Carpal Tunnel Syndrome	354.0	Carpal Tunnel Syndrome	64721	Median Nerve Decompression
Back Diagnoses	722.10	Lumbago or sciatica due to displacement of interverebral disc		
	722.73	Intervertebral disc disorder with myelopathy		
	724	Other disorders of back		
	7.24.2	Lumbago, lumbalgia, low back pain		
	724.3	Sciatica		
	724.5	Backache, unspecified		

Table F9. Coding Scheme for Work-related Musculoskeletal Disorders of the Neck, Back and Upper Extremity

Soft Tissue Nature Code and Description

190	Dislocation or herniation of discs (back and neck only)
260	Inflammation or irritation of joints, tendons or muscles
310	Strains & sprains
400	Multiple injuries (upper extremity only)
560	Nervous system
562	Bell's Palsy and other diseases of the nerves and peripheral ganglia (carpal tunnel syndrome)
580	Symptoms and ill-defined conditions
995	Other injury, not elsewhere classified
999	Unclassified

NOTE: INJURY NATURE HAS TO BE COMBINED WITH INJURY TYPE AND BODYPART

Types of Non-Traumatic Soft Tissue Disorders by Code

Rubbed or abraded by:

81	leaning, kneeling, or sitting on objects (not vibrating)
82	objects being handled (not vibrating)
83	vibrating objects
85	repetition of pressure
86	repetitive motion
100	bodily reaction (strain, sprain, rupture or other internal injuries resulting from assumption of unnatural position or involuntary motion such as efforts to recover balance from slip)

120	overexertion
121	in lifting objects
122	in pulling or pushing objects
123	in wielding or throwing objects
124	in carrying objects
129	overexertion, not elsewhere classified
899-999	unknown (primarily strain, muscle soreness, pain with lifting etc)

Results: Work-related Musculoskeletal Disorders

Incidence and direct costs for workers' compensation cases of WMSDs by body area and specific conditions have been reported by Washington State (Table F10). Industry groups at high risk appear in construction, health care and trucking (Table F11). WMSDs of the neck, back and upper extremity represent more than 25% of all state fund claims, more than 40% of all lost time claims and 45% of all costs. Indirect costs range from two to five times direct costs.

There were 336,608 State Fund accepted claims for WMSDs of the neck, back and upper extremity, averaging 37,401 per year from 1997 - 2005, resulting in:

- $4.1 billion in direct costs
- 27% of all State Fund-accepted claims
- 36% were compensable (four or more timeloss days) versus 24% of all claims
- Average claims incidence rate (CIR) of 258.0 claims and severity rate (SR) of 18,461 days per 10,000 full-time equivalent employees (FTEs)
- Average compensable claims incidence rate of 92.9 per 10,000 FTEs
- Average of 217 timeloss days per compensable WMSD claim
- 51% of claims involved back disorders, 37%% involved upper extremity disorders

The average number of State Fund WMSD claims for the neck, back and upper extremity was 37,401 per year and averaged $12,377 per claim.

There was a significant decrease in accepted State Fund CIR for all claims, -5.9% per year over the study period ($p<0.0001$). The CIR for WMSDs decreased -5.6% per year ($p<0.0001$), slightly slower than the -5.9% for all non-WMSD claims. Decreases in rates of neck (-5.5% per year), back (-5.5% per year) and upper extremity (-5.4% per year) WMSDs decreased significantly but not differently than for all other claims. There was no difference in median body mass index (BMI) for all compensable WMSD claims compared to all claims (BMI=27.2). Those with WMSDs tended to be on the job about two months longer than those with other claims (14 versus 12 months).

For the Self-Insured, coded data was available only for compensable closed claims (four or more lost time days). There were 74,361 compensable closed WMSD claims (8,282 per year) resulting in:

- 47% of all Self-Insured compensable closed claims
- Average compensable CIR of 140 per 10,000 FTEs
- 46% were back disorders and 39% were upper extremity disorders
- Claims rate for all compensable claims decreased on average -5% per year, and for WMSDs, -4.7%, not significantly different from - 5.2% for all other claims.

Since approximately 30% of Self Insured claims are compensable, the estimated number of total (medical only + compensable) WMSD claims per year would be approximately 27,600 over the study period.
The CIR for all State Fund compensable claims decreased -4.0% per year ($p<0.0001$) with no difference in decrease between WMSD compensable CIR and all other compensable claims.
We looked at several specific diagnostic codes (ICD-9) for WMSDs in the State Fund and found:
For **sciatica**, there were 7,478 accepted claims (808 per year), with a CIR of 5.7 and a severity rate (SR) of 1,954 days per 10,000 FTEs, they were extremely costly:

$69,237 per claim on average

- 77.6% were compensable with an average time loss of 554 days
- The CIR for accepted sciatica claims decreased -1.5% per year, compared to -5.9% for all other claims.

For **rotator cuff syndrome**, there were 22,611 accepted claims (2,512 per year) with:

- An average CIR of 17.3 claims and SR of 2,344 days per 10,000 FTEs
- Average cost of $32,169 per claim
- 63% were compensable with an average time loss of 334 days
- The CIR decreased -1.2% per year over the study period ($p<0.0002$), significantly slower than the -5.9% for all other claims ($p<0.02$).

For **epicondylitis**, there were 14,467 accepted claims (1,607 per year) with:

- An average CIR of 11.1 claims and severity rate of 546.6 days per 10,000 FTEs
- Average cost of $12,006 per claim
- 41.8% were compensable with an average time loss of 271 days
- There was a significant decrease in CIR, -2.3% per year, over the study period, not significantly different than other claims ($p<0.09$).

For **carpal tunnel syndrome**, there were 26,685 accepted claims (2,965 per year) with:

- An average CIR of 20.4 claims and SR of 2,478 days per 10,000 FTEs
- Average direct cost of $22,686 per claim
- 65% were compensable
- Average time loss was 258 days
- The CIR decreased significantly (-4.8% per year, $p<0.0001$), slightly slower than -5.9% for all other claims.

Among State Fund compensable claims, rotator cuff syndrome incidence increased 1.5% per year ($p<0.01$) while all other claims decreased significantly averaging -4.4 per year ($p<0.001$) and epicondylitis decreased significantly slower (-1.9% slower) than non cases (-4.0% per year, $p<0.05$).

For **hand/wrist tendonitis**, there were 19,908 accepted claims (2,212) per year with:

- An average CIR of 15.3 and SR of 1,199 per 10,000 FTEs
- Average cost of $14,045 per claim
- 41% were compensable with an average time loss of 264 days
- The CIR decreased significantly over the study period, -5.4% per year ($p<0.0001$) but not significantly faster than all other claims. For compensable claims, the decrease -2.6%, slower than the decrease for all other claims (-4.03%). The difference was of was borderline significance ($p<0.10$).

Gender: In some respects, men and women have the same compensable claims incidence pattern by age group for industries where they are likely to be doing similar types of work such as retail, health care and manufacturing. WMSD incidence rates tend to peak in the 35-44 age groups but go down more rapidly for men by the 45-54 age groups. For men in transportation the peak is between 25-34

years, and for women between 35-44 years. Although in construction, rates for both men and women peak between ages 35-44, the incidence rate for women is about three times higher. This may reflect different tasks. The incidence rate is somewhat higher for men, primarily because they are more concentrated in construction. Mean lost days tend to increase with age for both men and women through 55-64. There are some spikes for women in construction and agriculture in the oldest age group, probably due to the volatility of small numbers of women in these age/industry groups. For both men and women, the longest lost work days are in construction, followed by agriculture.

We used the Prevention Index (PI) to identify industries with the greatest impact of WMSDs. Industries are listed in rank order by the number of claims and by the rate of claims. The PI is the average of the two ranks for each industry. An industry therefore is high on the PI if it has a relatively high number of claims and a relatively high CIR.

Table F10. WA State Fund Workers Compensation Claims. Work-related Musculoskeletal Disorders (WMSDs) by Body Area, 1997-2005.

	Neck	Back	Upper Extremity	Shoulder	Elbow Forearm	Hand Wrist
Total claims 1997-2005	41,182	174,571	127,885	46,479	21,986	64,396
% of all claims	3.3%	14.1%	10.3%	3.7%	1.8%	5.2%
Total direct cost 1997-2005 in **millions**	$150	$1,900	$1,494	$645	$131	$602
Average total no. claims/year	4,576	19,397	14,209	5,164	2,443	7,155
Average total no. individuals/year	4,260	16,613	12,602	4,813	2,308	6,580
% female	46.1%	31.1%	43.2%	36.8%	40.3%	50.6%
Median age	39	36	38	39	40	38
Compensable claims median BMI*	26.6	27.1	27.4	27.3	26.6	27.7
Compensable claims median months on the job*	16	12	18	17	14	24
Average yearly claim rate per 10,000 FTEs	31.5	133.9	97.9	35.5	16.8	49.4
Overall yearly claim rate per 10,000 FTEs	31.4	133.3	97.6	35.5	16.8	49.2
Overall severity rate (lost days) per 10,000 FTEs	602.9	8383.8	7132.2	2835.2	693.8	3083.6
Total compensable claims	20,514	67,268	47,198	19,743	7,584	25,068
% of accepted claims	49.8%	38.5%	36.9%	42.5%	34.5%	38.9%
Overall yearly compensable claims rate per 10,000 FTE	15.7	51.4	36.0	15.1	5.8	19.1
Average time loss days	279	195	234	258	222	216
Median time loss days	53	24	74	83	64	69
Average total direct cost/claim**	$15,813	$11,626	$12,481	$16,092	$8,317	$10,983
Median total direct cost/claim**	$950	$834	$948	$1,111	$672	$939

BMI=weight in kilograms/height in meters^2

* 35.3% of compensable claims do not indicate length of employment

* 20.6% of compensable claims do not indicate height/weight

** adjusted to 2005 dollars (medical CPI+ general CPI for wages)

Table F11. WA State Fund WMSDs of the Neck, Back & Upper Extremity, 1997-2005. Top 25 4-digit NAICS by Prevention Index. *Compensable* Claims Incidence & Severity Rates per 10,000 FTEs

PI Rank	NAICS Code and Description	Count	Lost Days (000)	Rate per 10,000 FTEs	Rate Ratio	Severity Rate per 10,000 FTEs	Rate Rank	Count Rank
1	2381 Foundation, Structure, Bldg Ext Contrac	5,742	1,468	272.6	2.9	69,698	10	1
2	6231 Nursing Care Facilities	2,540	391	275.1	3.0	42,374	9	8
3	2383 Building Finishing Contractors	3,046	783	250.5	2.7	64,348	20	4
4	6233 Community Care Facilities Elderly	2,419	409	259.7	2.8	43,939	17	9
5	2361 Residential Building Construction	3,460	843	218.8	2.4	53,313	28	3
6	4842 Specialized Freight Trucking	1,299	264	265.6	2.9	53,935	13	25
7	6222 Psych & Substance Abuse Hospitals	796	101	310.3	3.3	39,419	7	32
8	4841 General Freight Trucking	1,895	344	233.4	2.5	42,319	24	16
9	5621 Waste Collection	723	101	373.3	4.0	52,181	3	41
10	5617 Services To Buildings And Dwellings	2,946	555	193.3	2.1	36,401	40	5
11	2389 Other Specialty Trade Contractors	1,505	401	197.5	2.1	52,664	38	19
12	7213 Rooming And Boarding Houses	1,372	256	207.7	2.2	38,753	34	23
13	3219 Other Wood Product Manufacturing	1,282	255	206.5	2.2	41,114	35	26
14	3116 Animal Slaughtering And Processing	665	105	263.5	2.8	41,563	16	48
15	4248 Beer, Wine, Alcohol Wholesalers	767	87	220.5	2.4	25,039	27	37
16	2382 Building Equipment Contractors	4,633	964	150.8	1.6	31,397	66	2
17	4451 Grocery Stores	2,253	347	157.6	1.7	24,245	61	10
18	2362 Nonresidential Building Construction	1,439	378	170.6	1.8	44,856	52	20
19	1133 Logging	702	203	216.9	2.3	62,790	32	43
20	8111 Automotive Repair And Maintenance	2,038	522	144.4	1.6	36,949	76	11
21	6239 Other Residential Care Facilities	689	113	186.4	2.0	30,512	43	45
22	3212 Veneer, Plywood, Wood Product Mfg	484	90	231.8	2.5	43,071	26	63
23	6232 Res Mentl Retrd, Mentl Hlth,Subst. Abuse	395	44	326.7	3.5	35,985	4	86
24	2373 Highway, Street, Bridge Construction	694	216	180.1	1.9	55,999	46	44
25	3315 Foundries	475	95	217.4	2.3	43,540	30	65
46	3115 Dairy Product Manufacturing	170	33.0	407.6	4.4	80,269	1	152
129	1132 Forest Nurseries, Gather Forest Products	22	0.60	375.5	4.0	10,872	2	271

Shaded in gray are industries in the top three by rate or count but not in the top 25 by prevention index.

NAICS groups averaging less than 100,000 hours per year were excluded from the analysis
950 cases missing NAICS code
Severity rate=time loss days per 10,000 FTEs

Conclusions: Work-related Musculoskeletal Disorders:

Work-related musculoskeletal disorders continue to be a large and costly problem in Washington State. The incidence rates for most WMSDs are decreasing; in some cases, the rate is relatively flat (epicondylitis, sciatica) or increasing (compensable rotator cuff syndrome). Severity rates have increased since last year's report. The highest risks are in industries characterized by manual handling and forceful repetitive exertions. These estimates of the burden of WMSDs are an underestimate because the lower extremity is not included, there is evidence of under-reporting of these kinds of disorders in the literature, and the indirect costs to the employer, employee and society are not included.

Priority Focus Area:

The Washington State Fatality Assessment and Control Evaluation (FACE) Program

Final Progress Report
July 1, 2005 – June 30, 2010
September 30, 2010

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Abstract
On average, seventy-seven workers died every year in preventable work-related incidents in Washington State according to The Washington State Fatality Assessment and Control Evaluation (WA FACE) surveillance program. In most years, the majority of work-related fatalities in Washington State are in the construction industry, followed closely by the agriculture, forestry, fishing, and hunting industries. Regardless of industry, every work-related fatality provokes a significant financial and emotional burden on the employers, employees, and families involved. WA FACE considers every work-related fatality to be preventable and is dedicated to the objective of eliminating occupational fatalities.

To realize this goal, WA FACE collects and organizes high quality data on every work-related fatality. WA FACE uses over a dozen data sources including WA State Division of Occupational Safety and Health (DOSH) investigation reports, medical examiners' reports, death certificates, law enforcement records, WA State Workers' Compensation data, as well as internet and media sources and collects up to one hundred individual variables per case. The high volume and quality of data collected provides WA FACE with several approaches to prevention. These range from the development of detailed profiles of individual cases that include incident specific practical preventive measures to multi-year perspectives of cases that communicate methods to identify and avoid frequent hazards. For individual cases, WA FACE continues to develop and refine fatality narratives for the construction, and more recently the agriculture industry. The mailing distribution list for FACE construction fatality narratives contains approximately 700 valid addresses and continues to expand after several years, while the relatively new agriculture fatality narratives mailing list is growing quickly. WA FACE also conducts in-depth investigations and prepares longer investigation reports. These reports are also distributed using a growing mail distribution list. Fatal facts are a type of report WA FACE uses to characterize hazards in a particular industry, associated with a specific job, or of a common incident type among several industries. These often encompass several years and have been developed for motor vehicle crashes and loading / unloading hazards in transportation and hazards to workers operating and around construction machinery.

In addition to various reports and their respective distribution lists, WA FACE is capable of targeted and broad dissemination of prevention materials using the unique WA State Workers' Compensation (WC) database to generate mailing lists of at risk employers. These lists are generated using combinations of risk class, industry and occupation codes, business size, and key words to ensure that FACE is reaching employers probable to utilize and benefit from FACE publications. WA FACE materials are distributed broadly through the partnering with several stakeholders, multiple presentations by FACE staff, and the recently developed collaboration with WA Labor Neighbor Radio (LNR). WA FACE contributes topical subject matter, data, and technical support and LNR develops one or more prevention-focused radio spots. LNR estimates that there were several million opportunities to hear different radio spots over the last year.

WA FACE uses several tools to evaluate the reach, impact, and quality of their prevention efforts. All WA FACE publications are available on the Safety and Health Assessment and Research for Prevention (SHARP) website and the number of downloads are tracked monthly and in relation to distribution efforts. Along with an increase in the number of publications, the number of downloads has increased over time. The number of downloads of a publication over time provides insight into the utility of the material. WA FACE has also used construction fatality narratives for on-site employer and employee trainings. These have provided opportunities to solicit feedback with evaluation surveys. The majority of responses from these surveys ranked WA FACE narratives as 'very good'. The most recent web based evaluation survey completed by recipients of WA FACE fatality narratives revealed that very high percentages of respondents reported using the information to identify hazards or make changes in their workplace.

WA FACE has become a resource for all of Washington by maintaining a responsive expert staff, and nimble database, and an extensive web catalog of materials. In return, WA FACE benefits from extensive support from the health and safety, employer, and worker communities.

SECTION 1

Highlights/Significant Findings

For the previous five year grant cycle, WA FACE documented a decrease in the number of work injury fatalities from 81 to a FACE program low of 64 for calendar years 2005 to 2009. To provide better perspective, the Washington State fatal work injury rate was calculated using the number of fatalities as determined by WA FACE and Bureau of Labor Statistics (BLS) current population survey employment estimates for Washington State. The fatal work injury rate in Washington State declined from 2.96 in 2005 to 2.26 per 100,000 full-time equivalents (FTEs) in 2009. Compared with US fatal work injury rates generated by the Census of Fatal Occupational Injuries (CFOI), Washington State rates followed a similar decreasing trend over the five year cycle and averaged approximately 1.12 per 100,000 FTEs lower over the five years. WA FACE continues efforts to reduce the number and rates or work injury fatalities in the Washington.

