

Washington Occupational Injury and Illness Surveillance Program

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Washington Occupational Health Indicators Project

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List of Terms and Abbreviations

ABLES	Adult Blood Lead Exposure System
APP	Accident Prevention Plan
BLS	Bureau of Labor Statistics
BRFSS	Behavioral Risk Factor Surveillance System
CDC	Centers for Disease Control and Prevention
CDL	Commercial Drivers' License
CFOI	Census of Fatal Occupational Injury
DOSH	Division of Occupational Health and Safety
FACE	Fatality Assessment and Control Evaluation
FIIRE	Firefighter Injury and Illness Reduction Initiative
FTE	Full time equivalent (One FTE is 2000 hours worked per year)
I/O	Industry and Occupation
L&I	Washington State Department of Labor and Industries
LSI	Logger Safety Initiative
MSDs	Musculoskeletal Disorders
NAICS	North American Industry Classification System
NIOSH	National Institute for Occupational Safety and Health
OHI	Occupational Health Indicators
OIICS	Occupational Injury and Illness Classification System
ORD	Occupational Respiratory Disease
OSHA	Occupational Safety and Health Administration
PSSS	Puget Sound Safety Summit
PNASH	Pacific Northwest Agriculture Safety and Health Center
ROPS	Roll-over Protective Structures
SA	Specific Aim
SHARP	Safety & Health Assessment & Research for Prevention
SOC	Standard Occupational Classification
TIRES	Trucking Injury Reduction Emphasis through Surveillance
WA	Washington State
WC	Workers' compensation
WSIRB	Washington State Institutional Review Board
WMSD	Work related musculoskeletal disorders
WRII	Work related injury or illness

Abstract

The Washington Occupational Injury and Illness Surveillance program focused on collecting data and providing information for action to prevent work-related immediate inpatient hospitalizations, occupational fatalities, work-related musculoskeletal disorders in home health workers, and occupational respiratory diseases.

Data for surveillance of Washington's occupational injury and illness comes from many sources, among them Washington workers' compensation data, the WA Behavioral Risk Factor Surveillance System, worker and employer surveys and injured workers case-follow up interviews, WA Department of Health databases, with fatality reports coming from multiple sources including news feeds, death certificates, coroner reports, state patrol, employer notifications, and federal collaborators.

In this six year grant cycle, Washington State occupational surveillance programs have had several significant impacts. The overall surveillance program: 1) provided data and subject matter expertise to the WA Legislature to improve the safety of temporary agency workers, 2) identified worker self-reported workplace injury rates which were significantly associated with industry and occupation, male gender, lower socioeconomic status, chronic health conditions, and substance abuse, 3) developed a surveillance program for immediate inpatient hospitalizations for worker injuries, the NIOSH funding led to the program being adopted by Washington State with dedicated funding.

Washington's FACE program focuses their efforts on high risk industries and characterizes persistent hazards—publishing education and prevention resources for: falls in roofing, siding, and framing, logging catastrophic injuries, tractor and machinery hazards in agriculture, and workplace homicide of women in retail. FACE also identified emerging issues, specifically robot-related injuries, with a laser guided forklift fatality and severe injuries with construction robots. FACE also organized Washington's participation in the national prevention campaigns for construction falls and trenching fatalities.

Washington's Trucking Injury Reduction Emphasis through Surveillance (TIRES) program with assistance from its employer and labor steering committee has produced 74 safety posters, 72 injury narratives, 69 tip sheets, 43 eNewsletters, 11 company safety manager profiles, 10 training simulations, 9 eLearnings, 8 technical reports, 3 peer-reviewed journal articles, and other publications. More importantly, in a first of a kind innovation, the TIRES Safety Program Development Tool was created to help small and mid-size companies develop a safety program tailored to their needs.

The Washington State Occupational Respiratory Disease Surveillance program actively monitors for the occurrence of occupational asthma, silicosis, asbestosis, inhalations of toxic substances, and occupational infectious diseases. Identifications of hop dust as an asthma causing agent, of silica exposure in countertop manufacturing, and contributions to knowledge of diacetyl exposures in coffee roasters, safety protocols of applying isocyanates via a roll-on or paint brush method, and cannabis as a causative agent for work-related asthma are recent contributions of this surveillance program.

Surveillance of Work-related Musculoskeletal Disorders in the growing Home Health Care Workforce yielded data on the high availability of lift assist equipment, significant hesitancy in reporting musculoskeletal injuries or symptoms, and an absence of consideration for the physical demands and risks facing aides when care plans for patients are developed.

Section 1: Washington Occupation Injury and Illness Surveillance - OHI Project

PI: David Bonauto, MD, MPH; Sara Wuellner, PhD, MPH

OHI: Significant or Key Findings

Specific Aim 1: Collect, analyze, and disseminate surveillance data for 20 Occupational Health Indicators and employment demographic profile annually.

Our semiannual publication of Washington's occupational health indicators provided the public with understandable data regarding fatal and non-fatal injuries, occupational exposures and diseases. A key output of longstanding interest was publishing trend data for the Washington OHI. This culminated in a technical report published in September 2019 documenting indicator trends from 2000-2014. Among the findings are a workforce that is aging, more racially diverse, specifically Latinx workers, and also a greater percent of the workforce employed in industries and occupations with a high risk of morbidity and mortality. For occupational health outcomes, there were decreasing trends in work-related hospitalizations and many other work-related injuries and diseases and unfortunately a decreasing trend in the number of worksites visited by our state OSHA program. Data are presented in the semiannual updates providing visual presentations of recent trends in OHIs.

Specific Aim 2: Prioritize industries for research and prevention activities by identifying common high cost work-related injuries and illnesses using Washington workers compensation data.

The surveillance program conducted surveillance on COVID-19 workers compensation claims, firefighter workers compensation claims specifically work-related musculoskeletal disorders and cancer claims, and occupational heat exposure claims. The COVID-19 claim data has been used to advertise the plight of COVID-19 in healthcare, agriculture and construction. The firefighter claim data has helped Washington's Firefighter Injury and Illness Reduction (FIIRE Initiative). The occupational heat exposure data has assisted stakeholders in understanding the inadequacy of Washington's current rules to protect workers from overexposure to heat. SHARP's Prevention Index has been used by other states for analysis of their workers compensation claims data and is often used when industries must be prioritized for research and intervention.

Specific Aim 3: Develop a multiple data source surveillance system for acute inpatient work-related hospitalizations.

A new surveillance program has been developed for work-related immediate inpatient hospitalizations. The program links hospital discharge data to workers' compensation claims for workers who have an acute inpatient hospitalization on or within one day of work-related injury. The system provides descriptive data regarding high-risk injuries, allows WA to assess the completeness of mandated employer reporting of such cases, and to inform injury prevention efforts.

Specific Aim 4. Develop a population-based surveillance system for worker-reported occupational injury and illness.

Washington State has collected and coded Industry and Occupation (I/O) data from 1997 through 2020 on the Washington State Behavioral Risk Factor Surveillance System (BRFSS), allowing us to analyze a wide variety of conditions by I/O. In this project period, we developed 'Occupation Health Profile' using the BRFSS health behavior measures combined with occupation to describe the general health of a specific occupation, e.g. janitorial workers. We also use BRFSS to describe worker-reported occupational injury; such data was published in CDC's Weekly Morbidity & Mortality Weekly Report.

Specific Aim 5: Continue Adult Blood Lead Epidemiologic Surveillance (ABLES) outreach and intervention.

The ABLES program successfully petitioned the Washington State Board of Health to change the definition of adult elevated blood lead. The numbers of significantly elevated blood lead levels (>40 mcg/dl) had declined significantly over the last two decades.

OHI: Translation of Findings

The surveillance data and the communication of these data to the public, workers, employers, unions, business associations informs their deliberate actions to reduce workplace injuries and illnesses.

OHI: Research Outcomes/Impact

Important intermediate outcomes

1. Based on work from the OHI project, the Washington State legislature provided state funding for a permanent immediate inpatient hospitalizations surveillance program as a result of the pilot work supported by the NIOSH OHI surveillance grant. Per the legislation, *'The department will develop and maintain a tracking system to identify and respond to all immediate inpatient hospitalizations and will examine incidents in defined high-priority areas, as determined from historical data and public priorities. The research must identify and characterize hazardous situations and contributing factors using epidemiological, safety-engineering, and human factors/ergonomics methods.'*
2. As a result of surveillance of temporary agency worker injuries from the 2010 – 2015 funding cycle, the Washington State legislature passed protections for these workers which include enhanced training requirements and coordinated communications between the temporary agency and the host employer on the completeness and adequacy of training.
3. Emergency surveillance of COVID-19 cases required subject matter experts in coding industry and occupations to collaborate with the Washington Department of Health. Covid-19 data was provided to Washington L&I and I/O codes were assigned. These data have been cited in the press, throughout government and informed policy on COVID-19 in agricultural, construction, and healthcare workers.
4. Data from our surveillance program has informed actions among firefighters, logging, janitors, agricultural workers, and has involved the following injuries and illnesses – occupational burns, carpal tunnel syndrome, chainsaw injuries, and heat exposures.

Section 1: Washington Fatality Assessment Control Evaluation (FACE)

PI: Todd Schoonover, PhD, CSP

WA FACE: Significant or Key Findings

For the grant period, FACE documented a 5-year average increase in the annual number of work injury fatalities from 67 in 2010-2014 to 70 in 2015-2020. The Washington State fatal work injury rates generated by the Census of Fatal Occupational Injuries (CFOI) were compared with US fatal work injury rates. The fatal work injury rate in Washington State increased from 2.1 per 100,000 full-time equivalents (FTEs) in 2015 to 2.3 in 2019 while the rates for the US increased from 3.4 in 2015 to 3.5 in 2019.