WA FACE data shows that the top three industry sectors with the highest numbers of work injury fatalities in Washington State are: agriculture, forestry, fishing, and hunting; construction; and transportation and warehousing. The construction industry sector was highest for three of the five grant cycle years while the agriculture, forestry, fishing, and hunting industry sector was highest the remaining two years. Much of the WA FACE programs' efforts focused on these industries as displayed by the agriculture and construction fatality narrative series and frequent updates to industry specific supplemental reports.

In terms of incident type, motor vehicles were responsible for the highest number of work-related fatalities each of the five years. Each year, the industries comprising the truck transportation subgroup accounted for the highest number of motor vehicle incident fatalities. WA FACE added to the existing incident specific publications with a new fatal facts report that profiled ten years of fatal work-related motor vehicle incidents. WA FACE also generates annual supplements for high risk industries that list the frequency of work injury fatalities by incident type.

Translation of Findings

In response to significant findings, WA FACE focuses a majority of resources for prevention on the agriculture, forestry, fishing, and hunting, construction, and transportation and warehousing industries. These resources come in the form of construction and agriculture specific fatality narratives which are frequently published, widely distributed, and positively evaluated. In the construction industry, WA FACE has conducted 'tailgate trainings' using FACE fatality narratives to promote prevention strategies for new and frequent hazards. In response to a series of fatal tractor roll-over incidents in the agriculture industry, WA FACE administered a survey to assess the status and promote the usage of roll-over protection structures (ROPS) on tractors. WA FACE also began a series of agriculture fatality narratives in 2010. Resources specific to the transportation industry are the heavily downloaded *Fatal Facts: Work-Related Motor Vehicle Traffic Crashes* and *Fatal Facts: Hazards to Truck Drivers Loading and Unloading.*

WA FACE conducts in-depth investigations of select fatal incidents as defined in the NIOSH priority areas as well as Washington State priority areas. These investigations result in reports that contain specific and detailed recommendations for employers that will aid in the prevention of future incidents. Investigation reports along with recommendations for prevention are distributed using the growing mailing list.

The multiple products and recommendations produced by WA FACE are developed and distributed through reciprocal relationships with other networks such as DOSH, the Washington State OSHA, and several business associations and labor groups. WA FACE works closely with DOSH managers in the

development of products and recommendations which results in products that are used by DOSH staff. WA FACE maintains long-standing relationships with construction and machinery operator labor groups, WA Building Contractors Association, WA Farm Bureau, and Evergreen Safety Council, among others who have come to rely on WA FACE products and presence at meetings and events.

WA FACE uses relationships and evaluation surveys to solicit feedback and input to focus FACE efforts. Examples are the development of a combination of products characterizing hazards to operators of and workers around construction machinery. A FACE fatal facts report was developed in response to request from DOSH managers and the International Union of Operating Engineers (IUOE). A single page prevention-focused tri-fold was also developed for the same audience as a result of survey feedback that FACE should develop shorter products with practical prevention information. The IUOE subsequently used excerpts from the report for the safety section of their trade journal and WA FACE has filled requests for several hundred copies of both products to the union.

Outcomes/Relevance/Impact

Potential Outcomes

WA FACE produced a total of 59 fatality narratives in English and 15 in Spanish and directly distributed them to nearly 40,000 individuals. Fatality narratives were initially developed for the construction industry but data indicated a need and they were recently added for the agriculture industry. WA FACE also produced 11 fatal facts and 8 investigation reports during this period. In addition, 17 other summary reports were produced and published on the website. These documents were also used in numerous stakeholder meetings and presentations to business, labor, and government by FACE staff. From 2005-2009, FACE staff presented WA FACE data and documents to 148 stakeholders and partners and at 18 conferences and meetings.

Intermediate Outcomes

FACE construction fatality narratives were used as training materials for presentations given to construction workers, superintendents, apprentices and maintenance workers over a two-year period. Seven trainings were given to a total of 377 workers, out of which, 318 completed post-session evaluations for a response rate of 84%. Approximately 70% of the evaluators stated that they planned to make changes in identifying hazards and 50% planned to make changes in planning or setting up a job after the training. Over 25% reported planning to make changes in the use of tools or safety gear as a result of the training session.

WA FACE administered an electronic evaluation survey in 2009 to assess the utility and impact of our fatality narratives and case investigations. These evaluations suggest that over 88% of the respondents believe the narratives and investigations rate from good to excellent for readability and usefulness. 65% of respondents planned on making changes in hazard identification and 40% planned on making changes in job set-up, safety procedures, tool or safety gear use. 70% of respondents reported using narratives for increasing awareness, training, and distributing to employees while 40-50% reported posting them on bulletin boards and retaining them for future use.

End Outcomes

Specific topic areas where WA FACE data, documents, and staff expertise have contributed to policy change include heat stress, ROPS, fall protection, and crane safety. WA FACE data was used by WA DOSH and state policy makers during the drafting of the WA State rules on worker heat-related illness prevention, ROPS, fall protection, and crane safety. The WA FACE administered survey of tractors and ROPS documented increases in the percentage of older tractors equipped with ROPS when compared to other states with less protective rules. This study simultaneously identified the low level and need for increased seat belt usage among tractor operators and that better protective structures are needed for tractors operated under overhead obstacles.

SECTION 2

Scientific Report

Background for the Project

The WA FACE Program has been conducting fatality surveillance and prevention activities in Washington State since 1997. The FACE program enjoys extensive and near universal support from the employer and worker communities. The program continues to develop, maintain, and enhance its goal of preventing work-related traumatic injuries and deaths. The program has four components: 1) surveillance, 2) investigation, 3) prevention activities/information dissemination, and 4) evaluation. Detailed surveillance data is collected on all work-related fatalities in Washington State. The data is used to help focus incident investigations as well as describe the incidents and associated risk factors. The data is also used to develop and disseminate information on preventive actions.

Specific Aims

The nine specific aims of the WA FACE program along with five year updates are:

1) Maintain and enhance the current program's timely multi-source traumatic occupational fatality surveillance system.

The WA FACE surveillance system manager has over twelve years experience maintaining the system. Enhancements to the system include: simplifying and 'flattening' of data base for ease of use and access; coding of all cases for country of origin; coding of all fall cases to include height of fall elevation; addition of 'green-related' indicator variable; addition of height variable for fall incident; addition of 'language' indicator variable; addition of numeric code-linked text descriptions for industry and incident codes; updating to 2010 version SOC codes; and enhanced incident coding.

2) Identify situations and factors using epidemiological, safety engineering, and human factors/ergonomics methods to focus prevention strategies.

The WA FACE staff consists of an industrial hygienist, safety engineer, and research specialist with several years of education, training, and experience. FACE staff continues to utilize fundamental epidemiologic tools to identify frequent and new hazards and promote practical preventive safety measures.

3) Investigate select fatal incidents as defined in the NIOSH priority areas as well as Washington State priority areas. Current priority incident types include deaths: associated with machinery; due to falls in residential and commercial construction; associated with renewable or green energy generation; and to foreign-born workers.

WA FACE has investigated eight priority area fatalities and generated and disseminated relevant hazard identification and prevention communications to targeted audiences. All investigation reports contained several detailed recommendations for preventing future incidents.

4) Develop and disseminate prevention materials that can be used to reduce the risk of fatal occupational injuries.

WA FACE strives to develop prevention materials with several practical recommendations for hazard identification and prevention that can be used by employers of various sizes and levels of resources. WA FACE developed a fall prevention hazard assessment tool that is still being tested and evaluated for use in residential construction. In the most recent FACE investigation report of a glass 'L' rack-related fatality, detailed recommendations were presented and attainable at various levels off resources.

5) Develop a series of case narratives for construction and agricultural fatalities.

WA FACE now develops distributes both construction and agricultural fatalities. Narratives have been enhanced with a new easily identifiable look, a hyper-linked section of relevant WA standards, and a section of relevant, specific, and practical recommendations.

6) Utilize Washington State non-fatal injury data for potential incorporation into industry and hazard specific prevention materials.

WA FACE has incorporated injury statistics into several draft publications including recent agriculture and construction machinery-related fatalities reports. Reviewers of the drafts reported that the inclusion of nonfatal injury statistics from the Washington State Workers' Compensation System were 'out of place' and thus, were not included in final versions. WA FACE will continue to investigate the use of fatal and nonfatal injury statistics for hazard identification and characterization. Nonfatal injury statistics were used in a recent publication prepared by FACE staff to characterize the frequency, severity, and costs of injuries within the construction industry.

7) Identify and utilize public and organizational media outlets (like radio, blogs, organization newsletters and trade publications) to increase dissemination of targeted prevention materials.

WA FACE has collaborated with labor Neighbor Radio to produce 12 sixty-second occupational health and safety radio spots, 10 of which have aired and two are pending. These spots have aired on 57 different stations in WA and LNR estimates there were 14 million opportunities for listeners to hear these spots. WA FACE has also partnered to use external websites including WA DOSH, KeepTruckingSafe.org, and Pacific Northwest Agriculture Safety and Health (PNASH) center that host FACE publications.

8) Evaluate the materials that are developed and disseminated using electronic surveys, website activity tracking, and feedback from trainings.

The most recent FACE electronic survey in 2009 yielded 85 responses. The objective of the survey was to assess the utility and impact of our fatality narratives and case investigations. These evaluations show that over 88% of the respondents believe the narratives and investigations rate from good to excellent for readability and usefulness. More importantly, 65% of respondents planned on making changes in hazard identification and 40% planned on making changes in job set-up, safety procedures, tool or safety gear use.

WA FACE now has an on-line survey linkable from all FACE web pages that is available to evaluate every FACE document. Survey respondents are able to identify the specific FACE document they are reviewing by title and the survey contains options for every title separated into drop-down boxes by narratives, investigations, fatal facts, and other data summaries. This will allow FACE to generate feedback regarding specific products and continually evaluate all products over time.

Several FACE documents, despite being somewhat dated are continuously downloaded at much higher rate than the average FACE document. Specifically, *Fatal Facts: Hazards to Truck Drivers Loading and Unloading* is downloaded between 1700-2000 times each month and a series of documents developed for preventing injuries and fatalities among highway construction zone workers are downloaded nearly 500 times each month.

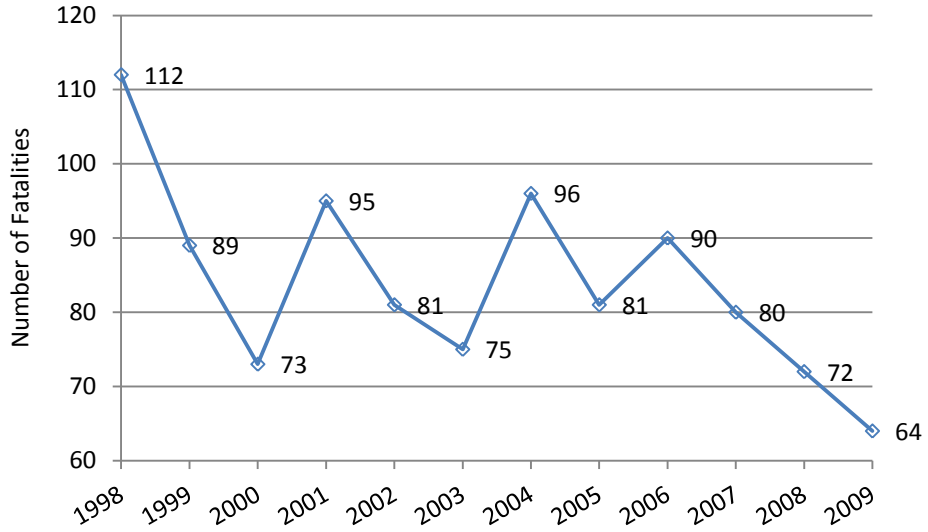
9) Evaluate the impact of Washington FACE Program prevention activities by focusing on outcomes for selected incident types in high-risk industries.

WA FACE has characterized incident types by frequency in high risk industries in WA State and continues to investigate these incident and industry permutations. WA FACE will also continue to investigate the possible effect of FACE materials and activities on the frequency of non-fatal occupational injuries in high-risk industries.

Results

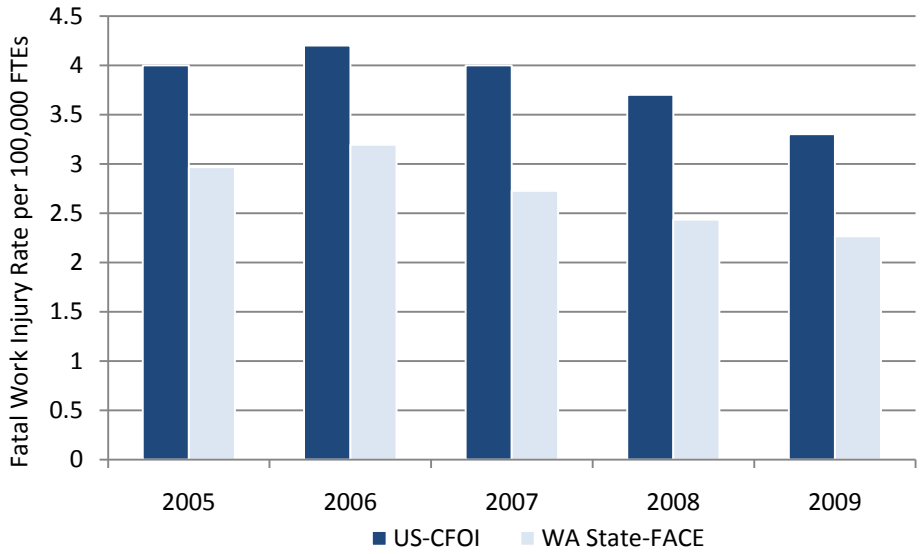
The number of work injury fatalities in Washington State has significantly declined from 2005 to 2009.

Washington State Work Injury Fatalities, 1998-2009



The rate of work injury fatalities in Washington State is consistently lower than the US level as reported by CFOI and has declined from 2005 to 2009.

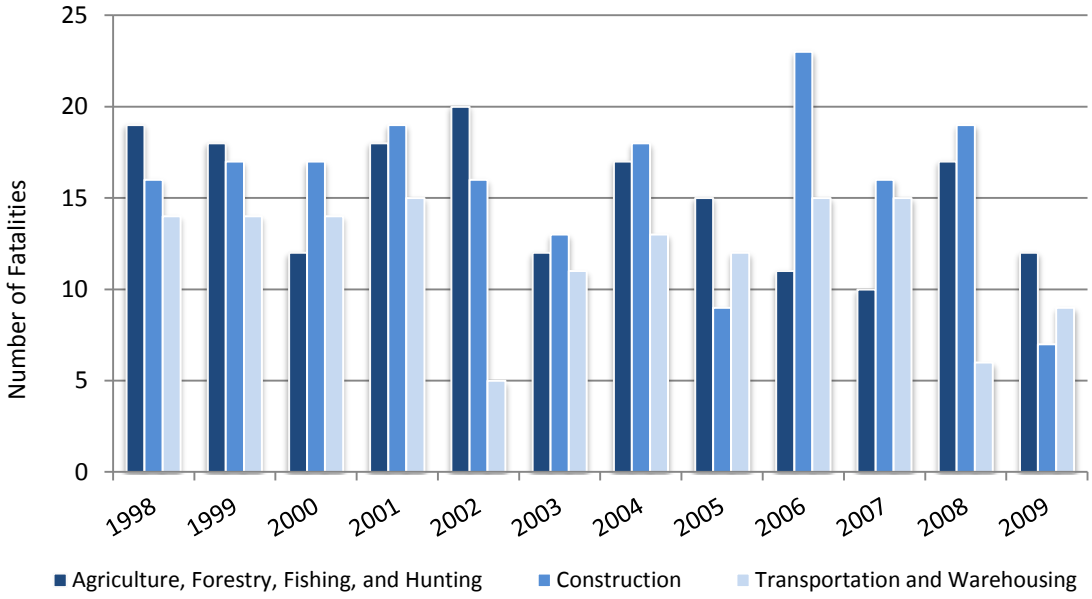
US and Washington State Fatal Work Injury Rates, 2005-2009*



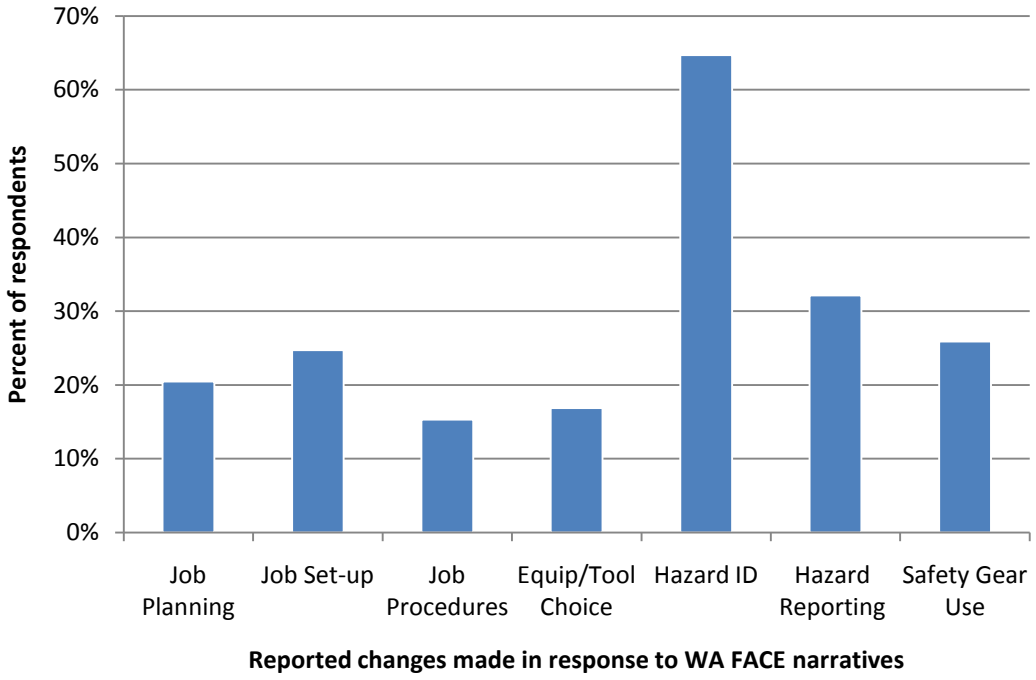
*The employment figures are annual average estimates of employed civilians, 16 years of age and older, from the Current Population Survey (CPS). The resident military population is not included.

The number of work injury fatalities in major industries in Washington State has declined from 2005 to 2009.

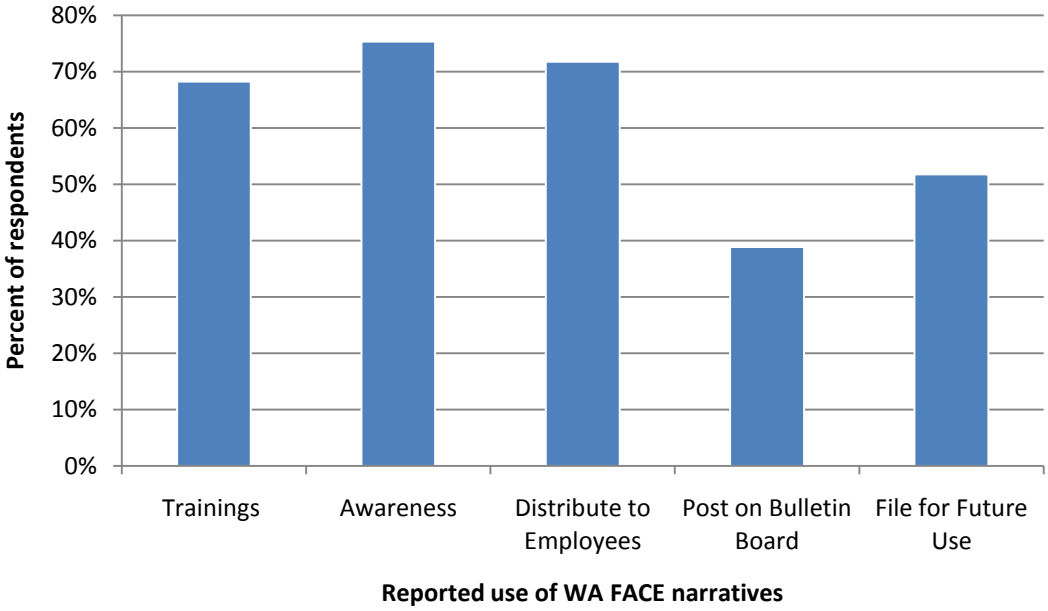
Washington State Work Injury Fatalities by Top Three Industries, 1998-2009



WA FACE Evaluation Survey-Reported Changes Made in the Workplace, 2009



WA FACE Evaluation Survey-Reported Use of Narratives in the Workplace, 2009



Publications and Presentations

WA FACE Publications, 7/1/2005 to 6/30/2010

FACE Publications 7/1/2005 to 6/30/2010	Number of Documents
Fatality Investigation Reports	8
Fatality Narratives	59
Spanish Translations of Fatality Narratives	15
Fatal Facts	11
Fatality Data Summaries by Year	5
List of Fatal Incidents by Year	5
Industry and Other Fatality Reports	7

WA FACE Downloads, 7/1/2005 to 6/30/2010

Year	Number of Documents	Number of Downloads	Percent Change
2010 (as of 6/30)	250	149,893	+37%[A]
2009	246	219,392	+42%
2008	214	154,888	-25%
2007	190	208,581	+8%
2006	151	193,334	
2005	n/a	n/a	
		Total = 926,088	

A. Estimation based on 24,982 downloads/month for the first six months of 2010.

WA FACE Presentations, 7/1/2005 to 6/30/2010

FACE Presentations, 7/1/2005 to 6/30/2010	Number of Presentations
Stakeholder and Partner Presentations[A]	148
Conference and Meeting Presentations[B]	18

A. Major stakeholders and partners include: Washington Residential Construction Safety Council, Washington Safety & Health Training Institute, Association of Builders and Contractors, Master Builders Association, Build It Smart, Associated General Contractors.

B. Major conference and meetings include: American Society of Safety Engineers, Puget Sound Safety Summit, , WSDOT Traffic Control Oversight Committee, New Paths: Health and Safety in Western Agriculture, National Occupational Injury Research Symposium, Governor's Industrial Health & Safety Conference.

WA FACE Fatality Investigation Reports, 7/1/2005 to 6/30/2010

52-20-2010 Assembler / Fabricator Dies When Struck by "L" Rack Loaded with Glass Mirrors in Washington State

52-19-2009 A 16-Year-Old Worker Dies When Struck by a Portable Gantry Crane used as an Engine Hoist

52-18-2008 Maintenance Worker Electrocuted While Attempting to Change a Light Bulb in Washington State

52-17-2008 Two Teen Workers Asphyxiate in an Agricultural Silo

52-16-2007 Temporary Construction Worker Dies After Falling from a Scaffold Plank in Washington State

52-15-2006 Maintenance Worker Killed When Struck by a Vehicle along a Highway in Washington State

52-14-2006 Flagger Fatally Injured When Struck by a Car at a Highway Work Zone in Washington State
52-13-2005 Utility Construction Supervisor Killed When Struck by a Pickup Truck at a Work Zone in Washington State

WA FACE Fatality Narratives, 7/1/2005 to 6/30/2010

71-95-2010 Roofing Contractor Falls from a Boom-Supported Elevating Work Platform
71-94-2010 Operating Engineer Struck by Concrete Slab
71-93-2010 Farm Tractor Operator Falls From Tractor and Run Over
71-92-2010 Cellular Tower Crew Foreman Killed in Fall from Antenna Mast
71-91-2010 Farm Laborer Dies from Heat Stroke
71-90-2010 Well Driller Struck By Water Drill Pipe Sliding Off Back of Truck
71-89-2010 Carpenter Struck By Concrete Pump Hose
71-88-2009 Foreman Killed When Collapsing Steel Columns Knock Over Boom Lift
71-87-2009 Laborer Killed When Run Over by Reversing Dump Truck
71-86-2009 Security Guard at Construction Site Pinned between Door and Frame of Pickup Truck
71-85-2009 Laborer Backed Over by Water Truck in Highway Work Zone
71-84-2009 Aerial Platform Operator Crushed
71-83-2009 Crane Operator Falls While Descending Crane
71-82-2009 Siding Installer Supervisor Dies in Head-on Motor Vehicle Collision
71-81-2009 Excavator Operator Killed When Excavator Tips Over
71-80-2009 Framing Contractor Falls from Roof
71-79-2009 Excavator Operator Killed When Excavator Rolls On Its Side
71-78-2008 Carpenter Falls into Elevator Shaft
71-77-2008 Laborer Falls into Trench and Struck by Excavator Bucket
71-76-2008 Construction Equipment Mechanic Killed While Working Under Truck
71-75-2008 Concrete Finisher Driving Flatbed Truck Dies When Vehicle Leaves Road and Crashes
71-74-2008 Well Driller Helper Killed When Stationary Well Drilling Truck Tips Over
71-73-2008 Construction Engineer Killed When Struck by Car in Highway Work Zone
71-72-2008 Roofer Falls from Extension Ladder When it Collapses
71-71-2008 Painter Killed When Scissor Lift Tips Over
71-70-2008 Journeyman Telecommunications Technician Electrocuted After Contacting Overhead Power Line
71-69-2008 Foreman Performing Maintenance Work on Fuel Storage Tank Killed in Explosion
71-68-2007 Laborer Struck by Excavator Bucket
71-67-2008 Mechanic Killed When Tunneling Locomotive Crashes
71-66-2007 Carpenter/Pile Driver Struck by Falling "Strong-back"
71-65-2007 Sider Falls from Scaffolding
71-64-2007 Skid Steer Loader Operator Ejected and Crushed by Bucket
71-63-2007 Carpenter Struck By Falling H-beam
71-62-2007 Roofer Falls from Roof After Un-clipping from Lifeline
71-61-2007 Pipe Layer/Laborer Falls into Catch Basin
71-60-2007 Laborer Dies While Attempting to Stop Runaway Vehicle
71-59-2007 Laborer Run-Over by Backing Dump Truck

71-58-2007 Ironworker Falls While Moving Roof Decking Bundle
71-57-2007 Laborer Dies from Heat Stroke
71-56-2007 Framer Falls from Roof
71-55-2007 Electrical Contractor Electrocuted After Contacting Energized Conductors
71-54-2006 Workers Killed in Motor Vehicle Crashes
71-53-2006 Apprentice Lineman Electrocuted After Contacting Underground Primary Cable
71-52-2006 Laborer Electrocuted When Truck Mounted Boom Contacts Overhead Power Line
71-51-2006 Site Superintendent Falls Through Skylight Cutout
Superintendente de campo se cae por la abertura de un tragaluz (Spanish version)
71-50-2006 Sider Installer Falls from Ladder
Instalador de paneles laterales se cae de una escalera (Spanish version)
71-49-2006 Journeyman Carpenter Struck by Falling Wall Section
Jornalero golpeado por una sección de pared que se cayó (Spanish version)
71-48-2006 Carpenter Falls From Top Plate
Un carpintero se cae de la placa superior (Spanish version)
71-47-2006 Carpenter Falls From Balcony
Un carpintero se cae desde un balcón (Spanish version)
71-46-2006 Mechanic Crushed Between Bed and Frame of Dump Truck
Mecánico aplastado entre la caja y el chasis de un volquete (Spanish version)
71-45-2006 Operator Killed When Tractor Rolls Over
Operador muerto cuando un tractor se vuelca (Spanish version)
71-44-2006 Excavation Contractor Killed When Bulldozer Rolls Over While Unloading from Trailer
Un contratista de excavaciones murió cuando se volcó un buldózer mientras lo descargaban de un remolque (Spanish version)
71-43-2006 Helper Killed When Trench Collapses
Un ayudante murió cuando se desplomó una zanja (Spanish version)
71-42-2005 Contractor Struck By Falling Wall Section
Contratista golpeado por una sección de pared que se cayó (Spanish version)
71-41-2005 Workers Killed in Motor Vehicle Crashes
Trabajadores muertos en choques de vehículos de motor (Spanish version)
71-40-2005 Specialty Trade Contractor Falls from Ladder
Contratista de productos especializados se cae de una escalera (Spanish version)
71-39-2005 Carpenter Falls Through Skylight Opening
Carpintero se cae por la abertura de un tragaluz (Spanish version)
71-38-2005 Ironworker Falls Through Roof Opening
Trabajador siderúrgico se cae por una abertura del techo (Spanish version)
71-37-2005 Carpenter Falls from Top Plate of House Wall
Un carpintero se cae desde la placa superior del muro de una casa (Spanish version)

WA FACE Fatal Facts, 7/1/2005 to 6/30/2010

47-19-2009 Logging Fatalities 1998 to 2008
47-18-2009 Agriculture Fatalities 1998 to 2008
47-17-2009 Construction Machinery Fatalities 1998 to 2008
47-16-2009 Fatal Work-Related Motor Vehicle Traffic Crashes in Washington State, 1998 to 2007

47-15-2008 Truck Driver Fatalities
47-14-2007 Commercial Cleaner Dies of Carbon Monoxide Poisoning
47-13-2007 Electrocution Hazard from Overhead Lighting Systems
47-12-2007 Farm Tractor Hazards
47-11-2006 Fall Hazards in the Construction Industry
47-10-2005 Electrocution Hazard Working Near Overhead Powerlines
47-9-2005 Silos and Silo Gas Hazards

WA FACE Fatal Data Summaries by Year, 7/1/2005 to 6/30/2010

2009 data
2008 data
2007 data
2006 data
2005 data

WA FACE List of Fatal Incidents by Year, 7/1/2005 to 6/30/2010

2009 listing of fatalities
2008 listing of fatalities
2007 listing of fatalities
2006 listing of fatalities
2005 listing of fatalities

WA FACE Industry and Other Fatality Reports, 7/1/2005 to 6/30/2010
Construction industry, 2008
Construction industry, 2007
Construction industry, 2006
Construction industry, 2005
Commercial Fishing Fatalities, 1998-2006
Workplace Homicides, 1998-2006
Agriculture industry, 1998-2005

WA FACE Peer-reviewed Publications, 7/1/2005 to 6/30/2010

Schoonover, T., D. Bonauto, et al. (2009) "Prioritizing prevention opportunities in the Washington State construction industry, 2003-2007." J Safety Res 41(3): 197-202.

Stevens E, Cohen M, Spielholz P. (2009) “Optical Properties of Plane and Convex Mirrors: Investigation of Mirror Use to Enhance Construction Flagger Safety,” International Journal of Occupational Safety and Ergonomics, 15(1), pp. 89-100.

Spielholz P, Clark R and Sjostrom T, (2007), “Development and Use of Fatality Narratives to Convey Hazard Information,” *Professional Safety*, April: 22-25.

Spielholz, Clark R and Sjostrom T, (2007), “Fatal Falls from Elevation in Construction: An Evaluation of Incidents in Washington State and Recommendations for Prevention,” *AIHCE Proceedings*, Philadelphia, PA, June 4-8, (abstract).

Kedan G, Spielholz P, Sjostrom T, Trenary B and Clark R, (2007), “An Assessment of Gases in Oxygen- Deficient Hay Silos and the Effects of Forced Ventilation,” *Journal of Agricultural Safety and Health*, 13(1), pp. 83-95.

Spielholz P, Sjostrom T, Clark R and Adams D, (2006), “A Survey of Tractors and Rollover Protective Structures in Washington State,” Journal of Agricultural Safety and Health, 12(4), pp. 325-333.

Spielholz P and Chavez M, (2006), "Reducing Injury Risk Factors Through Building Specifications," *IEA 2006 Triennial Conference Proceedings*, Maastricht, Netherlands, July 10-14.

Cohen, M. A., R. E. Clark, et al. (2006). "Work-related deaths in Washington State, 1998-2002." J Safety Res 37(3): 307-19.

Priority Focus Area:

Washington State Trucking Injury Reduction Emphasis through Surveillance (TIRES)

Final Progress Report
July 1, 2006 - June 30, 2010
September 24, 2010

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A component of the
'Washington Occupational Safety and Health Surveillance Program"
CDC/NIOSH Cooperative Agreement 5 U60 OH 008487

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Abstract
The Washington State trucking industry has some of the highest costs and rates for work-related injuries. However, surveillance and research efforts have solely focused on preventing motor vehicle collisions, with relatively little effort dedicated to other common injuries. The most common and costly injuries in trucking are musculoskeletal disorders, falls, motor vehicle collisions and injuries from being struck by or against an object. These conditions comprise 80% of the industry's workers' compensation claims, costs and lost workdays.

TIRES conducted in-depth occupational safety and health surveillance in the Washington State trucking industry to identify work environments that put trucking industry workers at increased risk. TIRES surveyed trucking industry workers who held Commercial Driver's Licenses, trucking companies and injured workers and used the information gathered to identify potential risk factors for worker injury and death.

The TIRES steering committee, a group of industry stakeholders comprised of labor, business, insurance companies, trucking schools and independents, was developed to formulate and assist with dissemination of prevention strategies to those who could intervene in the workplace. Workers' compensation data was used to identify and monitor all reported work-related claims in the industry. Case follow-up, site visits and information dissemination focused on the above priority conditions.

The TIRES program, along with the TIRES steering committee, developed a collaborative web site, www.KeepTruckingSafe.org for publication and information dissemination. Additionally, TIRES developed a first of its kind, interactive, simulation training tool that measures the force of jumping from a cab or trailer. (An action that contributes to the most common injury type - non-traumatic musculoskeletal disorders.) This tool has been downloaded from the web site over 2,000 and several industry safety professionals from all over the country have requested it for use in their trainings.

In the past year alone, there have been nearly 80,000 downloads of TIRES educational materials and 88% of the web site users have added TIRES to their favorites. Two of Washington's major trucking industry groups, the Washington Trucking Associations and the Washington Refuse and Recycling Association have linked to the web site.

Highlights/Significant Findings

- **Developed and implemented surveillance case follow-up for the trucking industry.** Case follow-up interviews with injured workers for the top four injury types in trucking: musculoskeletal disorders (MSDs), slips, trips and falls, motor vehicle crashes and struck by injuries, led to the identification of four job tasks associated with these injuries. They are: a) loading/unloading (and other manual handling), b) exit/entry from the cab or trailer, c) securing a load, and d) walking around the job site. TIRES received a second grant to continue surveillance research and intervention strategies. Now, in addition to collecting information about all injuries in the trucking industry the follow-up criteria will be refined to focus on the four work activities in order to understand the precipitating mechanisms and causal factors that result in injuries to truckers.

- **Formed the TIRES steering committee** comprised of industry stakeholders including business, labor, insurance, truck driver training schools and independent owner/operators. The steering committee has been invaluable to the work of TIRES, lending expertise, knowledge and ideas including reviewing and editing all 69 safety materials produced by TIRES. Although the steering committee meets only twice a year, they are in contact monthly and many are "on-call" whenever the TIRES program needs them. Suggestions like, the collaborative web site and on-line training tools came directly from the steering committee.

- **The majority of injuries in trucking occur at the customer site.** This is another significant finding from the case follow-up interviews. This creates a challenge for outreach training as the employer doesn't have the ability to monitor work processes. Truck drivers are independent workers who are often trained on the job by other drivers. They are in a hurry to get their cargo loaded/unloaded to get to the next job. This is a business where "time is money" and a "get the job done at all costs" attitude prevails. Therefore, risk is often considered a part of the job and unsafe shortcuts may be taken to save a few seconds. They may have deeply entrenched work routines or lack the appropriate equipment to complete the task safely. There is the expectation that drivers will get the delivery done no matter what. The employer may be the cause of the lack of proper equipment or maintenance or may just lack the ability to exert safety controls over their independent workforce.