FACE data shows that the top three industry sectors by numbers of work injury fatalities in Washington State were: construction; agriculture, forestry, fishing, and hunting; and transportation and warehousing. In the 5-year period, construction had the highest single year fatalities with 19 in 2020 while transportation and warehousing saw the highest annual number of fatalities in 2018 with 13.

In terms of incident type, motor vehicle incidents were responsible for the highest number of work-related fatalities overall. Falls accounted for the second highest number of incidents. Homicides increased in 2018-2020 and were the third most frequent incident type. Suicides also increased in 2018-2020 and were the fifth most frequent incident. Machinery incidents were highest in 2020 and fourth in terms of frequency. Accidental overdoses increased in 2020 with 6 fatalities.

WA FACE: Translation of Findings

To address significant findings, FACE focused more resources for prevention in the following sectors: construction; agriculture, forestry, fishing, and hunting; and transportation and warehousing. Prevention resources and incident investigation reports were published, widely distributed, and positively evaluated. FACE aggressively pursued opportunities to investigate construction fall and trucking-related cases and develop prevention resources for employers and workers at risk.

FACE used data to focus on high-risk industries and characterize persistent hazards. In construction, FACE published narratives with recommendations on how to prevent falls in roofing, siding, and framing. In crop and animal production, FACE published and communicated narratives on how to control tractor and machinery related hazards.

FACE continued to develop logging injury alerts that are used by employers. Each contains a sign-in sheet that employers and safety trainers can use to document topic-specific training. FACE developed new trucking industry fatality narratives and began a dedicated mailing list in response to the high number of fatalities among general freight trucking-long distance drivers.

In response to increased suicides and accidental overdoses in construction industries, FACE developed hazard alerts and SHARP Stats. The hazard alerts profiled specific cases and included several contacts for crises and counseling.

In response to increased homicides among retail workers and women in particular, FACE developed a case-series hazard alert and a SHARP Stat. The case-series hazard alert profiled describes multiple incidents where women were killed while working in retail and includes several practical recommendations for preventing incidents.

To address falls and trenching hazards in construction, FACE collaborated with several internal and external stakeholders to support and promote employer participation in national prevention campaigns. Promotions consisted of a dedicated website updated annually, a new promotional video, daily topics with resources mailed to employers, and announcements during online meetings. Each annual campaign culminated with an evaluation survey, a recognition page, and certificates mailed to participants.

WA FACE: Research Outcomes/Impact

Potential Outcomes

FACE includes case and evidence-based practical recommendations within all fatality narratives, investigation reports, and hazard alerts. Recommendations are communicated using the growing email lists, target employer mailings, and through relationships with other networks. FACE now develops new trucking fatalities at a regular frequency. Currently, almost all Fatality Narratives are developed into slideshow versions and select versions are translated into Spanish.

FACE asked select users to evaluate the 2018 and 2019 FACE annual reports in the categories of understandability and usefulness of data presentation, graphics, and text. All reviewers said that the report elements were easy to understand and were useful.

Intermediate Outcomes

Notable intermediate outcomes are the multiple highlights and publications of FACE reports in social media, trade journals, and professional magazines. These demonstrate the recognition of the value of FACE prevention resources and recommendations to a large and diverse audience. Each report contains industry and incident-specific recommendations that can be used by employers and others who can intervene.

End Outcomes

Employers and safety professionals consistently inform FACE that they have made changes in workplace policies, work practices, and equipment and PPE selection in response to FACE resources and recommendations.

FACE was also contributory in identifying and characterizing emerging hazards that can guide others in future research and investigation efforts. Most notably are FACE's investigation of robot-related fatalities and injuries. FACE identified, investigated, and published resources describing a warehouse worker killed while working with a laser-guided forklift and a series of severe injuries related to working with construction robots. This prompted extensive inquiry from researchers and employers about how to anticipate, identify, and prevent similar incidents.

Section 1: Trucking Injury Reduction Emphasis through Surveillance (TIRES)

PI: Caroline Smith, PhD, MPH

The trucking industry has some of the highest injury rates among all industries in Washington State and the US. It also suffers from high claims costs, driver shortage, and like many other industries, an aging workforce. The (TIRES) project began working with the trucking industry in Washington State in 2005 to help identify injuries and hazards and recommend mitigation and prevention practices to reduce injuries. TIRES' fifteen-year span of achievements blazed new trails in trucking safety research, hazard and injury identification, digitally-mediated education and training, and online safety program development.

TIRES 2006–2010: Significant or Key Findings

TIRES reached several initial milestones during this first phase. The formation of a 12-member steering committee of safety experts from labor, business, insurance, and education led to a multi-sector collaboration that guided nearly every aspect of the project over the years. The team developed a surveillance system to collect workplace injury data in the Washington State trucking industry. TIRES conducted hundreds of interviews with injured workers from the Trucking industry, and analyses of this data led to identifying the most common injury types – musculoskeletal disorders, falls, motor vehicle collisions, and struck by or against injuries. In addition, we identified four job activities that resulted in over 80% of compensable (time loss) injuries. These activities are: 1) entry/exit of the cab/trailer, 2) material handling/load/unloading, 3) walking around the truck or jobsite, and 4) securing the load or tarping.

TIRES 2006–2010: Translation of Findings

Multiple educational and safety related documents and training applications were developed to address these important areas of safety, including one of our most downloaded documents –the technical report “Preventing Injuries in the Trucking Industry Focus Report.”

TIRES 2006–2010: Research Outcomes/Impact

Additional research outcomes and impact from the project's first phase was the creation of keeptruckingsafe.org, a website that serves as an information and download center for TIRES newsletters, injury narratives, tip sheets, posters, reports, and trade journal articles. These publications are freely available to help trucking companies develop injury prevention training and safety program management.

TIRES 2010–2015: Significant or Key Findings

TIRES generated another set of accomplishments during its second phase from 2010-2014. Data collection methods improved with the addition of more qualitative questions to the surveillance system. Revisions to new case follow up site visit protocols helped to better identify risk factors, safety innovations, and best practices. The team conducted over 300 case follow-up interviews in English and Spanish to better understand common factors and injury root causes. The enhancements paid off as they found that

root causes of most injuries included lack of control of the worksite, co-worker support issues, equipment maintenance or mismatch issues, and company support and training deficiencies. TIRES reported its new findings with another peer reviewed journal article: Smith, Caroline K., & Williams, Jena. (2014). Work related injuries in Washington State's Trucking Industry, by industry sector and occupation. *Accident Analysis & Prevention*. 65 (2014) 63-71.

TIRES 2010–2015: Translation of Findings

The project's range of safety training products expanded with a new array of online simulations, YouTube videos, blog posts, and a revamped monthly email distribution newsletter with links to published training materials.

TIRES 2010–2015: Research Outcomes/Impact

TIRES' high caliber work also gained attention in the NIOSH Extramural Research and Training Program Annual Report of Fiscal Year 2012. DHHS (NIOSH) Publication No. 2014-114, p. 57.

TIRES 2015–2021: Significant or Key Findings

TIRES capped off its history with more remarkable achievements during its third and final phase from 2015 to 2021. While injury surveillance and data collection winded down, the project focused its attention on developing the online TIRES Safety Program Development Tool. We worked with our Steering Committee and small/medium sized trucking companies to revise and enhance our Safety Program Development Tool.

TIRES 2015–2021: Translation of Findings

A first-of-its-kind innovation, the TIRES Safety Program Development Tool will help small to mid-size companies comply with state safety program requirements and teach them why and how to implement safety in their companies. Any trucking company can use the tool to create and update a safety program tailored to their specific mix of vehicles, equipment, and work environments. The team also equipped the safety program with interactive short instructional e-learning modules that users can download from the TIRES website.

TIRES 2015–2021: Research Outcomes/Impact

In addition to the development of the safety program tool, the project did COVID-19 prevention outreach that consisted of a newly-created webpage, seven tip sheets, blog articles, and tweets. TIRES continued its high volume output of tip sheets, injury narratives, blog posts, and monthly newsletters—all available on its revitalized website. Finally, the project wrote its last technical report describing the nature, costs and magnitude of injuries in Washington State's trucking industry. Overall, the TIRES team created 74 posters, 72 injury narratives, 69 tip sheets, 43 eNewsletters, 11 company safety manager profiles, 10 training simulations, 9 eLearnings, 8 technical reports, 3 peer-reviewed journal articles, hundreds of social media posts, and several other miscellaneous publications.

The TIRES project's achievements present a wide variety of tools to keep truck drivers, diesel mechanics, loading dock workers, and other employees safe on the job.

However, the project's completion underscores the need for trucking safety researchers, safety professionals, industry leaders, and company management to carry the torch further. TIRES has shown that determining and targeting the root causes of injuries in trucking is an ongoing critical mission. There will always be a need for better hazard identification and injury prevention methods because the industry's evolving mix of technology, people, and environments will change how, where, why, and when hazards, risks, and injuries occur.

Section 1: Occupational Respiratory Disease Surveillance in Washington State

PI: Carolyn Whitaker, MS, CIH

ORD: Significant or Key Findings

The first of four key findings under Aim 1, Conduct Surveillance for Respiratory Disease and Toxic Inhalation, is the identification of 310 valid work-related asthma claims over the reporting period and the finding that rates of work-related asthma decreased significantly in comparison to all claims filed during the period 2002-2016. Second, in 2016 we created surveillance for and validated six silicosis cases, 52 asbestos-related cases, and three cases of Valley fever. Third, in 2019 we created a surveillance system for toxic inhalation and identified 2604 valid inhalation cases with exposure to at least one substance; there were 388 unique substance categories. Fourth and final, in 2020 we successfully launched surveillance for COVID-19 using the staff and modeling the protocols and processes from our respiratory surveillance systems.

In Aim 2, Surveillance using Washington-OSHA Airborne Exposure Data, we surveilled 890 OSHA inspections and described approximately 4500 airborne chemical or noise exposures. A key outcome was the adoption of our newly created query exposure database by our OSHA staff. We published portions of the data in a technical report.

Aim 3 was 'Increase the Type and Number of Cases Brought into Surveillance'. The key outcome was establishing silicosis and hypersensitivity pneumonitis as legally notifiable conditions (WAC 246-101), with clinician reporting direct to the SHARP program. As desired, this will increase occupational respiratory cases reported to us.

We conducted two key case-based investigations aimed at prevention under Aim 4. First, on-site prevention tours took place during the hop harvest to exchange knowledge with employers about hop dust exposure and the risk of work-related asthma. Second, we conducted an extensive exposure assessment at a coffee roaster and showed frequent and widespread over-exposure to diacetyl; the assessment helped the employer prioritize risk reduction strategies.

Key findings from Aim 5, Program Evaluation, are specific to our new toxic inhalation surveillance system. Upon evaluation, we modified to improve the case capture strategy for our eight primary inhalation conditions. We identified cleaning chemicals, agricultural chemicals and pharmaceuticals as predominant exposures that could be added to the eight primary conditions already in the system.

ORD: Translation of Findings

Example 1: Work-related asthma from hop dust exposure. Prior to the current reporting period, we published a case-series of respiratory disease associated with occupational inhalation to hop dust during harvest and processing. In 2015 we gave a presentation to growers on the risk of work-related asthma at a trade association meeting. Thereafter we toured two farms where we learned that hop growers had adopted our educational materials to improve their safety programs. Growers were receptive to the knowledge that dust control practices already in place could be adapted to reduce the risk of respiratory disease. The WA Hop Commission subsequently requested an ergonomic assessment for hop bale sampling, the results of which they subsequently used to draft new language to their Hop Inspection Manual. In partnership, we successfully introduced both respiratory and musculoskeletal best-practices across the hop industry.

Example 2: Severe silicosis in engineered stone workers. We published a single case of accelerated silicosis in a countertop fabrication worker as part of a larger U.S. case series ([MMWR 2019](#)). Additionally, our WA-DOSH exposure surveillance showed historic over-exposure to silica dust in countertop fabricators, which greatly added to the weight of evidence for this hazard. The DOSH program adopted the findings from both of our surveillance systems and launched an emphasis program regarding silica exposure in 2020. To-date, approximately ten inspections have been completed in the countertop fabrication industry, with at least two worksites obtaining medical surveillance for their workers. Our surveillance efforts were directly used to reduce silicosis risk in engineered stone workers through a highly publicized journal article, enforcement inspections with exposure assessments for airborne silica dust, and subsequent medical surveillance for workers found to be over-exposed to silica dust.

ORD: Research Outcomes/Impact

Policy influence: Our published work-related asthma data on isocyanates was used by Green Seal regarding their Architectural Thermal Insulation Material Standard (GS-54) and by California's Safer Consumer Products Program.

Policy influence: Data from our exposure surveillance program was used to inform Washington's interagency workgroup on methylene chloride and regulatory efforts.

Scientific expertise on S&H in cannabis industry: Dissemination of our surveillance data on cannabis disease and injury prompted inquiries from WA State legislatures, academic researchers, occupational physicians, and employers, all of whom received our research information in a way that informed their decision making.

Work-related asthma: Controlled and in situ assessment of airborne isocyanates at a state transit agency informed their safety protocols to reduce the risk of isocyanate asthma when applying paints to transit stations.

Work-related respiratory disease: Workplace assessment of airborne diacetyl and carbon monoxide at a coffee roaster informed their practices and protocols to reduce employee risk for bronchiolitis obliterans and carbon monoxide over-exposure.

Section 1: Characterizing the Burden of Work Related Musculoskeletal Disorders (WMSDs)

PI: Ninica Howard, MSc, CPE

WMSDs: Significant or Key Findings

WMSDs, across all industries, continues to be the most prevalent injury type in the Washington State workers' compensation system. Between 2006 and 2015, 39.3% of all accepted claims were attributed to WMSDs. Direct costs for WMSD workers' compensation (WC) claims totaled \$3.7 billion. Within the Health Care and Social Assistance sector, WMSDs accounted for 49.4% of all compensable claims. Associated direct costs for WMSDs claims was \$424 million.

A comparison of the Washington State WC claims between 2006 and 2016 of home-based health care (HBHC) found WMSDs were overwhelmingly the most common injury among HBHC claims (47.3% of all compensable claims). Over a quarter of WMSD claims were attributed to overexertion from lifting. WC claims due to falls (falls on the same level and to a lower level) were also shown to be prevalent (22.9% of all compensable claims compared to 15.6% for clinical health care).

Between 2006 and 2016, home-based health care claimants (HBHC) were significantly older than claimants in clinical health care (45.7 vs. 43.8 years). HBHC claimants with WMSDs were younger than clinical care WMSD claimants. Most HBHC WMSD claimants (56.4%) between 30-49 years; among clinical care WMSD claimants, most (52.6%) were between 40 and 59 years; the majority of injured home-based health care providers were considered overweight or obese, with a BMI of 25 or greater. A larger proportion of claimants injured from a falls on the same level (FSL) and falls to a lower level (FLL) were classified as overweight and obese (76.2% FSL, 75.8% FLL)

Though year-over-year workers' compensation claim rates for all compensable claims and WMSD claims, between 2006 and 2016, declined. Claims rates were found to be lower for clinical health care than home-based health care, however, home-based health care claims were more expensive and involved more lost work days.

Analyses of an additional surveillance system, BRFSS, suggested that home-base health care workers may have different underlying health issues than other health occupation groups. Home-based health care workers suffered from more chronic health conditions than their comparison. Home based health care workers suffered more often from arthritis (33.2%), diabetes (9.4%) and depression (32%). These workers also had twice as many days of poor physical health in the previous month (4.2 days).

Factors that May Contribute to Home Health Care Aides injuries and WMSDs

In a survey of home-based health care workers (n=259), over half (55%) reported moving, transferring and repositions patients several time a day. Most care workers (80%) reported access to patient handling equipment, which included assisted devices such as shower chairs and gait belts, which do not eliminate risk factors associated with back WMSDs and injuries. Most surveyed indicated that they did not report (30%) or were moderately to extremely hesitant (23%) to report symptoms and injuries. There is

a hesitancy to seek medical care for symptoms and injuries. Many never sought medical treatment (41%) while 17% waited more than a month to seek medical care.

Factors involving the aide-patient and aide-employer relationships may contribute to injuries and WMSDs. Interviews with injured home-based health care aides (n=31) revealed an accepted level of risk within their job. The patient's safety and satisfaction is priority over their own health and safety. Aides feel little agency, having little choice by to meet the demands of their patients or patients' families. Focus groups with agency representatives (n=6) revealed that care plans for patients are developed without input from the aide. There is a lack of realization of the physical demands and the risks facing aides when care plans are developed without their input. While agencies representatives identify educating aides to set boundaries and educate families about the limits of care, these are the very factors that aides feel they cannot do in order to ensure patient satisfaction and safety.

WMSDs: Translation of Findings

Analyses of Washington State's workers' compensation system showed the continued high burden of injuries and WMSDs. The findings of this research suggest that both the health and risk factors faced by home-based health care workers differ from that of workers in clinical care and as such, injury prevention programs developed in the clinical care environment may not be efficacious in the home care environment. The need for evidenced-based prevention programs, developed specifically for home-based health care, is warranted.

This research suggests that the improvement of home-based health care workers health cannot be achieved solely through behavior modification of the worker. A social ecological model is needed to address risk factor contributors that move beyond the individual care provider. The influence of the aide-to-patient and aide-to-employer relationships illustrates the need to address the role of the interpersonal, organizational, community perception and public policy aspects on the risk of injury.

A shift from workers' compensation systems to other health programs is one possible explanation for the decline observed in the claim rates since 2006. Eligibility criteria for coverage by workers' compensation for occupational diseases, such as WMSDs, is typically more difficult to reach. This suggests that improved surveillance of WMSDs is needed. A multi-source approach to surveillance is needed. The utility of additional data sources, such as syndromic surveillance systems or all-payer databases, should be assessed to be used in conjunction with workers' compensation data to capture WMSD cases.

WMSDs: Research Outcomes/Impact

Potential Outcomes

An electronic database was developed that allows the dissemination of workers' compensation claims data upon request. This provides stakeholders with a tool to quantify the burden.

Intermediate Outcomes

- a. 2020 Washington State House Bill 2646, addressing WMSDs in health care, used data Technical Report 40-12-2015 to support the need.
- b. The American Association of Occupational Health Nurses is offering CNE credits associated with an exam on the content of the article by Howard, N., & Marcum, J. (2020). Published in Workplace Health & Safety

Data from a technical report describing workers' compensation claims data, Technical Report 95-02-2019, were cited in another research paper by Quinn et al, 2021.

Section 2: Washington State Occupational Injury and Illness Surveillance Program; Washington Occupational Health Indicators Project

PI: David Bonauto, MD, MPH; Sara Wuellner, PhD, MPH

Background

The overall goal of Washington's Occupational Injury and Illness Surveillance program is to reduce the incidence of workplace injury and illness in Washington State by providing relevant, timely, accurate public health information to people who can effect positive change in workplaces.