- **Produced collaborative web site www.KeepTruckingSafe.org.** In the early stages of TIRES, the safety materials were mailed out to trucking companies, however the steering committee informed TIRES that most employers find their safety materials on the Web. Additionally, truckers who spend a lot of time on the road, have little to do during their DOT required rest time. Often these drivers are on the internet. In response to this feedback, the www.KeepTruckingSafe.org web site was created. This collaborative site has industry and sector specific information. Also, TIRES responded to requests from the publications evaluation survey to develop materials for mechanics and health issues.

Translation of Findings

- Safety resources should be focused on the most common and costly injuries in trucking. Resources and legislation are already focused on motor-vehicle crashes; however, little is being done in the areas of musculoskeletal disorders, slip, trips and falls and struck by injuries. Mitigating the risks of these injuries should be a primary concern of employers, the industry and future research. TIRES is already meeting this need with production of relevant safety materials focused on the most common and costly injuries.

- The TIRES Force Simulation tool is a prime example of educating the worker on the strain to the body caused by jumping from the cab or trailer or "riding the door" of the trailer. This type of

safety material was recommended by our steering committee as a way to reach young workers using a media (web-based) that they are most comfortable with. At trucking events, this simulation receives shocked responses, especially from young workers. Comments like “Oh my gosh! I do that all the time!” are very common. Independent workers, such as truckers, need to develop their own buy-in for safety as no one is looking over their shoulder to make sure they are working safely. Additional visual tools that educate and develop buy-in for safety are needed in this industry. Therefore, in the next TIRES grant, more simulations will be developed for the four target activities.

- Additionally, communication with customers should be increased to be sure they are aware of the risk. Slips, trips and falls and struck by injuries are common at customer sites. Often the driver knows the site is unsafe, yet is required to deliver there. Many times even the employer requests changes and is ignored. Additional research is needed to determine the best way to educate and develop buy-in of the customer. TIRES intends to work with dispatchers and sales people in the upcoming grant to discover what barriers and opportunities are involved in working with the customer to improve their site. Additionally, the TIRES safety engineers will conduct “ride alongs” with drivers on their routes to assess the various risks they face. A safety checklist has been developed to use on these ride-alongs and site visits.

Outcomes/Relevance/Impact

TIRES fills a training gap in the trucking industry. Prior to TIRES development of the www.KeepTruckingSafe.org web site and the accompanying safety education/injury prevention materials, there was no other consolidated internet safety resource for the US trucking industry. The web site logically organizes material for safety professionals and other stakeholders to quickly and easily find relevant publications to meet their training needs. 158,315 downloads tell us that we are meeting a need in the industry. 85-90% of the users add TIRES to their “favorites.”

TIRES publications include:

- 23 Safety posters
- 9 TIRESPIN newsletters
- 14 Tip sheets for use in safety trainings.
- 18 True story narratives of actual Washington truck drivers injured or killed at work.
- 4 Dollars and sense to show the value of investing in safety
- 2 Short reports that contain additional information to support the posters and tip sheets.

Using surveillance of claims data, TIRES targeted the most common injuries in trucking. Case follow-up surveillance of the most common injuries in trucking gathered data that TIRES staff used to target root cause of injuries, although there is more work to be done, TIRES case follow-up data have determined four tasks that lead to the majority of injuries. 1. loading/unloading (and other manual handling), 2. exit/entry from the cab or trailer, 3. securing a load, and 4. walking around the job site. The next TIRES grant will focus on these activities for intervention activities and safety materials. Additional force simulation tools will address these tasks.

Additional research needs to be done to determine how to reach the customer site to improve safety there. TIRES will meet this need in the next grant, also. The TIRES safety engineer will ride-along with drivers on deliveries and interview dispatchers and sales staff. TIRES has developed a checklist to assess risk at site visits. Quantifying risk data will give employers the information they need to target risk at their sites.

Section 2: Scientific Report

TIRES: Background:

This surveillance project focuses on the NORA disease and injury priorities of musculoskeletal disorders, low back disorders, and traumatic injuries (falls, motor vehicle crashes, struck by and caught in): and the tools and approaches priorities of exposure assessment methods (for surveillance purposes) and surveillance methods. Additionally the specific focus of this project is a very high-risk industry, not only in Washington State, but also throughout the country and other parts of the world: *trucking and courier services.*

In the U.S. trucking industry (SIC code 421), there were approximately 52,000 lost day injuries in 2002, with a rate 2.1 times higher than the entire U.S. private industry sector [US BLS, 2002]. For the trucking industry, injury rates for Motor Vehicle Crashes (MVC), Falls from elevation, and Overexertion incidents were 6.0, 3.5, and 1.9 times that of the entire private sector, respectively. Injury rates for Fractures and Sprains/strains in trucking were 2.9 and 2.3 times that of the entire private sector. Many of these injuries were due to crashes with vehicles, falling to walkways or the ground, or by lifting or being struck by parts, materials, or containers. The largest number of reportable injuries in 2002 was among truck drivers (n=112,200) with half of them being reported as strains and sprains stemming primarily from overexertion, contact with objects or falls. In estimating the cost of occupational injuries and illnesses (including indirect) in 1993, Leigh et al [2004] reported that trucking and courier services ranked first among 3-digit SIC codes for total costs of fatal and all non-fatal injuries and illnesses, $4.4 billion in 1993 representing 0.067% of the gross domestic product.

In Washington State, based on State Fund workers' compensation data, there are approximately 3,600 approved worker's compensation claims annually in SIC code 421, with 35% of these claims having more than 3 days of time loss. These time loss claims account for $33 million dollars in claims costs annually. Non-traumatic upper extremity and back musculoskeletal disorders (NT-MSDs) accounted for 39% of the time loss claims, while falls, struck by, caught in and motor vehicle crashes accounted for 20%, 16%, 9%, and 5% of the claims, respectively. NT-MSDs accounted for approximately 36% of the total claim costs, while falls, motor vehicle collisions, and struck by incidents accounted for 23%, 15%, and 12% of the total costs, respectively.

Table 1. Priority Conditions in Washington Trucking Industry

Condition	# Compensable Claims	Claims Rate per 10,000 FTEs	Costs $ (Thousands)
Caught in	161	17.1	3,645
Falls	1342	142.1	41,091
Non-Traumatic Back/Upper Extremity Musculoskeletal Disorders (NT-MSD)	2496	264.3	62,565
Struck by	1175	124.4	21,160
Motor Vehicle Crashes (MVC)	649	68.7	26,661
Lower Extremity Musculoskeletal Disorders (LE-MSD)	567	60.0	11,189

While the occupational health indicators developed by the Council of State and Territorial Epidemiologists are useful for a national system of state-based occupational safety and health surveillance, they greatly under-represent the burden of injury and illness in the trucking industry (Table 2). There is clearly some overlap between claims in Table 1 and Table 2, e.g., some falls or motor vehicle crashes would have resulted in hospitalization and/or amputations. Nevertheless, a surveillance system designed to track the true burden of injury in the trucking industry for prevention purposes, must go beyond the indicators.

Table 2. CSTE Indicator Conditions in Washington Trucking Industry NAICS, State Fund Compensable Claims (more than 3 lost workdays), 1998-2002 (WR: work-related)

Condition	# Compensable Claims	Claims Rate per 10,000 FTEs	Costs $
1. All non-fatal injuries/illness claims	6,862	726.7	171,653,291
2. WR hospitalizations	619	65.6	67,799,342
3. Fatal work injuries	21	2.2	3,429,318
4. WR amputations	44	4.7	1,787,511
5. WR amputation claims (all)	49	5.2	1,814,786
6. WR hospitalized burns	10	1.1	797,208
7. WR musculoskeletal disorders (NT-MSD)	2,382	252	63,580,674
8. WR carpal tunnel syndrome	242	26.6	15,367,924
9. WR Hospitalized pneumoconiosis	0	0	0
10. WR Pneumoconiosis mortality	0	0	0
11. WR Acute pesticide illness	1	0.1	378,125
12. WR Malignant mesothelioma	1	.1	301,921
13. WR Elevated adult blood leads	0	0	0

In an effort to understand what was happening with injuries in the trucking industry, SHARP developed a surveillance system to identify and monitor all reported work-related claims in the trucking industry, the Trucking Injury Reduction Emphasis through Surveillance (TIRES) project.

The overall goal of this surveillance project was to reduce the incidence of non-traumatic back and upper extremity musculoskeletal disorders (NT-MSD), falls, motor vehicle crashes, lower extremity musculoskeletal disorders (LE-MSD), struck by and caught in injuries within the trucking industry of Washington State. These conditions comprise 90% of the industry's workers' compensation claims, costs and lost workdays.

Specific Aims:

The TIRES surveillance system had 6 specific aims which included:

1) Build and maintain partnerships with representatives from both management and labor within the trucking industry,
2) Publish a technical report describing injuries, trends and costs within the trucking industry by sector utilizing state workers' compensation data,
3) Develop and implement a TIRES surveillance system to track claims in the trucking industry, with particular focus on the six priority conditions,
4) Develop and implement case follow-up protocols for identifying risk factors and solutions for the priority conditions,
5) Conduct industry-wide surveys of employers and employees to identify hazards and risk factors for the priority conditions, needs and possible solutions based on company type and size, and
6) Identify opportunities for the use of educational materials and other interventions to reduce hazards and injuries within trucking.

A brief summary for each specific aim, as well as detailed methods, results and a discussion section are provided below.

Specific Aim 1: Build and maintain partnerships with representative from both management and labor within the trucking industry

Methods: The TIRES steering committee was developed early in the grant to provide guidance for TIRES projects and plans. The TIRES steering committee is comprised of representatives of business, labor, independent owner/operators, insurance companies, and a representative from a publically-funded truck driving school.

TIRES research staff participate in various industry events and are often asked to speak about TIRES and to present safety materials at conferences such as the annual managers' meeting of the Washington Refuse and Recycling Association (WRRA) and the Washington Trucking Associations (WTA), two of the largest trucking industry associations in Washington State.

TIRES research staff participated in the past 3 annual WTA truck driving championships and also the past 3 annual World's Largest Convoy to benefit the Special Olympics. Both of these events have been extremely helpful in increasing the TIRES "brand" with trucking companies, truck drivers and their families.

Results:
As a result of these outreach events, TIRES with limited funding for advertisement, has expanded its reach to over 300 email subscribers and over 600 mailing list subscribers for TIRES materials. In addition the TIRES website receives on average 1,100 downloads a month. In addition to increased readership, these outreach events have been invaluable in obtaining industry contacts as well as providing TIRES with opportunities for company specific site visits and training.

Discussion:
Without the assistance of the TIRES steering committee, the prevention materials TIRES created would not have had the authentic tone and feel required to be successful in engaging and reaching both safety managers (many of whom are retired truck drivers), nor truck drivers themselves. Their assistance in creating meaningful documents, posters and other tools cannot be stressed enough. The use of "insiders" was critical to the success of TIRES.

Specific Aim 2: Publish a technical report describing injuries, trends and costs within the trucking industry by sector utilizing state workers' compensation data.

Methods:
The Economic Data
The information on the value of the services produced by the trucking industry for Washington State was provided by the Bureau of Economic Analysis of the US Department of Commerce. For the value of shipments carried by truck within Washington State we used the Freight Analysis Framework database of the Federal Highway Administration. Information on employment, wages and age of drivers comes from a special analysis of the unemployment insurance database performed by the Washington State Employment Security Department. Finally, information on the changing structure of the US trucking industry comes from a CDC/NIOSH report *Truck Driver Occupational Safety and Health: 2003 Conference Report* and from *The Freight Story: A National Perspective on Enhancing Freight Transportation* produced by the Federal Highway Administration.

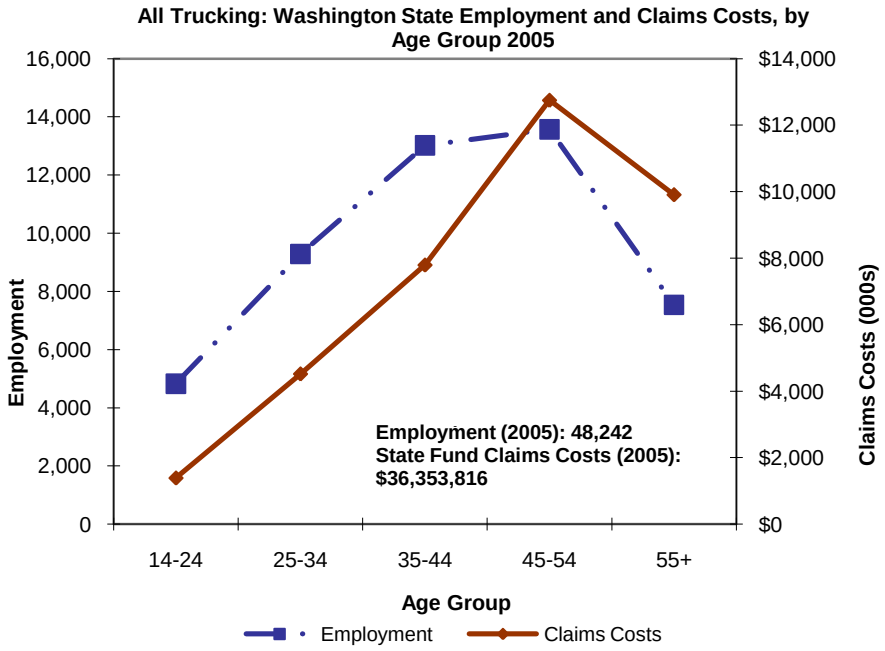
The Injury Data
The technical report "Preventing Injuries in the Trucking Industry Focus Report" summarizes the injury and illness data in the trucking industry for a 9 year time period. The workers' compensation data for this report was provided by Washington State Department of Labor and Industries (L&I). This report

includes workers' compensation claims with injuries occurring from January 1, 1997 to December 30, 2005. Workers' compensation claims are divided into two groups: medical-only and lost work time. Medical-only claims involve only medical expenses. Lost work time claims involve injuries with four or more days of lost work time compensation, total permanent disability, fatality or the worker being kept on salary. Unless stated otherwise all data for costs, injury counts and injury rates are for lost work time claims. Data for this report were extracted on November 13th, 2007.

Injuries which occurred during the study period may after the extraction date become lost work time claims and have increased costs. This is called 'development'. Therefore, future data extractions for the same time period may reflect slightly increased costs and claim counts. The L&I workers' compensation database includes a complete listing of the Self Insured lost work time claims, but not all medical-only claims, costs or lost work time days. To estimate the number of medical-only Self Insured claims we applied the State Fund medical-only lost work time ratio to the Self Insured lost work time claims. We used the State Fund average lost work time claims' cost and lost work time days to estimate the costs and lost work time for the Self Insured claims. Owner-operators are not required to have workers' compensation coverage so their injury experience is not captured in this report. Truck drivers working in non-trucking industries are not included in this report. Log carriers are included in agriculture and are not captured in this report. Under-reporting of work related injuries to workers' compensation systems is known to occur. Therefore injury rates in this report are likely an underestimate of the true burden of occupational injury in this industry. Employers report hours worked by employees to L&I. We used these hours to estimate a full-time equivalent employee (FTE). A FTE is 2000 hours for one work year. The Washington State Fatality Assessment and Control Evaluation (FACE) program provided the trucking fatality data.

Results:
The technical report "Preventing Injuries in the Trucking Industry Focus Report" was released in the spring of 2008. This report covers the years 1997-2005 and includes workers' compensation data and prevention tips for the trucking industry. The report can be downloaded from www.KeepTruckingSafe.org or http://www.lni.wa.gov/Safety/Research/Trucking/Pubs/Default.asp.
In 2005 the Washington State for-hire truck transportation industry generated over $1.8 billion in output while providing employment to over 48,000 workers. But the importance of the trucking industry to the state economy far exceeds its share in either gross state product or employment. A large part of the state's economy is dependent upon the trucking sector. In 2002 the value of all goods carried by truck in Washington State was $237 billion [Rauser, 2008].

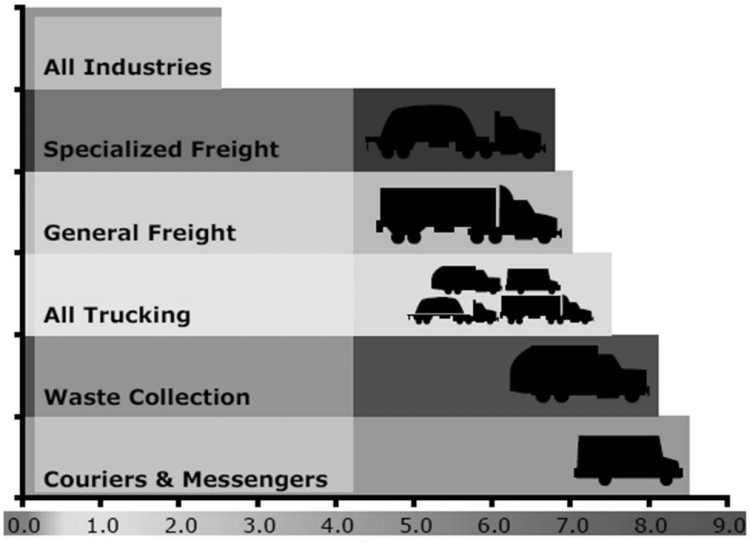
The average age of the truck drivers in Washington State has increased at a rate more than twice that of the workforce overall. Between 1997 and 2005 the average age of drivers in Washington State has increased from 39 to 42 years old. The impact of the aging workforce in trucking is likely to take two forms. On the one hand, evidence suggests that older workers tend to have fewer injuries than do younger workers in the same occupations. On the other hand, the evidence seems to show that when older workers do get injured they tend to take longer to return to work, and their overall claim costs are much higher than that of young workers in spite of fewer claims.



Overall injuries

From 1997-2005 there were over 21,000 lost work time claims and almost 38,000 medical only claims in Washington's trucking industry. Although claims rates for the trucking industry decreased from 1997 to 2005, the these rates far exceeded those of all other Washington State Industries.