Currently, Washington's Occupational Injury and Illness Surveillance program has a comprehensive state-based surveillance program that collects and disseminates data on selected health, injury, and exposure indicators. The 'Indicators' were selected through a collaborative effort of state occupational safety and health researchers with the Council of State and Territorial Epidemiologists and National Institute for Occupational Safety and Health (NIOSH). Resources provided by NIOSH for state 'fundamental surveillance programs' allow states to complete the indicators and conduct small innovative surveillance research projects to advance state-based surveillance.

In Washington, surveillance data are used to focus state regulatory, research, and other occupational injury prevention efforts to the industries and workplaces where they are most needed. Washington's surveillance program uses workers' compensation data to rank industries, by claim count and claim incidence rate, to more effectively and efficiently target resources for prevention and intervention. Washington State OSHA uses these data to guide compliance and consultation services which research studies have found to reduce the future occurrence of workers compensation claims among employers receiving such services. The prioritization of industries is based on workers compensation data, a data source subject to known limitations including incomplete data; however, for Washington, workers' compensation data provides detailed information on the work location, causes, and medical outcomes of nearly 37,000 workplace injuries and illness annually that result in lost time from work.

Meetings of national and state surveillance experts have recommended improving workplace injury and illness by developing surveillance systems less dependent on employer reporting of injuries and illnesses. Recommendations included creating state-based surveillance systems for acute work-related inpatient hospitalizations and developing a worker-reported rate of occupational injury and illness. These recommendations reflect Washington State priorities.

Creating a surveillance system for tracking acute work-related inpatient hospitalizations would provide much needed information on preventing these serious injuries. Additionally, it can be used to evaluate employer compliance with new Washington State OSHA rules, enacted in 2009, requiring employers to report all work-related acute inpatient hospitalizations within 8 hours of injury event. The intent of the reporting rule is to dispatch promptly OSHA inspectors to the worksite of incident. Employer compliance with this reporting rule has never been evaluated.

In an effort to assess occupational injury and illness independent of employer involvement, Washington's Occupational Injury and Illness Surveillance program has used the Washington State - CDC based Behavioral Risk Factor Surveillance System (BRFSS) annual survey. By adding industry and occupation questions to the survey, Washington's surveillance program has successfully used the BRFSS data to describe the health status and health behaviors of workers by industry and occupation. Using this annual survey of nearly 3,500 Washington State employed residents to obtain information about work injury or illnesses seems plausible. Thus, allowing estimates of occupational injury and illness rates without the potential barriers related to employer involvement in occupational injury and illness reporting. We intend these efforts to serve as a possible foundation for a state worker survey on occupational health and injury.

With this in mind, we worked towards the following specific aims:

1. Collect, analyze, and disseminate surveillance data for 20 Occupational Health Indicators and employment demographic profile annually.
2. Prioritize industries for research and prevention activities by identifying common high cost work-related injuries and illnesses using Washington workers compensation data.
3. Develop a multiple data source surveillance system for acute inpatient work-related hospitalizations.
4. Develop a population-based surveillance system for worker-reported occupational injury and illness.
5. Continue Adult Blood Lead Epidemiologic Surveillance (ABLES) outreach and intervention activities.

Methods and Results

Specific Aim 1: Collect, analyze, and disseminate surveillance data for 20 Occupational Health Indicators and employment demographic profile annually.

Occupational Health Indicators (OHI) are a set of metrics that provide an overview and general assessment of the employment characteristics and occupational health of Washington State. We created during this grant period a data report for 2000-2014 to assess injury trends over time and inform prevention efforts. Subsequently we added to our OHI Indicator website more recent trend data. In the information below, we augment the report findings with data from 2015-2019. (https://ini.wa.gov/safety-health/safety-research/files/2021/80_17_2021_WA_Indicators_2021Apr.pdf)

The key findings were for:

A. Employment characteristics:

- Washington workers are aging, which may put more workers at risk for occupational injuries and illnesses. This trend continued through 2019, with about 5.4% of the workforce being over 65 years of age.
- The workforce is also becoming more racially/ethnically diverse, with implications for training and prevention. In 2019, the percentage of the workforce who are Hispanic is 13.5% up from ~5% in the year 2000.

- The percentage of workers employed in high-risk industries and occupations increased, warranting additional resources and prevention efforts. The trend appears to level off from 2014 through 2019.

B. Injury and illness outcomes:

- Large declines over time in work-related hospitalizations. These trends continued from 2014 through 2018.
- Small declines in work-related fatalities, including fatal injuries and deaths from pneumoconiosis. More recent data from 2014-2019 do not show changes in the rate.
- No change in rates of mesothelioma. More recent data from 2014-2019 do not show changes in the rate.
- Rates of workers' compensation claims for amputations and work-related pesticide poisonings increased during first part of the study period, before declining to rates in 2014 that were similar to rates observed at the beginning of the study period. More recent data from 2014-2019 do not show changes in the rate.

C. Interventions:

- Washington's state OSHA (DOSH) enforcement activities are reaching fewer establishments and covering fewer employees.

Conclusions

Current declines in many work-related injuries and illnesses are encouraging. However, trends may change, especially given the increase in workers in high-risk industries and the decrease in the reach of DOSH enforcement activities. Appropriate training and prevention activities are still needed to ensure that workplace injury and illness rates continue to decline among all industries, occupations, and workers. This is especially true for work-related fatalities and mesothelioma, where rates experienced little change over the fifteen years.

The OHI do not explain why rates might be changing; further studies can identify the factors that drive occupational injury and illness rates, and to what extent systemic changes within data sources affect rates. Finally, the OHI provide a partial view of workplace health and safety.

Specific Aim 2: Prioritize industries for research and prevention activities by identifying common high cost work-related injuries and illness using Washington workers' compensation data.

Overall, we've prioritized industries by using the NAICS coding structure and ranked industries by rate and number of claims by the 'Prevention Index.' The data from the workers compensation system are typically grouped by common injury events, e.g. falls from elevation, overexertion, and this serves as a foundation for how Washington and other states evaluate their data. In this grant cycle two efforts stand out given the current rulemaking environment for controlling occupational heat exposure and the COVID-19 pandemic. The data generated by our surveillance programs are unique.

COVID-19 Surveillance

Certain industries experience a disproportionate risk of COVID-19 infections and hospitalizations, although the risk has changed over time. For the time period from March 2020 – April 2021, data from Washington’s Disease Reporting System were coded by NAICS Sector (Table1).

Between March 2020 and January 2021, the two industries with the highest monthly case rates were Health Care and Social Assistance and Agriculture, Forestry, Fishing and Hunting. As of March 2021, rates among these two groups fell below the rates of nine other industries. In April 2021, the highest rates of COVID cases occurred in Construction and Accommodation and Food Services, exceeding case rates in all other industries.

Industry trends in case rates likely reflect the combination of vaccine uptake, the adoption of transmission control efforts like use of personal protective equipment, improved ventilation, and telework, and enforcement of workplace safety regulations.

As the pandemic continues to evolve with emerging variants, shifting behaviors, and changing policies, prevention strategies must also continue to adapt to the current environment. Limited data on the industry and occupation of COVID cases impedes development of such strategies. Work information continues to be a relevant piece of information for understanding and controlling this pandemic.

In the time period, there were 115,373 positive cases, 3392 hospitalized cases, and 227 deaths. It is important to note that the data with industry and occupation codes represents only a fraction of the available cases, hospitalizations, and deaths. Despite efforts to improve industry and occupational coding of COVID-19 cases, there were decrements in the quality and completeness of coding over the course of the pandemic.

Nevertheless, specific NAICS industry sectors had elevated risk of COVID-19 cases, hospitalizations, and deaths. While employment in Health Care and Social Assistance (NAICS 62) accounted for 12.9% of Washington’s employed workers, the industry sector had 19.9% of COVID-19 positive cases, 20.8% of the hospitalizations, and 16.7% of the deaths. Similarly, Agriculture, Forestry, Fishing, and Hunting (NAICS 11) employs 2.5% of Washington workers but experienced 5.2% of COVID-19 positive cases, 5.7% of the hospitalizations, and 8.8% of the deaths. The elevated risks in these industry sectors likely represent a combination of occupational and non-occupational risks. Within the Healthcare sector there is likely much more occupational exposure to COVID-19 positive individuals than in other sectors. In the Agricultural sector, close working conditions in packing houses, harvesting and close living quarters of farmworkers – or non-healthcare congregate living arrangements.

Conversely, specific NAICS industry sectors had a lower risk of COVID-19 cases, hospitalizations, and deaths. While employment in Educational Services sector (NAICS 61) accounted for 8.3% of Washington’s employed workers, the industry sector had 5.2% of COVID-19 positive cases, 4.5% of the hospitalizations, and NR% of the deaths. Similarly, Professional, Scientific, and Technical Services employs 9.7% of Washington workers but experienced 3.7% of COVID-19 positive cases, 2.8% of the

hospitalizations, and NR% of the deaths. The lower rates likely reflect age differences between the working populations but also controls to limit exposure in the workplace.

Occupational Heat Exposure

Heat related illness (HRI) places a significant burden on the health and safety of working populations and its impacts will likely increase with climate change. The aim of the study was to characterize the demographic and occupational characteristics of Washington workers who suffered from HRI from 2006-2017 using workers' compensation claims data.

We used Washington workers' compensation data linked to weather station data to identify cases of work-related HRI. We utilized Occupational Injury and Illness Classification System codes, International Classification of Diseases 9/10 codes, and medical review to identify accepted and rejected Washington State (WA) workers' compensation claims for HRI from 2006–2017. We estimated rates of HRI by industry and evaluated patterns by ambient temperature.

We detected 918 confirmed WA workers' compensation HRI claims from 2006-2017, 654 were accepted and 264 were rejected. Public Administration had the highest third quarter rate (131.3 per 100,000 FTE), followed by Agriculture, Forestry, Fishing and Hunting (102.6 per 100,000 FTE). The median maximum daytime temperature was below the WA heat rule threshold for 45% of the accepted HRI claims. Latinos were estimated to be overrepresented in HRI cases.

Occupational heat-related illness claims are non-uniformly distributed across the workforce. Industries and occupations with outdoor work are likely at higher risk. Over 57% of claims for heat related illness occur in one of three industry sectors – Construction with 170 claims (26% of total), Agriculture, Forestry, Fishing, and Hunting with 111 claims (17%) and Public Administration (14.4%). In aggregate approximately 50% of the heat-related illness claims occurred below the maximum daily temperature maximum of 89 degrees Fahrenheit. Such temperature is significant in that it is the trigger level for workers protections to be activated by employers to prevent heat stress.

The WA heat rule threshold may not be adequately protecting workers and racial disparities are present in occupational HRI. Employers should take additional precautions to prevent HRI depending on the intensity of heat exposure. States without heat rules and with large industry sectors disproportionately affected by HRI should consider regulations to protect outdoor workers in the face of more frequent and extreme heat waves.

During the summer of 2021, the Pacific Northwest experienced a heat dome with very unusual temperature extremes of ~110 degrees Fahrenheit. This event plus the public's interest in climate change led to greater awareness of the inadequacy of current protections for workers from heat exposure. The data in this report was cited by many news outlets, government officials, and stakeholders likely will have impact in the future.

Specific Aim 3: Develop a multiple data source surveillance system for acute inpatient work-related hospitalizations.

Though work-related traumatic injuries that require immediate inpatient hospitalization make up a small proportion of Washington workers' compensation claims, they are

severe, costly, and can have devastating long-term consequences for the workers that experience them. A better understanding of these serious injuries can lead to the development of more effective interventions to prevent them.

Employers in Washington State are required to report worker injuries that lead to inpatient hospitalization to the Washington State Department of Labor and Industries Division of Occupational Safety and Health (DOSH) within eight hours. However, employer reporting is sporadic and often incomplete. To better understand and track work-related immediate inpatient hospitalizations, SHARP developed a surveillance system that links workers' compensation claim information with Washington hospital discharge data from the Comprehensive Hospital Abstract Reporting System (CHARS). Workers' compensation claims from employers insured through the Washington State Department of Labor and Industries' industrial insurance State Fund (SF) and those from Self-Insured (SI) employers are included.

We used this unique surveillance system to characterize work-related inpatient hospitalizations in Washington State from 2014 through 2018. The content from this report provides data to establish prevention priorities for Washington's newly funded work-related immediate inpatient hospitalizations surveillance system.

Key Findings:

- From 2014 through 2018, there were 3,684 work-related immediate inpatient hospitalizations in Washington State.
- Over the five-year period, the annual average number of immediate inpatient hospitalizations was 737, and there was an average rate of 28.7 work-related immediate inpatient hospitalizations for every 100,000 Full Time Equivalent (FTE) employees.
- There were 3,031 (82.3%) immediate hospitalization claims filed by workers covered through the Washington State Fund. There were 653 (17.7%) hospitalizations among workers from Self Insured employers.
- The majority of hospitalized workers were men (n=2,957, 80.3%).
- Older workers had the highest hospitalization rates. Workers aged 65 and over had the highest hospitalization rates, 40.8 per 100,000 FTE. Workers age 55-64 had the second highest rates at 32.1 hospitalizations per 100,000 FTE.
- Over 15% of workers (n=582) with a work-related immediate inpatient hospitalization claim preferred to receive claim information in a language other than English. Of those, 87.5% preferred Spanish.
- Falls from elevation were the leading cause of immediate inpatient hospitalizations, accounting for over a quarter of injuries (n=938, 25.5%). Falls from ladders were the most common type of fall from elevation.
- Although falls were the leading cause of work-related immediate inpatient hospitalizations for both men and women, there were notable differences. For men, falls caused 38% (n=1,125) of hospitalizations; of which nearly three-quarters were falls from elevation. For women, 56.4% (n=410) of hospitalizations were due to falls, of which nearly three-quarters were falls on the same level.

- The Construction industry sector (NAICS 23) had the highest number of immediate inpatient hospitalizations with 926— almost one-quarter of all hospitalizations— and the highest rate of hospitalizations per 100,000 FTE (117.1).
- Fracture was the most common injury nature involved in work-related immediate inpatient hospitalizations. Forty percent of hospitalizations were due to fractures.
- The types of injuries leading to immediate inpatient hospitalization and worker characteristics varied by industry.
- Smaller employers had higher rates of work-related immediate inpatient hospitalizations. Employers with ten or fewer FTE had an immediate inpatient hospitalization rate of 56.8 per 100,000 FTE, which was almost four times the rate of employers with 1,000 or more FTE.
- Among State Fund immediate hospitalization claims, the median number of time loss days paid was eighty-seven days.
- For State Fund work-related immediate inpatient hospitalization claims, total claim costs paid (including medical costs and time loss payments) were approximately \$334,918,000. The average claim cost was \$110,000.

Information from SHARP's work-related immediate inpatient hospitalization surveillance system shows that, while comprising only a subset of all Washington workers' compensation claims, workplace injuries that lead to immediate inpatient hospitalization are severe, typically traumatic in nature, and often lead to extended periods of time away from work or disability. This descriptive information demonstrates that some industry sectors and groups are at higher risk for work-related immediate inpatient hospitalizations, and that the type of injuries that lead hospitalization differ by industry. Hospitalization claim rates differ by employer and worker characteristics. These results can be used to better focus workplace traumatic injury prevention efforts, and to tailor interventions to be as effective as possible.

Specific Aim 4. Develop a population-based surveillance system for worker-reported occupational injury and illness.

This is an excerpt from an MMWR publication describing our efforts to develop the worker reported occupational injury and illness tools through BRFSS. It is an important summary of our ongoing work in this area.

BRFSS is a CDC-sponsored, statewide telephone survey conducted annually to collect information on health outcomes and behaviors. The sample includes adults aged ≥18 years in a private residence or college housing. Since 1995, the WA BRFSS has added questions* to collect information on industry and occupation. Trained coders assign industry and occupation codes to verbatim responses through automated and manual coding processes. During 2011–2014, WA BRFSS also collected work-related injury or illness information on working adults with a state-added question. The response rates in Washington during this period ranged from 31% to 44%.

Among the 51,335 respondents to the 2011–2014 WA BRFSS, 25,493 (50.0%) were eligible to answer the work-related injury or illness question, including those currently employed for wages (20,028, 78.5%), self-employed (4,059, 15.9%), and out of work for

<1 year (1,406, 5.5%). Among all eligible respondents, 24,650 (96.7%) participated in the optional work-related injury or illness module.

Associations between work-related injury or illness and select demographics, health conditions, and risk behaviors were examined. Results were weighted to the adult population in Washington. Statistical significance was determined using Rao-Scott chi-square tests, at $\alpha=0.05$.

During 2011–2014, an estimated 6.4% (190,076 annually) of employed Washington residents reported having a work-related injury or illness during the previous year (Table 1). The percentage of workers with work-related injuries or illnesses varied significantly by respondent's reported industry and occupation, with the highest prevalence reported among workers in the Transportation and Warehousing (9.2%), and Construction industries (8.9%), and the Installation, Repair, and Maintenance (11.1%), Service (9.7%), and Transportation and Material Moving (9.6%) occupations. The percentage of workers reporting work-related injury or illness was lowest among females (5.7%), married persons (5.4%), persons with ≥ 4 years of college (4.1%); and persons with an annual household income $\geq \$75,000$ (4.4%).

The percentage of respondents reporting work-related injuries or illnesses was higher among persons with chronic health conditions, such as heart disease, depression, arthritis, blindness or difficulty seeing, and asthma, than among workers not reporting these conditions. Reporting of these health conditions was not significantly higher among workers within high-risk industries and occupations (≥ 7 work-related injuries or illnesses reported per 100 workers) compared with workers in lower-risk (< 7 per 100 workers) industries and occupations.

The percentage of work-related injury or illness was significantly higher among workers who reported sleeping ≤ 6 hours per night on average (9.4%) compared with workers who slept an average of > 6 hours per night (5.0%). The percentage of workers who reported work-related injury or illness was significantly higher among respondents who reported use of pain killers to get high (15.9%) or marijuana (8.9%), being a current smoker (10.0%), and binge drinking (7.4%), compared with workers who did not report these behaviors.

This report demonstrates the utility of the WA BRFSS as a statewide occupational health surveillance system, which unlike other current surveillance systems, collects work-related injury or illness data. The WA BRFSS identifies cases by worker-report, and therefore is not subject to the same underreporting biases present in systems that rely on physician or employer reports of injury and illness. The WA BRFSS also collects demographic, health status and behavior information on workers that is not available in other sources of occupational injury and illness data, allowing for more complete characterization of persons with recent work-related injuries and illnesses. The WA BRFSS could serve as a model for other states to include similar questions to collect work-related injury and illness data to enhance their occupational surveillance capabilities, and allow for opportunities to aggregate state data for evaluation of this outcome on a larger scale. Further research might help to determine if there is segregation of workers by their demographic, health, and behavior characteristics into high-risk industries and occupations, or if these characteristics are causally related to

injury and illness. Assessment of health status and behaviors as potential contributors to occupational injury risk might inform future prevention activities, but does not mitigate the employer’s responsibility in providing a workplace free from hazards.