Injury Rates per 100 FTE for Trucking Industry Groups Compared to All Industries in Washington State.



Discussion:

Since this report was published, in the spring of 2008, it has been downloaded from the SHARP publication webpage over 31,000 times and has proven invaluable to safety managers in the industry as well as to TIRES staff when considering priorities for the development of prevention materials.

Specific Aim 3: Develop and implement a TIRES surveillance system to track claims in the trucking industry, with particular focus on the priority conditions

TIRES tracked the top four injuries in the trucking industry, which comprise 80% of the total injuries and costs in trucking. The Lower Extremity Musculoskeletal Disorders and the Caught In injuries were cut from surveillance due to low incidence rates. TIRES only had enough resources to track those claims that had seven or more days of time-loss. These are the more severe injuries and also the claimants most likely to still be at home and reachable for a telephone interview.

Over the 4 years of the current TIRES program, 479 interviews were completed for the 4 priority conditions. Twenty-two employer site visits were performed based on the results of these telephone interviews and with the permission of the injured worker. The TIRES safety engineer reviewed workers' compensation data to determine injury trends at the company to work with the employer to mitigate hazards and the risk of additional repeat injuries.

Methods:

Surveillance system development and maintenance:

The purpose of the TIRES surveillance system is to identify occupations, specific industry sectors, and hazards that are associated with the priority conditions for prevention purposes. SHARP relies on workers' compensation data as the source for case ascertainment using the case definitions shown in the table below.

Table 3. Case Definitions For Surveillance Of Priority Conditions In Trucking

Condition	Case Definition
Fall Injuries	Claims in the trucking industry*, in which the Accident Type is coded as a Fall from Elevation (030-039) or a Fall on Same Level (050-059).
Motor Vehicle Crashes	Claims in the trucking industry*, in which the Accident Type is coded as a Highway Motor Vehicle Accident (300, 310-313), a Crash or Sideswipe with a Standing Vehicle or Stationary Object (320–324), a Non-Crash Accident (330-334, 338), or a Non-Highway Motor Vehicle Accident (600, 610, 620, 630-639).
Caught in Injuries	Claims in the trucking industry*, in which the Accident Type is coded as Caught in (060, 069).
Back and Upper Extremity Non-Traumatic Musculoskeletal Disorders (NT-MSD)	Claims in the trucking industry*, that meet a previously established case definition for musculoskeletal disorders based on a combination of Nature of Injury or ICD-9, Accident Type and Body Part codes.

* The trucking industry is defined as the following NAICS codes: General Local Freight (484110), Long Distance Freight - Truckload (484121), Long Distance Freight - LTL (484122), Movers (484210), Specialized Local Freight (484220), Specialized Long Distance Freight (484230), Couriers (492110), Local Messengers & Local Delivery (492210), Solid Waste (562111), and Hazardous Waste (562112), Other Waste Collection (562119).

Cases were extracted from L&I's workers' compensation database on a monthly basis and imported into the TIRES database, maintained in Microsoft Access. Information collected included the following: the industry NAICS code (local, long distance, etc.), employer, claimant's occupation code, ANSI Z-16 codes (nature of injury, accident type, body part, source, and associated source), location if injury, time of day, day of week, claimant information (name, sex, date of birth, address, telephone number, time on job, hours worked), claim costs, and time loss days.

Periodic analyses of the data was conducted by industry sector for each of the priority conditions to determine root cause of injuries.

Results:
The surveillance system has been invaluable for the TIRES project in systematically identifying injury types, natures, counts and costs for all sub-sectors of the trucking industry. These data have helped to direct TIRES prevention efforts and have helped identify common themes and activities where prevention efforts can be focused to return the most on investment.

Specific Aim 4: Develop and implement case follow-up protocols for identifying risk factors and solutions for the priority conditions.
Case follow-up interviews were reviewed to determine the root cause of injury. This information is rarely available from workers' compensation data and was only attainable though the careful probing of an experience interviewer who is familiar with the trucking industry and vernacular. Review of the case follow-up data spotted injury/incident themes that were address in safety materials designed to target specific injuries. Additional themes included location of injury, lack of training, fatigue, maintenance issues and rushing to complete work.

Methods:
Case follow-up interviews:
Each month, trucking claims for the priority conditions that have reached seven consecutive days of time loss were identified and telephone interviews were attempted with the first ten (or a random selection of ten) of the claimants for each of the priority conditions (i.e., a maximum of 40 attempted telephone interviews per month). Claims with 7-days of time loss were selected for follow-up interview, because these may represent potentially more serious hazards, and workers who are off work may be more likely to be reached for the interview. The safety specialist conducted the review of claims data, conducted interviews and entered the interview data into the secured database. The data manager maintained the interview database. Information in the claim file included time of day, hours worked per day and days per week, gender, age, occupation, and a brief description of the incident. Some of the more important information for injury prevention was rarely in the claim files. Those include environmental conditions (present in ¼ of the claims) surface conditions (1/3), loading or unloading, or physical location of incident (rare). All interviews were manually entered into the TIRES database. Information collected from the interviews included onset (sudden, gradual), activity/job at time first noticed, circumstances, perceived main causes/conditions leading to injury, contributors (environment, work organization, pay structure, time pressure), and prevention ideas.

Results:
1,322 cases were downloaded from the workers' compensation claims data, of these 433 did not meet our inclusion criteria (in one of the four injury types, or were not a driver), leaving 810 potential cases to interview. Of these 810, 440 were interviewed, (response rate of 54%). All were qualified workers' compensation claims with 7 or more days of time-loss in the trucking industry NAICS. Of the 440 interviewed, descriptive analyses have been completed for those interviewed as of June 30, 2009.

Table 4. Descriptive characteristics of interviewed drivers (N=370)

Characteristic	N	%
Age (mean ± SD)	47	11
Male	351	94.9
BMI	n=362	%
<25	46	12.7
25-29	132	36.5
30-40	184	50.8
Race/ethnicity		%
White	329	88.9
Black	19	5.1
Other	22	6.0
Hispanic origin	18	4.9
Educational Level	n=369	%
<High School	56	15.2
High School	191	51.7
>High School	122	33.1
Income	n=369	%
Less than $35,000	63	17.0
$35,000 to less than $50,000	163	44.2
Over $50,000	130	35.2
Don't Know	11	3.0
Refused	2	0.05
Average hours worked per day (mean±SD)	11	2
Median number of miles driven per week (Q1, Q3)	1,500	(600,2500)
Average hours worked prior to injury (mean±SD)	5	3
Type of trucking they do		
Less than truck-load (LTL)	130	35.0
Long Haul	86	23.3
Specialized/Activity-based	81	22.0
Regular Route	50	13.5
Line	23	6.2
Type of freight transported		
Construction Materials	81	21.9
General Freight	75	20.3
Furniture	38	10.3
Garbage/recycling	29	7.8
Vehicles	26	7.0
Frozen Foods	25	6.8
Dangerous Goods/Fuel	22	5.9
Agriculture	21	5.7
Courier/Messenger	21	5.7
Other	18	4.9
Logs	10	2.7
Animals	2	0.5
Oversize Load	2	0.5

In the original grant application the TIRES project was to interview 12 new claimants who had a priority condition, but who lacked the 7+ days of time loss criteria, in order to assess whether those cases were significantly different from the cases tracked in the TIRES surveillance system. Due to decreased funding, the TIRES project was unable to conduct these additional follow-up interviews.

Case follow-up Site Visits

Methods: Types of injuries and proximal causes were prioritized through a frequency and rate analysis of workers' compensation data, and case follow-up interviews. The results were shared with the trucking advisory group to gain an industry perspective on the outcomes.

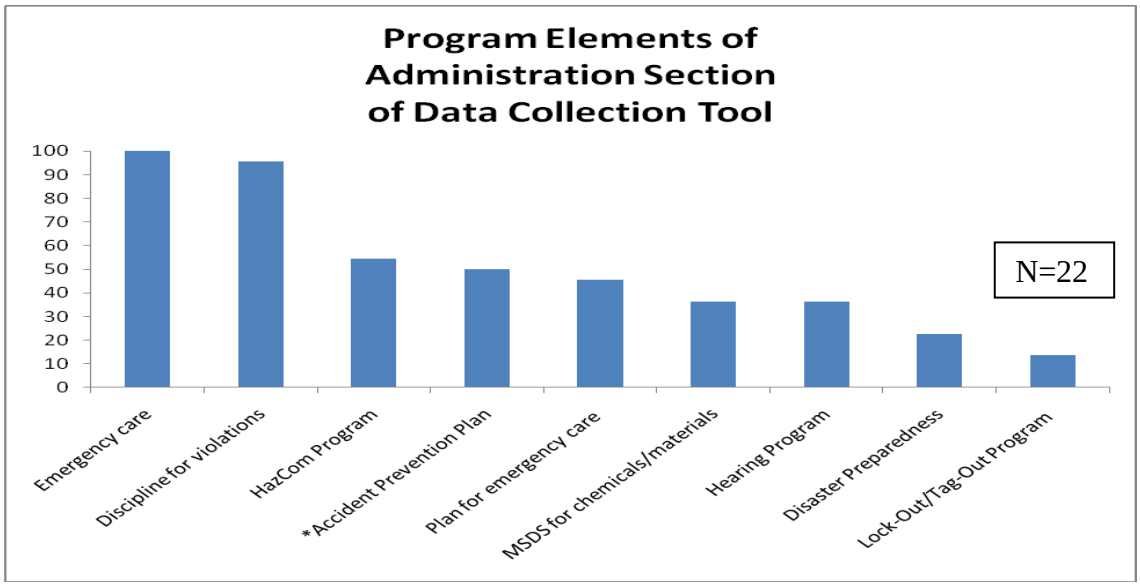
The safety engineer and project safety and ergonomics staff performed site visits to 22 selected sites. The site visits included documentation of environmental conditions, physical, individual and organizational factors that could influence the outcome.

Results:

Table 5. Description of companies visited by TIRES (n=22)

Size of company	Trucking industry subsector	Count
Large (more than 25 trucks)	Specialized Freight	5
	General Freight	4
	Moving and Storage	4
	Other	3
	Solid Waste Collection	1
Large Total		17
Small	General Freight	2
(more than 5 and less than 25 trucks)	Specialized Freight	2
	Solid Waste Collection	1
Small Total		5

Figure 3. Program elements from TIRES site visits (n=22)



While 100% of the companies utilize administrative controls to address something like working at heights, only 14% of the companies address the risk by incorporating engineering controls. For example, one company developed a method of tarping their flatbed loads without the employees having to climb the trailer and load. The hierarchy of control method ranking scheme places administrative

controls as a least effective method to reduce injury and illness incidences while the most effective control method is elimination of the hazard.

If a company relies on administrative controls for its safety program it must be supported by a positive safety culture. For the trucking industry this is essential since the drivers constitute a self-directed workforce as there is no supervisor or manager with them on a day to day or hour by hour basis. Once a driver leaves the home terminal they must be self-disciplined to follow established safety procedures.

Discussion:
The case follow-up interviews were invaluable to adding additional information such as where the injuries were occurring (terminal, truck stop, etc.), and to specific environmental, physical and equipment issues that may have contributed to the injury. By analyzing the case follow-up interview data, coupled with the workers' compensation data, TIRES was able to determine four main activities were being conducted for 80% of the injuries captured during this time. This ability to see not only specifics about an injury but to aggregate the four injury types into four activities that may be ripe for interventions, has been an important contribution to trucking injury surveillance in Washington State. Case follow-up site visits, while few, have identified some critical needs among both small and large (although primarily small) trucking companies. The lack of a written safety and health program, and the lack of policies specifically addressing hazards and abatement techniques, prompted the TIRES project team to develop a simple, easy to use safety manual for trucking companies in Washington State. This manual is currently under development and should be completed by early 2011.

Specific Aim 5: Conduct industry-wide surveys of employers and employees to identify hazards and risk factors for the priority conditions, needs and possible solutions based on company type and size
Industry-wide surveys of employers and employees were completed in 2005 and 2006 respectively. They were repeated in August/September 2010. (The results of the second set of surveys have not yet been analyzed.) The first set of surveys revealed interesting information and consistency between employer and employee understanding of the risks inherent to trucking.
Results of the surveys were published in the Journal of Safety Research in an article called "Assessment of perceived injury risks and priorities among truck drivers and trucking companies in Washington State" by Spielholz, et. al. [2008].

Methods:
Employee and company surveys collected information on injuries, incidents and risk factor by trucking sector. The organizational and physical environments vary greatly between the different segments of the trucking industry and between assignments within companies. The employee survey describes the specific type of trucking job, incident history, and perception of hazards, organizational/work conditions, and health status. The company survey includes the description of the trucking sector components, perception of hazards, incident history, needs assessment and prioritization, and measures of organization type. The surveys included some of the same questions so industry and employee perspectives could be compared. Collection of survey information directly from employees and company representatives is a key element of the full-spectrum approach to surveillance data collection which includes analysis of workers' compensation data, worker input, company responses, trucking safety management council consensus, and site visit systematic data collection and analysis.
TIRES used the Washington State Employment Security Department (ESD) Quarterly Unemployment Insurance files to obtain the addresses of all employers classified as belonging to the motor freight transportation industry by the North American Industrial Classification System (NAICS 2002) in Washington State.

The NAICS codes used to define the study population will be as follows:

Table 6. Trucking Industry Codes (NAICS)

NAICS 2002 Code	NAICS Industry Description
484110	General freight trucking, local
484121	General freight trucking, long-distance, truckload
484122	General freight trucking, long-distance, less than truckload
484210	Used household and office goods moving
484220	Specialized freight trucking, local
484230	Specialized freight trucking, long-distance
492110	Couriers
492210	Local Messengers & Local Delivery
562111	Solid Waste Collection
562112	Hazardous Waste Collection
562119	Other Waste Collection

As can be seen, the study group includes short-haul and long-haul trucking, courier delivery services, waste hauling and less-than-truckload hauling. We used Employment Security Department (ESD) data because ESD surveys all employers in Washington State over a three-year cycle to insure the NAICS codes remain a valid description of business activity. We also believe the ESD data has more accurate addresses than the Department of Labor & Industries (L&I) because of this continuous auditing of the employer data.

Survey Elements

Employee and company surveys were developed to ascertain needs and perceptions about safety in different sectors of the trucking industry. The surveys include questions about the type of truck and organization taken in part from Mayhew and Quinlan [2000]. Questions were also derived from significant variables related to accidents from a study by Monaco and Williams[2000]. Additional items relating to crashes and close-calls were adapted from Morrow [2004]. The employee survey scored scales on psychological demands and job control are from Karasek [1985]. Safety climate scales adopted from Dedobbeleer and Beland [1991] were included in both surveys. Work organization questions from the NIOSH job stress questionnaire and questions incorporating findings from Zohar [1980] were also included.

Employer Survey Frame

Included in our survey population are all establishments from the Washington Employment Security Department's (ESD) unemployment insurance employer database for the most recent available quarter in the first year of the grant period. In order to reduce the possibility of unreachable or closed establishments, to be eligible for the survey, businesses must have a minimum of five employees at the business address. Size categories are defined as follows:

- Small employers are defined as those with 5-10 employees
- Medium size employers are those with 11-49 employees
- Large employers are those with 50 or more employees

Names, addresses and telephone numbers were collected from the ESD database and matched by Unified Business Identifier (UBI) to the Labor and Industries claims database. The sample frame includes all establishments having a record in the Washington State Employment Security Department's Quarterly Unemployment Insurance file for the most recent quarter available.
The Gilmore Research Group was hired to administer the surveys.

A repeat survey was conducted in August and September of 2010, which will cover much the same topics with the possibility of comparing responses for each firm over time. Gilmore Research conducted

these surveys as well and will compare results by linking company name and address or company name and phone number.

Data cleaning
Gilmore removes all personal identifiers before sending us the final dataset combining the administrative data (claims counts and hours worked) and the survey responses. Steps taken to prepare the dataset for analysis may include: changing blank responses to either zeroes or "missing" as appropriate, creating new variables based upon combinations of survey responses and correcting "parent" responses that are inconsistent with "daughter" responses.

Statistical methods
Both STATA (version 8.2) and SAS (version 9.0) were used to set-up the datasets and to conduct analyses. Proportions of positive answers were calculated for all sectors of the trucking industry combined as well as for separate sectors of industry as defined by the NAICS code and the company size field. We used PROC MEANS and PROC GENMOD in SAS to conduct the univariate and multivariate analyses.

For each question, the proportion of positive answers was compared between the two surveys. The difference between the proportions in the two surveys was estimated as the difference between the estimated proportions. Standard errors and p-values for the differences were obtained from the survey regressions.

Employee Sampling Methods
Parallel to the trucking employer surveys, we conducted two truck driver surveys: one in the first year of the study and the other in the fifth year of the surveillance project. According to the Washington State Employment Security Department there were approximately 14,000 drivers employed within the for-hire trucking industry (SIC 421). This largely overlaps the same set of employers as that contained in the nine NAICS industries chosen for this study. To identify drivers we obtained a list of all individuals listed as working for an employer in each of the nine NAICS trucking industries for the most recent quarterly time period. The size and NAICS code of each individual's employer will also be recorded. Then this list of approximately 32,0000 individuals, identified by Social Security Number was sent to the Department of Motor Vehicles and matched to the current list of holders of commercial driving licenses (CDL). From the DMV record we attached the driver's age, home address and the category of CDL they possess. From this database we will drew a 20% sample, stratified by NAICS and size of employer, so as to assure representation in the sample of drivers in each type and size category. In addition to the drivers employed by the for-hire trucking employers, we attempted to draw a sample of 1,000 independent-operator drivers so as to be able to contrast their responses to those who work for wages. We were unable to get a good response from this sample. Gilmore processed this survey as well, entering the survey responses into a database, and striping all identifying information before the final dataset was sent to SHARP for analysis.

Results:
Survey Results
Employer: 359 trucking companies responded of 690 qualified companies.
Employee: 397 employees responded out of 700 qualified drivers.

The results of these surveys have guided TIRES in how best to reach the industry and the priorities of both companies and drivers. Additional discussion was reported in the Journal of Safety Research [Spielholz, 2008]. "The surveys highlighted differences in perceptions of injury risks, causes, and solutions between companies and drivers. Truck drivers generally reported a lower overall safety climate than did companies. Companies tended to more frequently state that worker behavior was the

primary cause of slip, trip or fall and other injuries than did the drivers. The drivers more frequently stated that physical conditions such as slippery ramps and docks were the primary injury causes." TIRES addressed both topics of concern. That of proper footwear, exit techniques and PPE for visibility and yard maintenance.

Strains, Sprains & Overexertions were identified as the biggest injury problem:

Reasons for Injuries:	Possible Solutions:
• Loading/Unloading Freight, Awkward Lifting	• Education, Training and Reminders
• Employee Behavior and Methods	• Planning, Communications, Working as a Team
• Tarping, Throwing Wrappers, Securing Straps	• Using Proper Equipment and Techniques

Slips, Trips, & Falls were identified as the second biggest injury problem:

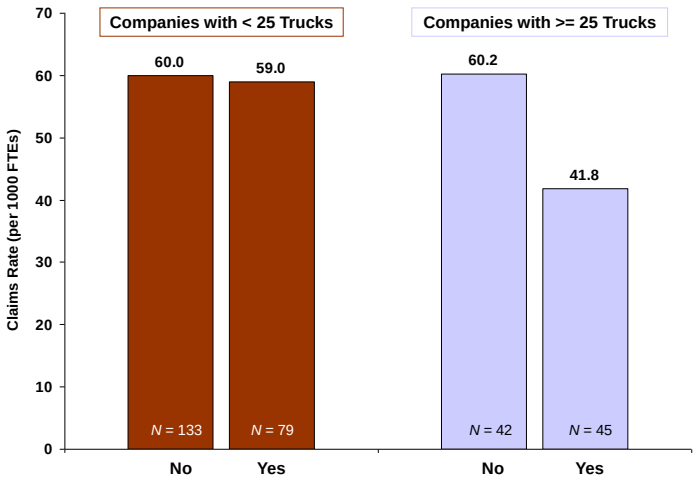
Reasons for Injuries:
- Employee Behavior and Methods
- Climbing In/Out, Falling off Load/Truck
- Weather/Slippery Walking Surface

Possible Solutions:
- Planning, Getting Help, Working as a Team
- Slip/Fall Interventions (shoes, surfacing, salt)
- Education, Training and Reminders

Companies listed the following as the most frequent barriers to putting solutions in place to prevent injuries:
- Employee Lack of Risk Awareness
- Time and Logistics of Doing Training
- Lack of Ability to Supervise or Control Environment

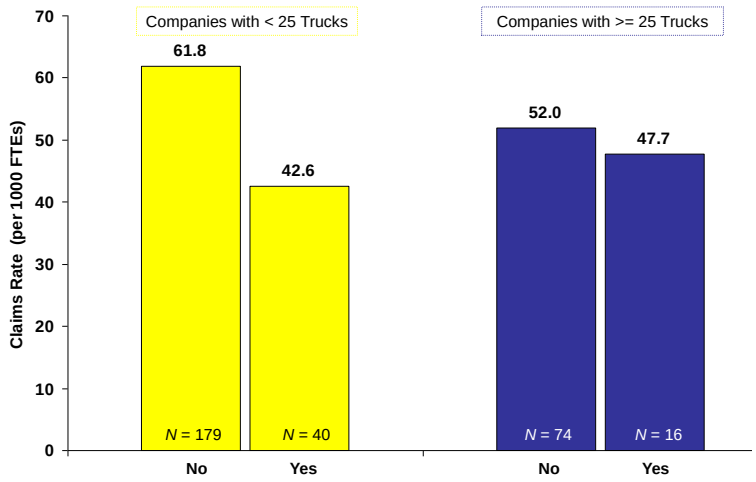
What companies are doing to reduce Claims?
Employers that have fewer injury claims than other trucking companies in Washington use specific practices to reduce injuries. We linked some of the practices identified in the survey to existing data on claims rates:

Figure 4 **Tying Claims Rate to Presence of a KOS/Light Duty Program**



- Companies who keep injured employees on salary (KOS/Light-Duty) have fewer claims.
- Larger companies (those with more than 25 trucks) had a greater reduction in their injury claims rate than smaller ones for those having a KOS/Light-Duty program.
- Companies with a safety incentive program for employees and one for supervisors have fewer workers' compensation claims than companies without these programs.

Figure 5. **Tying Claims Rate to Presence of a Safety Incentive Program**



- Having a safety incentive program appeared to have more of a positive effect in companies with less than 25 trucks).

Results of 2006 Survey of Washington State ***Truck Drivers***

- 44% were part of a small fleet (less than 25 trucks); 49% from a large fleet (25 or more trucks); 13 (3%) were owner/operators
- Respondents had an average of 17½ years experience as a truck driver
- 72 (18%) belonged to a union; 324 (82%) did not

Participants came from all different trucking industries:

1. General Freight (151 people)
2. Specialized Freight (205 people)
3. Couriers (34 people)
4. Local Messengers & Delivery (7 people)
5. Waste Collection (43 people)

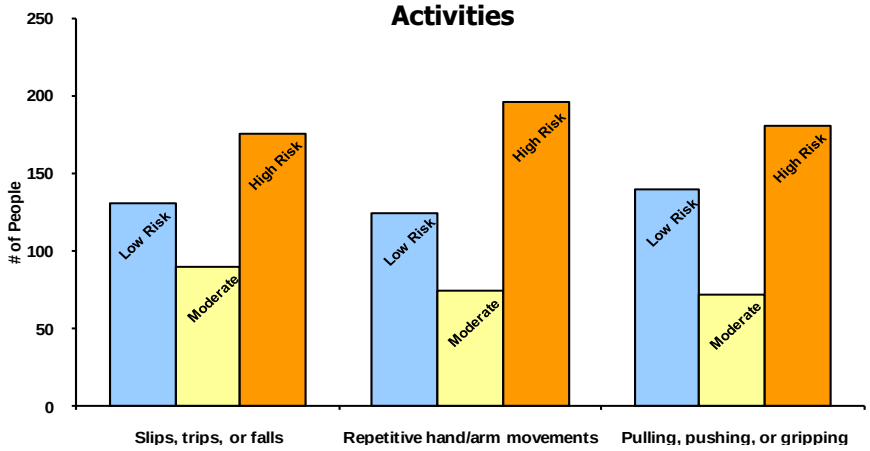
Drivers spend the majority of their work time driving a truck. However, many of them also spend more than 25% of their time handling material/cargo. And these drivers are 2 times more likely to report pain in their lower extremities due to work. Drivers *need* to consider their health and safety practices while working in and around the truck, but *not* at the exclusion of considering time spent in other tasks.

Table 7. Percent of time spent in work activities

	< 25% of work time	> 25% of work time
Driving	50	342
Sitting/Standing	308	49
Handling Material/Cargo	243	132
Standing/Walking	270	94

In fact, many workers rated non-driving activities (e.g., slip, trip, fall hazards, repetitive hand/arm movements, pulling/pushing) as some of the most hazardous exposures.

Figure 6. Risk Perceptions for Work Activities



Many drivers are also working long hours:

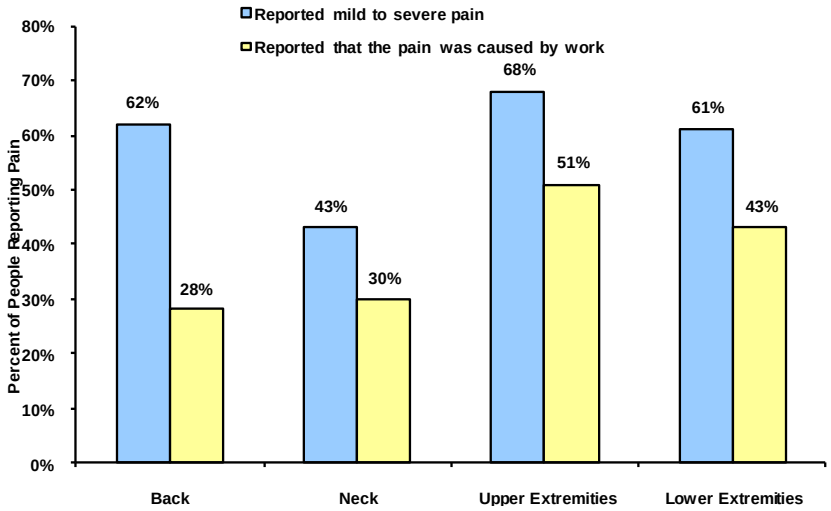
- 322 (81%) said they work 41-70 hours per week
- 27 drivers said they work more than 70 hours per week

Moreover, those who work more than 40 hours per week are also significantly more likely to feel pressure to work even longer hours. These drivers are more than 2 times more likely to report pain in their neck and upper extremities caused by their work.

Work-Related Injuries

We know there is under-reporting of injuries to employers. Of the 83 drivers who said they had a work-related injury in the past year, 43% did not file a workers' compensation claim. Moreover, several people report having pain as a result of their work even though they did not necessarily report having a work-related injury.

Figure 7. Pain levels in drivers' back, neck, upper extremities (shoulders, elbows/forearms) and lower extremities (knees, feet/ankles)



One quarter of the respondents reported there were significant changes in their job in the past year, with only about half of those drivers saying the changes were for the better. Moreover, employees who reported significant changes in their job in the past year were almost 2 times more likely to report back and neck pain as a result of their work.

Drivers who feel **physically exhausted** after work are about 2 times more likely to report back pain than those who do not; those who feel **emotionally exhausted** are almost 2 times more likely to report neck pain as a result of their work than those who are not emotionally exhausted. Alternatively, drivers who report higher job satisfaction are less likely to experience back and neck pain and are less likely to miss work due to any pain they have experienced. A safety climate is characterized by things like management attention to safety issues, employee participation in safety decisions, availability of proper/well-maintained equipment, overall prioritizing of safety, etc.

Employees in workplaces with a positive safety climate report:

Reduced exposure to…	Feeling…
▪ Vibration from driving ▪ Manually carrying heavy loads ▪ Exposure to slippery surfaces ▪ Repetitive hand/arm movements ▪ Activities that require pulling/pushing ▪ Exposure to falling objects	▪ Less pain in their back, neck, upper extremities, and lower extremities as a result of their work ▪ Less pressure to work longer hours ▪ Less pressure to work faster ▪ Greater job satisfaction

<u>Most Common Causes of Injuries</u>

Consistent with what employers told us in a 2005 survey, drivers reported that back, shoulder, & arm/hand overexertions and slips, trips, & falls are the most common causes of injuries.

- **Back, shoulder, arm/hand overexertions** → Lifting objects that are too heavy was noted as the number one cause. Getting help, using a fork lift, using proper equipment, getting equipment upgrades, and equipment maintenance were listed as top solutions.

- **Slips, trips, falls** → Slippery ramps and docks were noted as the number one cause. Being attentive, careful and aware of your surroundings was listed as the top solution.

These descriptions of hazards should demonstrate how the environment, job tasks, and the overall organization are inter-related. Fixing just one part of the larger system will likely not solve the problem!

Discussion:
Based upon the employer and truck driver surveys, TIRES project staff have identified some areas for improvement and intervention, in the hopes of reducing injuries in the trucking industry.

Briefly these are recommendations from employer survey results:
Long-Term Strategies to Reduce Injuries

- Proper equipment to reduce heavy and awkward lifting and manual loading and unloading may reduce the number of workers' compensation claims associated with strains, sprains, & overexertion injuries.
- Proper equipment and planning to reduce the sense of urgency among workers could reduce costs associated with slips, trips, and fall injuries.
- "Planning" and "working as a team" were consistently identified as solutions for how to strategically reduce workplace injuries.
- Having a well designed safety incentive program that rewards identifying and fixing hazards may reduce injuries and claims.
- Keeping injured employees on salary may reduce injury costs.
- Although each of these require upfront time and money, they are long-term investments that payoff in terms of direct cost savings from fewer injured workers and indirect savings in terms of a healthier and more productive workforce.

Recommendations from employee survey results:

- Implement and promote an **early reporting system** for symptoms and injuries. Dealing with issues early can save more costly injuries from happening.
- Address scheduling and other stresses with workers. For example, create ways for workers to have **more control** over their daily work can help.
- Promote a positive **safety climate** by demonstrating management commitment to safety. Involve workers and show that changes can be made quickly, when feasible.
- Demonstrate how **management truly cares** about driver safety by:
  1. Holding regular safety meetings with drivers
  2. Making properly and well-maintained equipment available
  3. Changing drivers' perceptions about potential risks on the job
- Off-the-shelf solutions and methods are available to **reduce the risk** of overexertions, slips, trips, and falls, and motor vehicle crashes (the top concerns of drivers). The web site www.KeepTruckingSafe.org responds to these needs with relevant safety training materials for the trucking industry.

Specific Aim 6: Identify opportunities for the use of educational materials and other interventions to reduce hazards and injuries within trucking.

TIRES goal was to go beyond traditional surveillance activities, and to use the data collected to educate the industry. The trucking industry is a vital, yet aging industry. They are also a high cost, low profit margin industry. Especially with the economic downturn, many truck drivers are barely making ends meet or have gone out of business altogether. Because of the high cost and rate of injuries in the trucking industry, employers were very open to receiving help in reducing their injury rate and eventually their workers' compensation premiums.

Thus, TIRES produced industry-relevant, injury-focused training materials that were at first mailed out to our trucking industry mailing list (developed using industry NAICS codes) and later on the collaborative web site www.KeepTruckingSafe.org. These materials are also available on the L&I site http://www.lni.wa.gov/Safety/Research/Trucking/Pubs/Default.asp. Currently 377 industry stakeholders have elected to be added to the distribution list to receive the semi-monthly TIRES E-news.
In addition to publications, TIRES responded to requests from the steering committee for online training by developing the TIRES force simulation tool (also available www.KeepTruckingSafe.org.) TIRES received so many requests for copies of this tool that it has been modified to make it possible for anyone to download the program from the TIRES www.KeepTruckingSafe.org web site.

Methods:
Using data collected and analyzed from the TIRES surveillance system, coupled with safety expertise and the invaluable assistance of the steering committee, TIRES was able to create meaningful, relevant prevention materials for the industry.

Results:
Prevention/educational materials: Safety Materials
335 industry stakeholders subscribe to the TIRES distribution list to receive the TIRES E-News. TIRES publications have been downloaded **142,313** times over the past 5 years. The Force Simulation Tool alone has been downloaded over 2,000 times since its release in May of 2010. These statistics show that TIRES is meeting a need in the industry.

Discussion:
Publications Evaluation Survey
53 of 64 (83%) trucking employers responding to a survey reported an intention to make at least one change to improve the safety of their workplace as a result of TIRES publications.

52 of 64 (82%) survey respondents requested at least one topic that they'd like to see addressed in future TIRES publications.

Although the survey responses are small in number, the sheer volume of document downloads and the increase in web site traffic and the number added to the mailing lists, without the benefit of a social marketing campaign to promote the TIRES project, speaks volumes for what can be accomplished with quality information and insider professional assistance in developing and disseminating relevant industry prevention materials.

Conclusions:

The TIRES project in the four-year grant cycle successfully completed all specific aims laid out in the original grant proposal, except those where the project was limited by a reduction in funds. In addition to creating a successful surveillance system, adding to this data in-depth information from case follow-up interviews and site visits, the TIRES project was able to fill an information and educational niche in the trucking industry, at the state and national levels. Using the surveillance data, TIRES identified four activity types that are at the root of over 80% of the injuries reported. This information was used to develop a second wave of TIRES surveillance activity which is currently underway. The goals of the second wave are to identify tasks within these four activities where interventions can be implemented in an effort to avoid the injuries from occurring. Along with the new focus for surveillance activities, the second wave of the TIRES project will continue to produce the in-demand prevention material, complete an easy to use safety program manual, develop additional simulation tools and continue to reach out to the industry, its' associations and the drivers themselves.

Publications

Journal Articles

Spielholz P, Cullen J, Smith C, Howard N, Silverstein B, Bonauto D: [2008] Assessment of perceived injury risks and priorities among truck drivers and trucking companies in Washington State. Journal of Safety Research 39 (2008) 569-576.

Technical Report

Rauser E, Foley M, Bonauto D, Edwards S, Spielholz P, Silverstein B: [2008] Preventing Injuries in the Trucking Industry Focus Report. Washington State Department of Labor and Industries, SHARP Program Technical Report number 90-17-2008.

Trade Journal Articles

Pratt J: [2009] Even on Foot, Trucking Is Risky Business. Transport Topics, June 8, 2009.

Pratt J: [2009] Trucking Is a Risky Business. Light & Medium Truck. September 2009.

Williams J: [2010] Is risk just a part of the job? The Route. Washington Refuse and Recycling Association News. September 2010.

Posters

23 eye catching, relevant and educational posters developed.

TIRESPIN Newsletter

9 newsletters that contain additional information on the industry and priority injury types.

Tip Sheet

14 safety training tip sheets designed to supplement industry trucking meetings.

True Story Narrative

18 true stories of Washington workers that were injured or killed on the job in the trucking industry. Include tips to prevent similar occurrences.

Dollars and Sense

4 cost benefit documents that show the financial benefits of investing in safety.

Short Reports
2 short reports were produced to supplement the information and explain the relevance of the accompanying tip sheets and posters.

Inclusion of gender and minority study subjects
Washington State's population is approximately 83% white, non-Hispanic, 6% Hispanic, 5.4% Asian and Pacific Islander, 3.3% African American. The truck driver and laborers, freight, stock and material mover population is 95% male. Race and ethnicity are predominantly white. All truck drivers will be encouraged to participate.