Specific Aim 5: Continue Adult Blood Lead Epidemiologic Surveillance (ABLES) outreach and intervention.

During this grant period, blood lead data from the Washington Disease Reporting System are electronically transferred to the ABLES databases. Reports are evaluated for elevated lead levels, and case follow-up with the worker, laboratory and employer may occur. Clusters of elevated lead levels in an employer without a history of such are potentially investigated either by L&I’s SHARP program, DOSH Consultation or Compliance programs. The ABLES program has been instrumental in providing data for Washington’s effort to update its occupational exposure to lead standard. The table below demonstrates the number of BLLs 10ug/dl and above.

Table 1: Blood Lead Test Reports Received by WA ABLES, 7/2015–6/2021

Lead Level (mcg/dl)	Number of Reports Received
> 10 to ≤ 25 mcg/dl	1775
> 25 to ≤ 40 mcg/dl	249
> 40 to ≤ 60 mcg/dl	34
> 60 mcg/dl and greater	18

Section 2: Washington Fatality Assessment Control Evaluation (FACE)

PI: Todd Schoonover, PhD, CSP

Background

FACE has been conducting fatality surveillance and prevention activities in Washington State since 1997. FACE 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 communicate information on preventive actions.

Results by Specific Aims

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

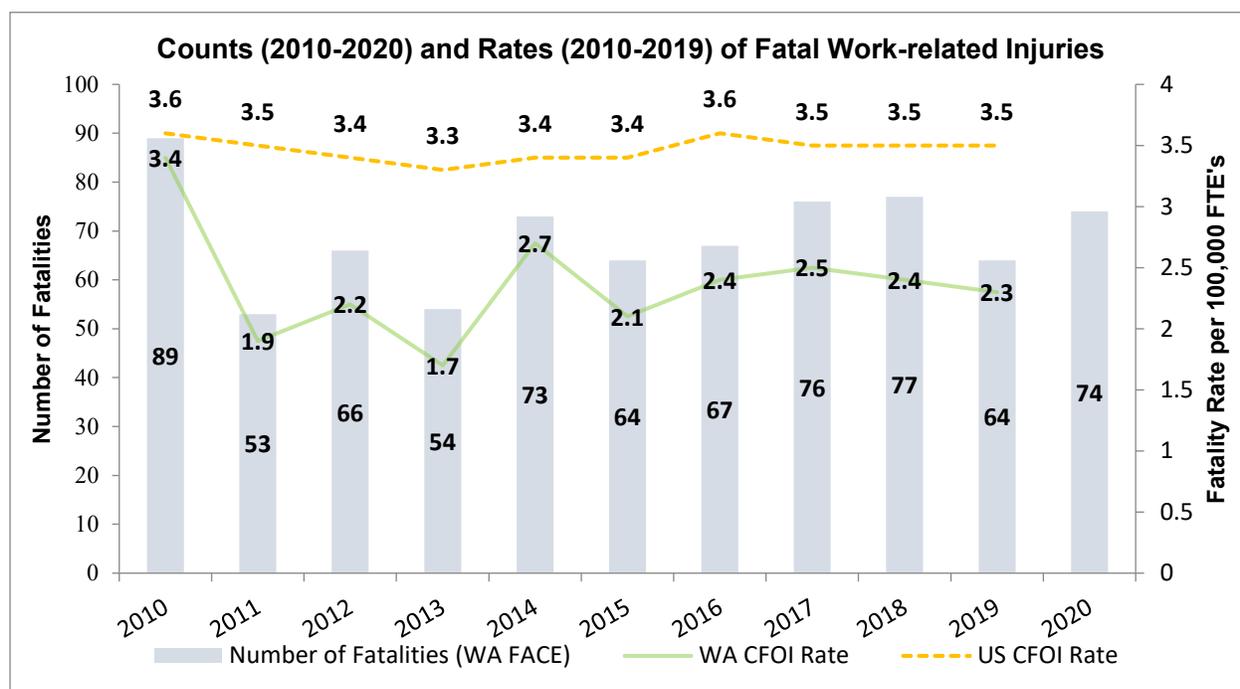
Specific Aim 1: Maintain and enhance the current program's timely multi-source traumatic occupational fatality surveillance system.

The FACE surveillance system manager has over sixteen years' experience maintaining the system. In addition, the recently hired FACE research investigator has expertise in the trucking industry and prevention messaging to employers. Having two FACE personnel with expertise has enhanced the timeliness and overall ability to fulfill the numerous specific data requests from internal and external parties.

Additions to the system include significant updates to the FACE fatality database. The new database is now capable of date, industry, and incident customizable reports. FACE uses reports to manage and share up-to-date detailed case information to DOSH, L&I, members of associations, logging health and safety professionals, and other industries.

FACE continues to receive and review weekly reports of traumatic injury cases reported to L&I. Reports are scanned for cases considered novel or highlighting hazards worthy of developing alerts or other prevention resources.

Figure 1. Fatal work-related injuries, 2010 through 2020



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

The FACE staff consists of an industrial hygienist, health and safety specialist, and research investigator 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.

FACE staff addresses every narrative and investigation case with a wide variety of expertise, resources, and research. Examples include reviewing literature for related fatality or injury cases, consulting with veteran ergonomists and topic-specific technical experts, and finding the most applicable standards and resource materials.

Specific Aim 3: Investigate select fatal incidents as defined in the NIOSH priority areas as well as Washington State priority areas.

FACE has investigated priority area fatalities and communicated relevant hazard identification and prevention resources to targeted audiences. FACE also investigated cases that were novel or reflected the changes in the distribution of case types occurring in the state. All investigation reports contained several detailed recommendations for preventing future incidents.

Table 1. WA FACE Fatality Investigations and Reports by Year.

Year	Recruitment Letters Sent	Investigation Reports Published
2015	15	4
2016	44	3

Year	Recruitment Letters Sent	Investigation Reports Published
2017	42	2
2018	31	4
2019	22	1
2020	24	
Total	178	14

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

FACE strives to develop prevention resources with several practical recommendations for hazard identification and prevention that can be used by employers of various sizes and levels of resources.

FACE prevention resources are used in academic training of future safety and health professionals.

During the 2020 Stop Construction Falls Campaign and separate Trenching Safety Stand-downs, FACE sent daily emails with topic-specific prevention resources approximately 7000 unique subscribers to FACE and DOSH email lists. Evaluations were received from campaign participants. Approximately 90% of employers said the resources they used were good to excellent in the categories of readability and usefulness. Nearly half of the employers who responded said they planned to change the way they train workers and identify hazards following their Safety Stand-Down. Employers also reported planned changes in their use of safety gear, setting up jobsites, and planning jobs, among others.

FACE brought together and leveraged the resources of several partners to create a successful 2020 Fall Prevention and Trenching Safety Stand-Down campaigns.

Partners included:

- WA State Dept. of Labor and Industries (L&I)
 - Division of Occupational Safety and Health (DOSH)
 - Public Affairs
 - Communications
 - Education and Outreach
- Construction contractors
- Construction industry associations
- Construction health and safety associations
- OSHA Region 10

FACE and the partners listed above:

- Identified new recent FACE Fatality Narratives describing diverse construction fall incidents and had them translated into Spanish, and fall safety resource packets including English and Spanish versions of the narratives, and information about the Stand-Down were communicated.

- Updated WA State Safety Stand-Down webpages annually that include information about the campaign, Stand-Down ideas, fall safety resources, and recognition opportunities for participating employers. <http://www.lni.wa.gov/StopFalls>
- Developed large posters that were sent to WA construction employers preceding the Stand-Down that encouraged participation in the Stand-Down and The Associated General Contractors of Washington to distribute to their members.
- With L&I's Public Affairs department, drafted a press release about the Stand-Down that included quotes from the DOSH Assistant Director and the owner of a local construction company.
- Promoted the Stand-Down on the L&I website, blog, Twitter, and Facebook page leading up to, during, and after the event.
<https://www.facebook.com/laborandindustries>
<https://twitter.com/lniwa>
<http://deptoflaborandindustries.tumblr.com/>
- Promoted the Stand-Down at meetings of the Puget Sound Area Safety Summit, which was attended by construction company safety professionals.
- Printed Stand-Down hard hat stickers with the "Safety Pays. Falls Cost." Logo in both English and Spanish, and distributed them to employers by mail and at safety events.
- Sent out daily emails for a week during the campaign to employers on FACE and DOSH listservs. Emails encouraged participation in the Safety Stand-Down and promoted fall prevention and trenching safety resources.
- Developed online Stand-Down evaluation survey to be sent to employers who received FACE fall safety resource packets by mail and listserv.

Specific Aim 5: Develop a series of case narratives that highlight fatal incidents, detailing risk factors for the incidents and recommendations for the prevention of future incidents.

Use these and other materials to focus discussion at construction companies' tailgate safety meetings. Expand the case narratives to include selected agriculture-related fatalities and translate narratives into Spanish.

FACE produced a total of 48 Fatality Narratives for the agriculture and construction industries. Slideshow versions were produced for most of the narratives. Similar prevention resources developed in the form of logging injury alerts. Select Fatality Narratives and slideshows were translated into Spanish.

FACE also produced 6 hazard alerts to inform employers of the risk of workplace violence and overdoses and how to identify and prevent them. These were mailed to at risk employers. Fourteen investigation reports were published during this period. Investigation reports were emailed to subscribers and mailed to employers likely at risk of these hazards.