Inclusion of Children – N/A

Materials available for other investigators
In Washington State, data sharing is governed by our state public disclosure laws and specific Washington State administrative regulations associated with notifiable conditions reporting, both will apply to data collected in our fundamental program. Generally, data is available upon request from qualified researchers.

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Morrow P, Crum M. Antecedents of fatigue, close calls, and crashes among commercial motor-vehicle drivers. Journal of Safety Research 2004; 35(1):59-69.

Rauser E, Foley M, Bonauto D, Edwards S, Spielholz P and Silverstein B. Preventing Injuries in the Trucking Industry. Olympia, Washington: Safety and Health Assessment and Research for Prevention (SHARP) Program, Washington State Department of Labor and Industries, 2008; Technical Report Number 90-17-2008.

Silverstein B, Kalat J. Work-Related Musculoskeletal Disorders of the Neck, Back, and Upper Extremity in Washington State, State Fund and Self-Insured Workers' Compensation Claims, 1993-2001. Olympia, Washington: Safety and Health Assessment and Research for Prevention (SHARP) Program, Washington State Department of Labor and Industries, 2003; Technical Report Number 40-7-2003.

Spielholz P, Cullen J, Smith C, Howard N, Silverstein B, Bonauto D: [2008] Assessment of perceived injury risks and priorities among truck drivers and trucking companies in Washington State. Journal of Safety Research 39 (2008) 569-576.

U.S. Bureau of Labor Statistics, Occupational Injury and Illness Survey, 2002, http://www.bls.gov/iif/oshcdnew.htm#02Supplemental%20Tables.

Zohar D. Safety climate in industrial organizations: theoretical and applied implications. J Appl Psychol 1980; 65(1):96-102.

Inclusion Enrollment Report

Study Title: Trucking Injury Reduction Emphasis through Surveillance

Total Enrollment: 425 **Protocol**

Grant Number: 5 U60 OH 008487

PART A. TOTAL ENROLLMENT REPORT: Number of Subjects Enrolled to Date (Cumulative) by Ethnicity and Race					
Ethnic Category	**Females**	**Males**	**Sex/Gender Unknown or Not**	**Total**	
Hispanic or Latino		26		26	**
Not Hispanic or Latino	19	380		399	
Unknown (individuals not reporting ethnicity)					
Ethnic Category: Total of All Subjects*	19	406		425	*
Racial Categories					
American Indian/Alaska Native		5		5	
Asian		1		1	
Native Hawaiian or Other Pacific Islander		3		3	
Black or African American	1	20		21	
White	18	351		369	
More Than One Race					
Unknown or Not Reported		26			
Racial Categories: Total of All Subjects*	19	406		425	*

PART B. HISPANIC ENROLLMENT REPORT: Number of Hispanics or Latinos Enrolled to Date (Cumulative)					
Racial Categories	**Females**	**Males**	**Sex/Gender Unknown or Not**	**Total**	
American Indian or Alaska Native					
Asian					
Native Hawaiian or Other Pacific Islander					
Black or African American					
White					
More Than One Race					
Unknown or Not Reported		26		26	
Racial Categories: Total of Hispanics or		26		26	**

Priority Focus Area:

Identifying Preventable Causes of Pesticide-Related Illness among Agricultural Workers

Final Progress Report
July 1, 2005 – June 30, 2010
September 30, 2010

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A component of the
'Washington Occupational Safety and Health Surveillance Program"
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Abstract.

Occupational safety and health issue addressed

This project addressed pesticide-related illness among Washington state farm workers. It identified root causes of illness from pesticide drift and exposures due to inadequate personal protective equipment (PPE).

Importance of the problem

Agriculture continues to be Washington's largest employer, contributing almost $29 billion, or 13 percent, to the state's economy. In 2000, there were an estimated 184,236 migrant and seasonal farm workers in Washington State. Washington ranks third in the nation for agricultural pesticide use. Some of the pesticides used in agriculture are highly toxic. Health problems resulting from over-exposure are well documented and can be life threatening. Farm workers are at unique risk of exposure to pesticides, as their jobs may bring them near pesticide applications or residues.

A safe work environment in agriculture is important. Everyone benefits from eating the food that farm workers provide. Costs of medical treatment and time away from work after an injury are burdens to the industry, society, and workers. Yet farm workers confront several barriers to reporting work-related illness, including economic status, language, and fear of deportation or job loss. Understanding the key preventable contributing factors involved in pesticide illnesses among farm workers enables reality-based and targeted preventive policies and actions.

Approach

This project's approach was to identify and track causal factors for pesticide illness and injury among farm workers. It expanded the ongoing program for pesticide illness monitoring and prevention at Washington State Department of Health (DOH) to include the collection and analysis of potential root cause information about pesticide illness among farm workers.

Data from the illness investigations conducted by DOH Pesticide Program were used to analyze the situations that lead to exposure in cases involving agricultural workers. Sixteen different underlying factors that contributed to illness were described. From 2003 through 2008 these factors were tracked, to determine the frequency and relative importance of each.

A multi-agency workgroup whose members came from academic institutions and state agencies involved in protecting farm worker safety and health reviewed this and other related research. With the workgroup's collaboration, the perspectives of farm workers were obtained and these perspectives informed the program recommendations.

Key findings

351 cases of agricultural workers with an illness or injury plausibly related to occupational pesticide exposure were documented by DOH Pesticide Program during the six years studied. Pesticide handlers made up 167 (48%) of the cases, and tended to include the more severe illnesses documented.

From 2003 through 2008 pesticide drift caused 80 events affecting 191 people. More than half of these events were drift to bystanders or workers outside of agriculture. Thirty-five of the events were responsible for 104 of the agricultural worker cases. Five of those 35 events involved aerial application. The remainder involved ground sprayers. Close proximity of workers to ground sprayers was more

commonly reported than high wind or other adverse weather conditions. Lack of communication between spray crews and other farm workers, on the same or neighboring farms was consistently identified as a key contributing factor of drift exposures.

During this same period, fifty-three percent (87/167) of agricultural pesticide handlers were missing at least one piece of required PPE or had an identified problem with their PPE at the time of their pesticide over-exposure. Eye protection was missing in 42 cases, followed by lack of proper gloves in 28 cases. Required respiratory protection was missing in 15 cases and was improperly worn in 18 cases.

How results can be utilized in the workplace

New prevention activities should focus on employers and their responsibility to provide and maintain required PPE and to ensure their employees wear it properly. Employers must ensure proper schedule for respirator cartridge change-out. Employers need to ensure that farm harvesting and other work crews are kept a safe distance from applicators and out of recently treated areas.

Prevention education for pesticide handlers and other farm workers will incorporate guidance based on the findings of this research. Many of the PPE problems identified by pesticide handlers are addressed by adhering to proper cartridge change-out and daily fit checking of respirators. Key messages to emphasize with farm workers are: Wear all required PPE when handling pesticides. Cleaning, maintaining, or fixing contaminated equipment is considered pesticide handling and so requires wearing PPE. If you experience what you think is pesticide drift, tell your supervisor immediately so that you can move or be decontaminated if necessary.

SECTION 1

Highlights/Significant Findings.

This program successfully developed new interview questions and coding to track 16 contributing factors for occupational pesticide-related illness and injury. We successfully worked with National Institute for Occupational Safety and Health (NIOSH) and other states that participate in the Sentinel Event Notification System for Occupation Risk (SENSOR)-Pesticides, to test and standardize the contributing factor coding for occupational pesticide illness cases. Prevention coding was adopted by all SENSOR-Pesticides states as a new standardized variable for tracking in January 2009.

The analysis of contributing factors over a six year period, (2003-2008) found that fifty-three percent (87/167) of pesticide handlers were missing at least one piece of required PPE or had an identified problem with their PPE at the time of their pesticide exposure. Eye protection was missing in 42 cases. Required respiratory protection was missing in 15 cases and was improperly worn in 18 cases. Two reasons for this were: (1) Workers had removed PPE to clean equipment or to do other tasks, and (2) Problems in supervision, such as the employer did not provided PPE, basic training, or oversight of worker PPE practices.

Close proximity of workers to power sprayers was more commonly reported as a root cause in pesticide drift than were high winds or other adverse weather conditions. A key factor was lack of communication between spray crews and field crews on the same or on neighboring farms. We found that supervisors had mistakenly thought workers were at a safe distance in the majority of these cases.

We collaborated with researchers from the University of Washington Pacific Northwest Agricultural Safety and Health (PNASH) Center, and with education and prevention specialists from Washington State Department of Agriculture (WSDA) and Washington State Department of Labor and Industries (L&I). This multi-agency work group considered the root causes research, and supplied complementary information. Findings were integrated into safety training. Farm worker feedback about the root causes research helped shape the recommendations.

Translation of Findings.

The prevention measures to avoid agricultural pesticide drift that developed out from this project are significant findings. Recommendations for preventing drift focused on improving communication on the farm and between farms. Pesticides applied by air blast sprayers were especially prone to drift off target. Agricultural employers, farm workers, and regulatory agencies have indicated interest in these findings. Enacting measures recommended in this research will help to prevent workplace illness and injury.

Prevention strategies concerning PPE practices focus on the employer's responsibility to provide and maintain required PPE and to ensure their employees wear it properly. Pesticide handlers should assure that their respirators fit correctly at every use, and that the respirator filters are changed regularly. Rules about respirator fit testing and filter changes are present in the federal Worker Protection Standards. These rules must be rigorously enforced by employers, supervisors, workers, and regulatory agencies.

NIOSH and the SENSOR-Pesticides states piloted the 16 contributing factors developed in this research and have added two more. These now 18 potential causal factors associated with reported illness are included in the data coding and entry forms for SENSOR-Pesticide states and have been added to the NIOSH pesticide-related illness database known as SPIDER. These collectively are

known as “prevention codes” and tracking them will help state-based pesticide illness surveillance programs prevent pesticide-related illness.

Findings and recommendations were discussed with representatives of the Washington State Farm Bureau. DOH Pesticide Program developed a PowerPoint presentation about the study and shared this with the Safety Director at the Farm Bureau, who then presented the findings to members at constituent meetings throughout the state.

Outcomes/Relevance/Impact.

This project led to improvements in occupational safety and health by identifying the root causes of the two most common scenarios of pesticide illness in farm workers: drift and inadequate PPE. The recommendations made resulting from research into why drift and PPE problems happen, will guide future investigations. To promote shared responsibility for preventing pesticide-related illness, specific recommendations are directed at pesticide handlers and other farm workers, agricultural employers and foremen, and the Environmental Protection Agency.

Important findings are classified as either potential, intermediate, or end outcomes.

1) Potential outcomes
    a. Findings and recommendations concerning PPE, highlighted the fact that eye protection was frequently missing or inadequate. Additionally, pesticide labels often lack the specific requirements of eye protection. Regular glasses or sunglasses do not provide sufficient protection for eyes from pesticides. Pesticide labels need to specify that eye protection means goggles with secure, unbroken seal around the eyes.
    b. Required respiratory protection was missing or improperly worn. Recommendations include that workers be instructed that PPE is necessary not only during application, but also during the acts of cleaning and repairing equipment. Employers and farm supervisors should provided PPE, basic training, or oversight of worker PPE practices.

2) Intermediate outcomes
    a. Results have been applied to ongoing and new research and prevention work by the University of Washington PNASH Center.
    b. Prevention coding was adopted by all SENSOR-Pesticides states as a new standardized variable for tracking in January 2009.
    c. Documentation of the link between air blast sprayers and pesticide drift add evidence to the value of rules requiring additional controls on their use; and encourage agricultural researchers and farm managers to look for alternatives to their use.

3) End outcomes
    a. As DOH and others share findings from this work, and implement recommendations, we hope to see a noticeable reduction in agricultural pesticide drift cases, and over-exposures due to inadequate PPE in the future.

SECTION 2

Scientific Report.

Project Background.

The Washington State Department of Health Pesticide Program conducts state-mandated surveillance for pesticide illness and injury. We receive reports of suspected pesticide illness events from numerous sources, including Washington Poison Center, (WAPC) L&I Claims Administration Program, WSDA, health care providers, and others. DOH Pesticide Program investigators interview individuals, obtain pesticide application and medical records and, at times, conduct field visits. The surveillance data are sent each year to NIOSH and published jointly with other Washington state agencies in an annual report of pesticide related activities. The DOH Pesticide Program uses data collected from these investigations to identify public health problems and develop strategies to prevent human exposure to pesticides. Federal and other state agencies, local government, advocacy groups, and legislators use the data for similar purposes.

In 2004, the Pesticide Program conducted a pilot project to evaluate a set of interview questions and a data coding scheme to collect information about prevention of pesticide illness. This pilot study indicated a clear need to further develop methods to accurately observe and record causal factors associated with common agricultural pesticide exposure scenarios.

In 2005, the Pesticide Program was awarded a five-year grant from NIOSH to improve our pesticide illness surveillance system. We concentrated on exploring the contributing factors that cause or enable pesticide illness and injuries among agricultural workers. Farm workers have been identified as a high risk group for pesticide illness in WA, representing about 30% of our total plausible cases each year.

Specific Aims.

The purpose of this work was to improve our ability to prevent occupational pesticide exposures and illness. The specific aim was to improve data collection and analysis of causal risk factors associated with common pesticide exposure scenarios among workers in the agricultural sector. The three specific aims of this project were:

1. Re-focus our surveillance investigation and data analysis efforts on specific common exposure scenarios;
2. Use the information derived from these efforts to critically evaluate the adequacy of existing prevention programs and policies; and
3. Modify and expand current outreach activities by incorporating information derived from these efforts into new and existing prevention activities.

Areas of focus included exposures to drift, exposures due to inadequate PPE practices, and the effectiveness of worker protection standard (WPS) training.

Procedures.

In 2005 and 2006, we conducted a records review on all occupational cases investigated between 2003-2005. Based on this analysis we developed additional questions on contributing factors, a coding scheme to sort the additional data collected for easy analysis, and enhanced our data system to store the data. We also recruited agricultural workers from our surveillance program to participate in research

interviews to test our questions and to ask about the work safety culture and how workers make decisions about what PPE to wear.

We worked with L&I and WSDA to develop a drift checklist. A multi-agency work group made up of key pesticide safety educators from L&I and WSDA, and University of Washington PNASH researchers assisted with further development and implementation of data collection tools and prevention messages.

Methods.

We reviewed existing data from investigations of farm worker illness cases. Sixteen different root causes of pesticide exposure were identified which appeared to impact both handler and non-handler categories. A coding sheet describing each of the contributing factors was developed and inserted into the standard data entry and coding form that Pesticide Program staff use when investigating an illness case. We then tracked these contributing factors from farm worker pesticide illness investigations conducted from 2003 through 2008.

Pesticide handlers were identified using the Environmental Protection Agency (EPA) Worker Protection Standard (WPS) definition of “handling.” Handlers were mixing, loading, or applying pesticides; cleaning or fixing contaminated equipment; or handling open pesticide containers. Other workers were harvesting, thinning, moving irrigation pipes or doing other agricultural work. Only cases classified as definitely, probably, or possibly due to pesticide exposure are included.

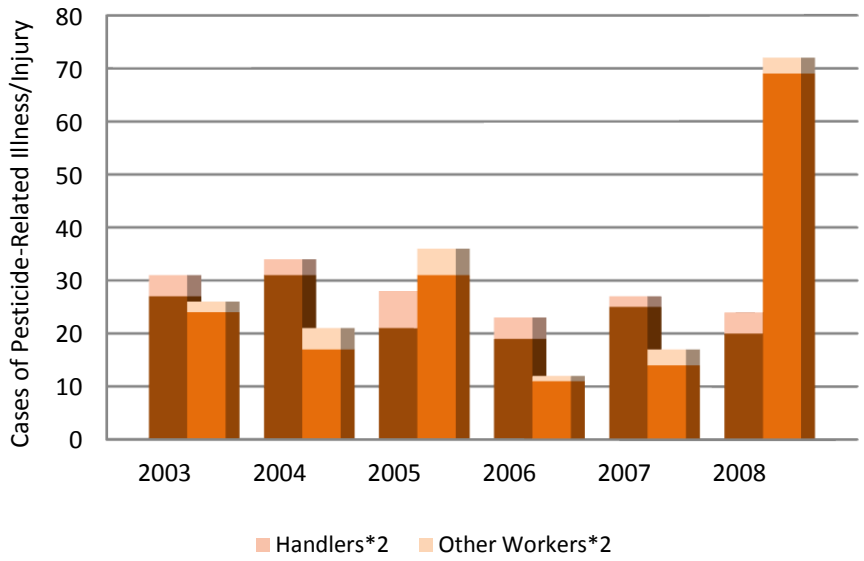
Study results were discussed with researchers from the University of Washington PNASH Center, and with WSDA and L&I. Members of these organizations who work on issues involving the health and safety of farm workers, formed an multi-agency work group with the goal of integrating these and other findings into preventive actions.

At the suggestion of the inter-agency group, results of the root-causes research were presented in Spanish, at WSDA sponsored pesticide safety trainings. Farm workers, pesticide handlers, and farm supervisors were invited to share their views about the information presented and to brainstorm solutions to the contributing factors identified. Their responses, like the root-cause research, serve to inform new and ongoing pesticide illness prevention efforts.

Results and Discussion.

From 2003 through 2008, DOH documented 351 cases of agricultural workers with an illness or injury plausibly related to occupational pesticide exposure (Figure P1). Medical outcomes were mostly mild in severity. Handlers had a higher percentage of moderate to severe outcomes (14%) compared to other workers (10%). We did not identify any deaths from occupational exposure among agricultural workers during this time period.

Figure P1. Pesticide-related illness cases among agricultural workers from 2003-2008



**The lighter shade represents workers with moderate to severe injury or illness.*

The results of the study of underlying factors that contributed to over-exposure are presented in Table P1. Among pesticide handlers (*n*=167), the leading contributing factors were lack of required PPE and other PPE problems. Among other agricultural workers (*n*=184), pesticide drift was the leading factor in their over-exposure.

Table P1. Contributing factors to pesticide illness among agricultural workers (2003 - 2008)*

Contributing Factors Identified	Handlers (*n*=167)	Other Workers (*n*=184)
Posting or notification didn't occur	2	20
People were exposed in the treated area during application	1	15
Structure not adequately ventilated before allowing people to re-enter	1	0
Early re-entry	0	19
Required eye protection not worn	42	2
Other required PPE not worn	43	5
PPE in poor repair, not maintained, not worn correctly	29	1
Spill or splash (not involving equipment failure)	27	2
Product not stored properly/ within reach of children	0	1
Decontamination not adequate or timely	14	2
Intentional misuse of a pesticide to cause harm	0	1
Other label violations identified	8	4
No label violation identified but person still became exposed/ill	53	41
Equipment failure	22	2
Drift	3	101
Applicator not properly trained and/or supervised	24	7
Other	1	7
Unknown	15	7

**More than one factor can be coded for each case so the columns do not add to the total cases from each category of agricultural worker.*

Agricultural Pesticide Handlers (*n*=167)
PPE problems that contributed to exposure (*n*=93 workers)
Fifty-six percent of handlers were missing at least one piece of required PPE (68 handlers) or had another identified problem with their PPE (29 handlers)(Table P2). Forty two workers were missing required eye protection, and 43 were missing another piece of PPE: gloves (*n*=31), respiratory PPE (*n*=15), rubber roots (*n*=6), and apron when mixing (*n*=4). Seventeen workers were missing both eye PPE and another required piece of PPE. Four workers were missing at least one piece of PPE and also had a problem with PPE that they were wearing.

Table P2. PPE Problems that contributed to exposure

Contributing Factor Identified	Total # workers with problem*		
Missing eye PPE	42	68 workers with at least one piece of missing PPE	93 workers with some PPE problem
Other required PPE not worn	43		
PPE in poor repair, not maintained, not worn correctly	**29**		

**The last two columns adjust for multiple contributing factors coded for some workers.*

When asked why they were not wearing PPE, handlers often responded that they didn't think it was needed. In 18/68 cases (26%), the worker was exposed while cleaning or fixing contaminated equipment or doing handling activities that were not strictly mixing, loading or spraying. In some cases, workers removed PPE to clean a sprayer or fix a plugged nozzle. These workers were either unaware that handler PPE was required for these tasks under the Worker Protection Standards or they were not motivated to wear PPE for tasks they perceived as having low risk of exposure.

Exposures to unexpected spill or splashes were co-factors in 26/68 cases (38%) in which the handler was missing required PPE. Half of these 26 cases were due to some type of equipment failure. This observation could be used to motivate workers to guard against unexpected splashes by wearing their PPE for all tasks where direct exposure is possible. Another underlying factor identified in 26% of cases with missing PPE was lack of training and supervision. This would include cases where the supervisor did not provide PPE, did not instruct the handler to wear PPE, or did not provide initial training or instruction.

Twenty-nine handlers were wearing PPE with some identified problem. These were largely issues with respirators and goggles. In eight cases, the respirator cartridge was not changed frequently enough nor had an incorrect filter. Cartridge change-out problems were noted if the worker reported smelling chemical through the mask or if there were long periods (days to weeks) between cartridge replacements. In four cases the handler was wearing a damaged respirator. In six cases the respirator had a poor fit and in five cases the goggles had a poor fit.

Poor fit was coded if the worker mentioned that the seal of the respirator opened on the side when they turned their head, or that the goggles let mist or drips in through the seal. Poor fit was also coded if co-investigation by another agency documented an improper fit.

A "respirator fit-test" is required at least once to confirm that the brand and size of a worker's respirator seals well over the shape of his face. In addition, a fit check is done each time the worker dons the respirator in order to detect improper seal due to loose-fitting straps, a faulty valve, or facial hair interfering with the seal of the respirator. The seal should not break when the worker moves his head in any direction. Many of the PPE problems identified could be addressed by attention to proper cartridge change-out and daily fit checking of respirators.

Spill and splashes (*n*=49)
Table P3 shows the cases for which spills and splashes were identified as a contributing factor. Cases are coded under two categories depending on whether failure of spray equipment was involved.

Table P3. Spills and Splashes Identified as Contributing Factors

Contributing factor	Applicators	Mixer/Loaders	Repair and Maintenance	Totals
Spills and splashes not involving equipment failure	6	15	5	**27***
Equipment failure	14	1	7	**22**
Totals	***20***	***16***	***12***	***49***

**Total for this row includes one additional worker who was transporting pesticides*

Spills and splashes were factors in 29% of the handler cases. Nearly half (45%) were due to equipment failures. The most common problems for applicators were ruptured spray hoses (*n*=7) and hoses and valves failing when the tank pressure was increased (*n*=3). The most common problem for mixers and loaders was eye injury from splashes not involving equipment failure (*n*=11). In eight of these cases, the handler was missing eye protection. The most common exposures for workers repairing or maintaining equipment occurred when unclogging nozzles (*n*=6) and washing sprayers after application (*n*=5). Cases in which spray mist blew back on the handler during the application were not included under spills and splashes.

Protection from spills and splashes should focus on 1) proper inspection and replacement of sprayer hoses, valves and nozzles; 2) splash protection for eyes and face when mixing and loading pesticides; and 3) ensuring that workers understand that cleaning sprayers and repairing valves and nozzles are handler tasks and require handlers PPE at a minimum. Handlers should wear splash protection for their face whenever they make adjustments or repairs to pressurized spray equipment. Increased adoption of closed mixing systems and water soluble packets would also minimize splashes during mixing.

Lack of training and supervision (*n*=24)
Poor training or supervision was coded as a contributing factor in 14% of all handler cases. This probably underestimates the problem since we did not directly ask about training or supervision in most cases. These cases represent only the cases where the worker reported lack of supervision as a contributing factor or where Health noted an obvious lapse in supervision or training. Examples are: supervisor didn't provide required PPE, handler was unable to read English yet no one explained the label to him, worker continued to work in soaked clothing after pesticide leak because he was unaware of the chemical hazard, and supervisor gave the handler unsafe work instructions. Lack of training and supervision was often a cofactor with either PPE problems or spills and splashes. Twenty of these 24 handlers were not licensed. Licensed applicators who supervise handlers should make sure all required PPE is worn and that handlers fully understand the potential for injury in their assigned tasks.

No label violation but handler still became ill (*n*=53)
This code was used when the handler appeared to have complied with the PPE requirements but was still exposed with resulting injury. In some cases, it appears that the handler had a sensitivity or allergic reaction to the spray. In other cases, the standard PPE did not protect the handler when a splash occurred or equipment broke. This was especially true of eye protection. There are four ways to meet EPA's requirement for eye protection: safety glasses with side, brow and bottom protection; goggles; face mask; and full-face respirator. Safety glasses in particular were not effective in protecting against splashes or wind-blown spray mist.

At least one scenario should be explored further to determine if the label is sufficiently protective. Handlers driving air blast sprayers in orchards frequently reported that they are exposed on their face

and neck when they turn the tractor at the end of the row. This is partly due to turning their heads to look back at the sprayer during the turn. In addition, they may drive back through spray mist as they start the next row. This included one worker with 80% depression in ChE activity who was wearing a fit-tested respirator, full PPE, and whose only reported exposure was that he sometimes smells and feels chemicals on his skin at the end of the rows. Eight handlers reported this type of exposure.

Pesticide drift (*n*=35 applications)
Pesticide drift was not a frequent cause of handler exposure but handlers are responsible to ensure that pesticides do not drift and contact other workers. Handlers and their supervisors should take note of the contributing factors for pesticide drift.

Other Agricultural Workers (*n*=184)

Pesticide drift (35 incidents involving 104 workers)
Drift from agricultural pesticides is a persistent source of documented illnesses. In this six-year period, 80 incidents involving 191 people were considered by Health to be plausibly related to agricultural pesticide drift. More than half of these incidents involved drift to bystanders or workers outside agriculture. Thirty-five incidents, exposing three handlers and 101 other agricultural workers, are described below.

All 35 incidents involved pressurized application equipment. Five incidents involved aerial applications; the rest were ground sprayers. Two-thirds of the incidents (22/34) involved ground sprayers in orchards (e.g., orchard air blast sprayer). No other crop had more than two drift incidents involving workers. Since differences in acres planted do not explain the higher frequency seen in tree fruit, we need to understand the factors that make drift-related illness more likely in orchards workers. One possible explanation is the acute toxicity of the products used in orchards. Nineteen of 22 orchard incidents involved insecticide exposures; three-quarters of these were cholinesterase inhibitors.

Another factor may be the high pressure fan-shaped spray produced by the typical orchard air blast sprayer. Drift research shows that fine droplets produced by this type of equipment are prone to drift. Our data suggest that drift-related illness among agricultural workers should decrease with continuing efforts to replace the most acutely toxic products used on tree fruit and to modify or replace air blast sprayers.

Other factors which appeared to contribute to drift were: proximity of workers to the spray equipment, inadequate communication, and in at least 4 incidents, windy conditions. In most of the drift incidents the workers could see or hear a sprayer nearby. In 15/34 incidents the reported distance between the worker and the sprayer was less than 50 meters or the worker was in the block/field being treated. In another 15 incidents, workers were in an adjacent block/field or at the edge of the block. When asked why workers were close to sprayers or in the same spray block, we often heard that they were not notified about the sprayer and were not sure they were permitted to leave their work when the drift reached them. Some also thought they were a safe distance from the sprayer. In five incidents, the applicator saw the workers but thought he was a safe distance from them. In ten incidents, the sprayer worked for a neighboring farm. Adjacent farms are not required to notify each other when treating their perimeter fields but such notification could help keep workers a safe distance from pesticide applicators.

Workers present in the treated area during application *(n=15)*
or exposed during early re-entry (*n*=19)
In 15 cases, workers were in the target area during the application. This resulted in exposure to direct spray or drift from nearby sprayers. Examples include a mechanic who was sprayed aerially while fixing

an irrigation pump, farm workers who received direct spray when a speed sprayer passed one row away, and a dairy worker who worked in the same room as an automated insecticide mister.

Poor communication or lack of notification appeared to be a factor in half of these cases. Examples include a mower who was surprised when a sprayer began working in the same area of the orchard and an apple packer who received spray in her face when a sprayer passed one row away. Farms need ongoing communication between pesticide applicators and other work crews to keep unprotected workers out of harm's way.

Early re-entry into a treated area was identified as a contributing factor in 19 cases (18 incidents). In several cases, neither the employer nor the workers were aware of the early re-entry before we compared the investigation notes with the pesticide application records.

Again, communication problems appeared to be an underlying factor in a majority of the cases. Crop advisors and irrigators did not see posted signs, other workers reported that they did not see posted signs and were following verbal instructions from supervisors. In one case, a crew of workers had already been sent to an area when the employer realized that an REI was still in place and moved the workers. The workers had not noticed any signs. Fields need to be posted according to the label and WPS. Since field workers rely on verbal instructions from their supervisors, a central system of tracking needs to be maintained so that supervisors do not assign workers to areas that are restricted.

Conclusions.

Pesticide Drift
The details of the drift incidents documented in DOH's investigations, coupled with the root cause analysis of six years of data, enable us to understand factors that contribute to agricultural pesticide drift. Preventable factors that contribute to agricultural pesticide drift are:

- Inadequate communication;
- Proximity of people and homes;
- Use of air blast sprayer;
- Use of fumigant and other highly toxic products; and
- Application during unfavorable weather conditions.

Although the NIOSH project focused on agricultural workers, the prevention data investigators collect is coded for every case. This information is important and its dissemination is crucial to prevention. Efforts are underway for 2010 and beyond, to share this information with farm workers and health care providers, and at trade association and other industry meetings.

One reason for choosing to analyze contributing factors for handlers separately from other workers is that these groups often access different venues for training. Handlers are educated mainly through pesticide license recertification classes and on-the-job training provided by licensed applicators. Other workers are reached through on-the-job training required under the federal Worker Protection Standards, radio shows, community services, and health fairs. Employers may want to emphasize different prevention messages when training their handlers and their harvesting crews. Public health and worker protection programs at DOH, L&I, and WSDA should incorporate the prevention messages most specific to their audience.

The following table suggests key prevention messages for different target groups.

Key Prevention Messages by Target Group

Male Hispanic Handlers (in Spanish)	• Important to wear all required PPE (especially goggles, gloves) • Employers must provide you with what the label requires • Wear for all handling tasks including cleaning spray equipment. • Always wear splash protection when adjusting or fixing pressurized equipment • Check the fit of your goggles and respirator every time. • Spray drift from air blast sprayers can travel far especially when trees are bare. Make sure thinners and other workers are a safe distance. • Communicate spray plans with foremen of other work crews, irrigators on farm**.**
Male and female Hispanic field workers (in Spanish)	• If a sprayer comes into your work area, find your foremen and move. • Report drift to your foremen and decontaminate exposed skin and clothes.
Agricultural Employers/foremen	• Provide workers with all PPE required on pesticide label. • Supervise to ensure they wear it and wear it correctly. Ensure proper respirator cartridge replacement. • Ensure that unlicensed handlers receive good supervision. • Keep workers out of harm's way: facilitate communication between spray crews and others. • Notify neighbor farms when spraying blocks along the property line. • Post treated fields with required warning signs throughout the re-entry period. • Track REI's centrally at the office where work is assigned; ensure that crews and irrigators are not verbally directed to work in areas before REI has expired.
EPA	• Review REI's to ensure they are protective • Give guidance for safe distance from orchard air blast

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Inclusion of gender and minority study subjects.

Human subjects involvement in this surveillance and prevention work consists of two parts - case ascertainment from reporting sources required by public health law to report of pesticide related illness (WAC 246-101 and RCW 70.104.055) and through case follow-up interviews including medical record review, physician interviews and employer pesticide spray records as mandated by state law (RCW 70.104.030).

The Pesticide Program investigates from 250 – 350 reports of pesticide illness each year. The most recent year of data for analysis for gender and minority subjects was 2007. In 2007 DOH conducted pesticide illness investigations involving 310 people. Following are some demographic characteristics of these cases.

Age

0-17	47	(15.2%)
18-65	239	(77.1%)
66 and older	17	(5.5%)
Unknown (adult)	7	(2.2%)

Gender

Male	167 (53.9%)
Female	143 (46.1%)

Race

White	142	(45.8%)
Mixed race	16	(5.2%)
Black	5	(1.6%)
Asian or Pacific Islander	1	(0,3%)
American Indian/Alaskan Native	3	(1.0%)
Other	30	(9.7%)
Unknown or declined	113	(36.4%)

Ethnicity

Hispanic	85	(27.4%)
Non-Hispanic	165	(53.2%)
Unknown or declined	60	(19.4%)

The Washington State population according to the 2000 US Census is 50.2% women; the racial and ethnic profile is 81.8% White, 3.2% Black; American Indian and Alaska Native 1.6% and 5.5% Asian. Those identifying themselves as Hispanic accounted for 7.5% of all Washingtonians.

The Washington State employed civilian population, according to the Geographic Profile of Employment and Unemployment, 2000, was 2,888,000 people. Of the employed population 47.4% were female; only 2.0% were age 16 to 17 and 2.3% 65 and older.

No subpopulation is excluded from participation based on age, sex, race, or ethnicity. However, case ascertainment criteria specify that a person must have attempted to seek health care for symptom(s) experienced. Consequently, we are not including those individuals who may have experienced health effects from exposure to pesticide that did not seek health care.

This research does include people who are immigrant and for whom English is a second language, as well as those who are monolingual Spanish speaking. Hispanic farm workers can be considered as a vulnerable population, both in terms of poverty rates, and barriers the may encounter to accessing medical care and safety information. Their involvement is crucial to this surveillance program and enables us to document and prevent pesticide illnesses.

Inclusion of Children.

Children are included in this research. The parents of children under the age of 18 are interviewed rather than the child themselves. In the event that a parent allows permission to interview a teenage child, both parent and older child would be interviewed.

Materials available for other investigators.
Prevention code boxes developed under this research were enhanced and adopted as standard variables by the Sentinel Event Notification System for Occupation Risks (SENSOR) Pesticide States. Since January 2009, these prevention codes have been used by all states that participate with SENSOR-Pesticides program in conducting state-based surveillance of pesticide illness.

Inclusion Enrollment Report

This report format should NOT be used for data collection from study participants.

Study Title: Identifying Preventable Causes of Pesticide-Related Illness among Agricultural Workers

Total Enrollment: 369 **Protocol Number:**

Grant Number: 1 U60 OH008487-01

PART A. TOTAL ENROLLMENT REPORT: Number of Subjects Enrolled to Date (Cumulative) by Ethnicity and Race				
Ethnic Category	**Females**	**Males**	**Sex/Gender Unknown or Not Reported**	**Total**
Hispanic or Latino	68	236	0	304 **
Not Hispanic or Latino	6	40	0	46
Unknown (individuals not reporting ethnicity)	6	13	0	19
Ethnic Category: Total of All Subjects*	80	289	0	369 *
Racial Categories				
American Indian/Alaska Native	1	3	0	4
Asian	0	0	0	0
Native Hawaiian or Other Pacific Islander	0	0	0	0
Black or African American	0	1	0	1
White	15	43	0	58
More Than One Race	11	39	0	50
Unknown or Not Reported	53	203	**0**	256
Racial Categories: Total of All Subjects*	80	289	0	369 *

PART B. HISPANIC ENROLLMENT REPORT: Number of Hispanics or Latinos Enrolled to Date (Cumulative)				
Racial Categories	**Females**	**Males**	**Sex/Gender Unknown or Not Reported**	**Total**
American Indian or Alaska Native	0	2	0	2
Asian	**0**	0	0	0
Native Hawaiian or Other Pacific Islander	0	0	0	**0**
Black or African American	0	0	0	0
White	9	10	0	19
More Than One Race	11	39	0	50
Unknown or Not Reported	60	238	0	298
Racial Categories: Total of Hispanics or Latinos**	80	289	0	369 **