These resources were also used in numerous stakeholder meetings and presentations to business, labor, and government by FACE staff.

Table 2. Outreach to Targeted Employers.

Prevention resources	Number produced	Number mailed	Number emailed
Construction Fatality Narrative	28	18300	70000
Agriculture Fatality Narrative	20	41000	30000
Trucking Fatality Narrative	3	600	NA
Services Fatality Narrative	3	1400	NA
Logging Injury Narrative	16	1220	4800
Slideshows	44	NA	88000
Investigation Report	14	4200	21000
Hazard Alert	6	2646	NA
SHARP Stat	6	NA	NA
Resources in Spanish	16	2000	32000
Total	150	71366	245800

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

FACE has incorporated injury statistics into several draft publications including recent Hazard Alerts. Non-fatal injury data were used to investigate injury hazards in the warehouse, construction demolition, and trucking industries. FACE used injury data to generate several summary tables characterizing injuries by incident and injury types.

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

FACE is partnered with L&I Public Affairs and other managers of established social media accounts to communicate all new and other relevant prevention resources via social media. Resources have already been communicated to Facebook and Twitter followers.

Table 3. Prevention Resources Communicated Through Social Media.

Publication Title	Publication Number	Account Holder	Posted to	Followers /Likes
Carpenter Saved From Potentially Fatal Fall	47-24-2015	NIOSH FACE	Twitter	6377
Safety Success Story: Carpenter Saved From Potentially Fatal Fall	47-24-2015	WA L&I	Facebook	27,993
Construction Fall Fatalities Infographic	47-25-2016	NIOSH Construction	Twitter	20692
Two Propane Gas Supplier Workers Electrocuted when Boom Truck Crane's Boom Contacts 7200 Volt Overhead Power Line	52-32-2015	WA L&I	Twitter	17,791
Log Truck Driver Dies When Struck by Logs Being Loaded Onto Trailer	52-33-2015	NIOSH FACE	Twitter	26,331
Orchard Laborer Dies after Being Struck and Run Over by Dump Trailer	52-34-2015	WA L&I	Facebook	30,098

Publication Title	Publication Number	Account Holder	Posted to	Followers /Likes
Truck Driver Dies After Being Struck by Semi-Trailer Truck in Trailer Yard	52-35-2015	WA L&I	Twitter	29,350
Fertilizer Company Worker Crushed to Death by Falling Concrete Ecology Block	52-36-2016	WA L&I	Twitter	11,228
Coffee Stand Owner Dies When Leak from Propane Cylinder Causes a Fire	52-37-2016	WA L&I	Facebook	48878
Forest Crew Worker Electrocuted While Trying to Cut Tree Fallen on High-Voltage Power Line	52-38-2016	WA L&I	Twitter	5109
Bark Company Owner Dies After Being Crushed By Ecology Block Wall	52-39-2016	WA L&I	Twitter	5193
Carpenter Falls from Ladder	71-134-2015	NIOSH Construction	Twitter	17600
Construction Worker Falls 14 Feet from a Beam onto Concrete and Suffers Serious Brain Injury	71-137-2015	NIOSH Construction	Twitter	33081
Hop Yard Laborer struck by Hop Pole	71-138-2015	NIOSH Construction	Twitter	44,313
Roofer Falls 20 Feet from Roof	71-139-2015	NIOSH FACE	Twitter	20,678
Pipe Layer Severely Injured in Trench Collapse	71-140-2015	WA L&I	Twitter	56258
Tractor Operator Dies When Tractor Rolls Over On Road	71-141-2015	WA L&I	Facebook	1316
Grade Checker Severely Injured When Backed Over by Grader	71-142-2015	NIOSH FACE	Twitter	39,098
Farm Worker Severely Injured When Struck By Wheel Rim	71-143-2015	NIOSH FACE	Twitter	12,543
Two Dump Truck Drivers Die When Their Trucks Crash Head-on	71-145-2016	NIOSH FACE	Twitter	6330
Carpenter Falls 13 Feet when Pump Jack Scaffold Collapses	71-146-2016	NIOSH Construction	Twitter	27637
Laborer Crushed during Demolition of Steel Structure	71-147-2016	NIOSH FACE	Twitter	76,496
Orchard Laborer Falls From Aerial Lift	71-148-2016	NIOSH FACE	Twitter	6213
Glazier foreman Falls from Stepladder	71-149-2016	NIOSH FACE	Twitter	18,141
Orchard Laborer Severely Injured When Thrown from Bin Carrier	71-150-2016	NIOSH FACE	Twitter	13,673
Farm Laborer Caught in Hay Baler	71-152-2016	WA L&I	Twitter	10,162
Dairy Laborer Dies when Loader Falls into Manure Pit	71-153-2016	NIOSH FACE	Twitter	6532
Dairy Laborer Dies when Loader Falls into Manure Pit	71-153-2016	WA L&I	Twitter	11,613
Roofer Falls 19 Feet from Roof	71-154-2016	WA L&I	Twitter	5144

Publication Title	Publication Number	Account Holder	Posted to	Followers /Likes
Construction Laborer Falls when Ladder Breaks	71-155-2017	NIOSH FACE	Twitter	31419
Pipe layer Dies when Trench Wall Collapses	71-156-2017	NIOSH Construction	Twitter	82,731
Siding Contractor Falls 23 Feet from Apartment Balcony	71-168-2018	WA L&I	Facebook	7,695
Shovel Operator Dies When Shovel Rolls Down a Ridge	92-23-2017	WA L&I	Twitter	9,965
Washington State Work-Related Fatalities Report	93-01-2016	WA L&I	Facebook	6359
Washington State Work-Related Fatalities Report 2016	93-02-2017	WA L&I	Twitter	11,903
Create and follow check-in procedures	94-11-2019	WA L&I	Twitter	34,153

Several FACE reports have been published as full articles and highlighted in trade journals and professional magazines.

Table 4. Association Publications and Trade Journal Articles.

Publication	Publication #	Journal/Publication
Laborer electrocuted by underground power line	71-136-2015	Safety & Health magazine
Two propane supplier workers electrocuted	52-32-2015	Safety & Health magazine
Fuel tanker delivery driver struck by parked truck when it rolls forward	52-36-2015	National Truckers Association
Logging company owner killed when struck by falling tree	92-19-2015	Springboard, Washington Contract Loggers
Washington State Work-Related Fatalities Report	93-01-2016	L&I press release
Rigging Slinger Injured by Log Rolling Downhill form Landing	92-20-2016	Springboard, Washington Contract Loggers
FACE Annual Report	93-01-2013	NIOSH eNews
Coffee Stand Owner Dies When Leak from Propane Cylinder Causes a Fire	52-37-2016	The Everett Herald
Coffee Stand Owner Dies When Leak from Propane Cylinder Causes a Fire	52-37-2016	Washington State Association of Fire Marshals
Bark Company Owner Dies After Being Crushed by Ecology Block Wall	52-39-2016	Safety & Health magazine
Glazier foreman Falls from Stepladder	71-149-2016	OPEXSHARE.doe.gov
Safety Success Story: Carpenter Saved From Potentially Fatal Fall	47-24-2015	OPEXSHARE.doe.gov
Coffee Stand Owner Dies When Leak from Propane Cylinder Causes a Fire	52-37-2016	L&I Small Business Newsletter
Construction Laborer Falls when Ladder Breaks	71-155-2017	JJ Keller Workplace Safety Newsletter
Construction Laborer Falls when Ladder Breaks	71-155-2017	OPEXSHARE.doe.gov

Publication	Publication #	Journal/Publication
Carpenter Falls 60 Feet from Bridge Concrete Form	71-158-2017	OPEXSHARE.doe.gov
Choker Setter Struck by Falling Chunk	92-24-2017	Springboard, Washington Contract Loggers
Orchard Tractor operator Dies When Run Over by Rotary Mower After Falling From Tractor	52-40-2017	EHS Today magazine
Timber Cutter Struck by Maple Limb	92-25-2017	Springboard, Washington Contract Loggers
Foreman and laborer Fall when Aerial Lift Struck by Vehicle	71-160-2017	Safety & Health magazine
Timber faller Killed When Struck by Maple Top	92-26-2017	Springboard, Washington Contract Loggers
Skid Steer Loader Operator Crushed	71-166-2018	OPEXSHARE.doe.gov
Base Machine Pulled Over by Steep Slope Machine	97-05-2018	FRA Safety Alert
Laborer Falls 12 Feet through Barn Roof	71-164-2017	Safety & Health magazine
Ironworker Falls 30 Feet through Skylight Roof Opening	71-169-2018	OPEXSHARE.doe.gov
Forklift operator Dies When Crushed between Forklift Overhead Guard and Mast	52-42-2018	JJ Keller Compliance Focus Newsletter
Forklift operator Dies When Crushed between Forklift Overhead Guard and Mast	52-42-2018	Safety & Health magazine
Warehouse Worker Crushed by Forks of Laser Guided Vehicle	71-171-2018	OPEXSHARE.doe.gov
Mechanic Crushed by Bin Destacker	71-165-2017	Safety & Health magazine
Choker Setter Struck when Hung-up Turn Clears	97-07-2018	Springboard, Washington Contract Loggers
Boat Maintenance Crew Supervisor Dies of Carbon Monoxide Poisoning while Using Gas-Powered Pressure Washer	52-44-2018	OPEXSHARE.doe.gov
A 19-Year-Old Landscape Laborer Dies When Entangled in Auger after Entering the Hopper of a Bark Blower Truck	52-41-2017	Safety & Health magazine
Choker Setter Struck by Falling Exhaust Flap from Motorized Carriage	92-27-2018	Springboard, Washington Contract Loggers
Laborer Severely Injured in 60-Foot Fall from Scissor Lift	71-175-2018	OPEXSHARE.doe.gov
Maintenance Mechanic Dies After Being Burned by Hot Boric Acid Solution While Removing Pump	52-43-2018	Safety & Health magazine
Supervisor at Used Clothing Processing Facility and Warehouse Dies When Struck by Falling Clothing Bales	52-45-2018	OPEXSHARE.doe.gov
Bark Company Owner Dies After Being Crushed by Ecology Block Wall	52-39-2016	Safety & Health magazine
Hazard Brief: Cell Phone Distractions	94-15-2018	Safety & Health magazine
Hazard Brief: Operator Crushed in Processing Head	94-14-2018	Springboard, Washington Contract Loggers
A Boat Maintenance Crew Supervisor Dies of Carbon Monoxide Poisoning While Using a Gasoline-Powered Pressure Washer.	52-44-2018	Safety & Health magazine

Publication	Publication #	Journal/Publication
Hazard Brief: Operator Crushed in Processor Head	94-14-2018	FRA Safety Alert
Near Miss Alert: Tether Line Breaks after Damaged by Bucket Move	97-06-2018	FRA Safety Alert
Near Miss Alert: Choker Setter Struck When Hung-up Turn Clears	97-07-2018	FRA Safety Alert
Construction Hazard Alert: Workers Severely Injured Using Demolition Robots	47-26-2019	Safety.BLR.com
Logging Injury Alert: Timber Cutter Struck by Small Hemlock	92-28-2018	FRA Safety Alert
Roofer Falls 18 Feet from Wet House Roof	71-178-2019	Safety & Health magazine
Worker Crushed by Forks of Laser Guided Vehicle	71-171-2018	ClaimsJournal.com
Workers Severely Injured Using Demolition Robots	47-26-2020	ClaimsJournal.com
Worker Crushed by Forks of Laser Guided Vehicle	71-171-2018	Safety & Health magazine
Roofer falls 30 feet from rain-slick roof	71-203-2021	Safety & Health magazine

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

The FACE electronic survey evaluations consistently showed that approximately 90% of the respondents believed FACE resources were good to excellent in terms of readability and usefulness. Major drawbacks were that the identity of reviewers and the specific resources being reviewed were unknown.

All investigation reports mailed to employers contained a self-addressed stamped evaluation postcard. The postcards allow for tracking feedback by the specific industry and resource being evaluated. Feedback across industries indicate that employer's rate FACE investigation reports high in terms of readability and usefulness.

Specific Aim 9: Evaluate the impact of FACE prevention activities by focusing on outcomes for selected incident types in high-risk industries.

The FACE electronic survey evaluations consistently showed that approximately 90% of the respondents believed FACE resources rate from good to excellent for readability and usefulness. More importantly, high percentages of respondents reported they planned on making changes in hazard identification, changes in job set-up, safety procedures, tool or safety gear use after reading FACE resources.

FACE continues to assess the impacts that prevention resources and activities have on employers. Evaluation surveys were mailed to target employers with all FACE Investigation Reports between. Employers were asked how they would use the FACE prevention resources and recommendations and what workplace safety changes they would make after reading it. Nearly 70% of employers said they would use reports to train workers and nearly 60% reported that they would make changes in the way they identify hazards.

Section 2: Trucking Injury Reduction Emphasis through Surveillance (TIRES)

PI: Caroline Smith, PhD, MPH

Background

The trucking industry has some of the highest injury rates among all industries in Washington State and nationwide. It also suffers from high claims costs, driver shortage, and like many other industries, an aging workforce. Maintaining a healthy, productive trucking industry workforce is vital to our economy. The Trucking Injury Reduction Emphasis through Surveillance (TIRES) project began working with the trucking industry in Washington State in 2005 to help identify injuries and hazards and recommend mitigation and prevention practices to reduce injuries. TIRES' fifteen-year span of achievements blazed new trails in trucking safety research, hazard and injury identification, digitally-mediated education and training, and online safety program development.

Specific Aims

The TIRES surveillance system, over its' 15-year lifespan had many 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. Continuously expand surveillance activities to include additional areas of investigation based upon industry specific needs, barriers, and issues.
6. 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
7. Identify opportunities for the use of educational materials and other interventions to reduce hazards and injuries within trucking.
8. Develop interactive short training modules accessible via computer, tablet or mobile phone.
9. Develop an interactive comprehensive safety and health program that exceeds Washington State Standards, and for use by small to mid-sized trucking companies.
10. Develop, pilot and evaluate an occupational safety intervention program using a case/control design.

Specific Aim 1: Building and maintaining partnerships with management and labor within the trucking industry.

Methods

Reaching out to industry business and labor associations, using contacts the SHARP program had developed over decades, the TIRES project was able to enlist the volunteer assistance of many trucking industry insiders (both business and labor). The TIRES steering committee met twice yearly during the grant period, and communicated monthly via emails and telephone calls. The TIRES steering committee is comprised of representatives of business, labor, insurance companies, and a representative from a publically funded truck driving school.

TIRES research staff also participated in various industry events and were 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 (WRRRA) and the Washington Trucking Associations (WTA), two of the largest trucking industry associations in Washington State.

TIRES research staff participated in the WTA truck driving championships and also the last Washington State Governor's Safety and Health Conference. These outreach activities are very useful for the dissemination of TIRES materials.

Results

As a result of our partnerships with the industry, we have been asked to speak at more company events (e.g., safety fairs), and our materials have been used in Teamsters' train the trainer programs. In addition, we have been able to speak honestly and openly with business and labor representatives about issues facing safety managers at companies and issues faced by drivers, all as a result of our continued involvement with the TIRES Steering Committee, and our expanded outreach.

Evaluation

During the tenure of the TIRES project, we asked for continual feedback from the steering committee. During the 2010- anonymous online survey for our steering committee members to evaluate how well we met their expectations and asked for input on how we can improve for the next grant cycle. The survey was sent to all former and current steering committee members (n=19). We received 13 responses (response rate 68.4%).

Overall the steering committee was pleased with how effective the team worked together. In evaluating our role on the committee, the majority of comments were positive. See Table 1 for results of the survey.

Table 1. TIRES Steering Committee Evaluation Results

1. How well have we done on planning and implementation?				
Sub question	Poor	Fair	Well	Excellent
Follow through on steering committee activities	0	0	5 (38.5%)	8 (62.5%)
Strengths and competence of L&I TIRES Staff	1	0	2	10
TIRES efforts to promote collaborative actions	0	0	4	9
TIRES processes to assess the trucking community's needs	0	0	7	6
Training and technical assistance provided by TIRES staff	0	1	6	6
2. How well have we done on communication?				
Sub question	Poor	Fair	Well	Excellent
Use of the media to promote awareness of the Steering Committee's goals, actions and accomplishments	0	1 (7.7%)	4 (30.8%)	8 (61.5%)
Communication among members of the Steering Committee	0	2 (15.4%)	3 (23.1%)	8 (61.5%)
Extent to which Steering Committee members are listened to and heard	0	0	3 (23.1%)	10 (76.9%)
Working relationships with L&I TIRES staff and Steering Committee members	0	0	4 (30.8%)	9 (69.2%)
Information TIRES L&I staff have provided on issues and available resources	0	0	4 (30.8%)	9 (69.2%)
3. To what extent has the steering committee...?				
Sub question	Poor	Fair	Well	Excellent
Addressed local concerns in ways that benefit the trucking community?	0	0	6 (46.2%)	7 (53.9%)
Enhanced understanding of issues that affect the trucking community	0	0	7 (53.9%)	6 (46.2%)
Enhanced the capacity of partners	0	1 (7.7%)	8 (61.5%)	4 (30.8%)
Strengthened collaboration among the steering committee members, and other organizations	0	3 (23.1%)	4 (30.8%)	6 (46.2%)
Produced and disseminated information and/or findings to community members in clear language respectful to the trucking community and in ways that will be useful for them.	0	0	3 (23.1%)	10 (76.9%)
Followed the norms of partnership (fostered mutual respect, open communication, and equitable decision making).	0	0	4 (30.8%)	9 (69.2%)
Acknowledged the contribution of partners in presentations and publications.	0	0	4 (30.8%)	9 (69.2%)

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), or truck drivers themselves. Their assistance in creating meaningful documents, posters and other tools cannot be stressed enough. The use of “insiders” was critical to our success.

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

Methods

Utilizing the rich data available to us, from the Washington State workers' compensation system, we have published two technical reports specific to the trucking industry in Washington State.

The first technical report, published in 2008 examined accepted workers' compensation claims from January 1, 1997 through December 31, 2005 (data extracted November 13, 2007), see Figure 1 for definitions of the trucking industry in Washington State, as defined by the TIRES program.

Workers' compensation claims are generally 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. The majority of the data reported in 2008 were for lost work time claims (unless otherwise noted), due to the incomplete data for medical only claims among firms who are able to self-insure. In this report, we described workers' compensation claims by injury type and trucking sector. In the second technical report, published in 2014, we examined each trucking sector in detail, breaking down injury types and description of injury events by sector.

Figure 1. The Trucking Industry as defined by the TIRES project, using North American Industrial Classification System (NAICS) codes.

Trucking Industry

NAICS 4841 General Freight Trucking

484110 Local

484121 Long-Distance, Truckload

484122 Long-Distance, Less Than Truckload

NAICS 4842 Specialized Freight Trucking

484210 Used Household & Office Goods Moving

484220 Local

484230 Long-Distance

NAICS 492 Couriers and Messengers

492110 Couriers

492210 Local Messengers and Local Delivery

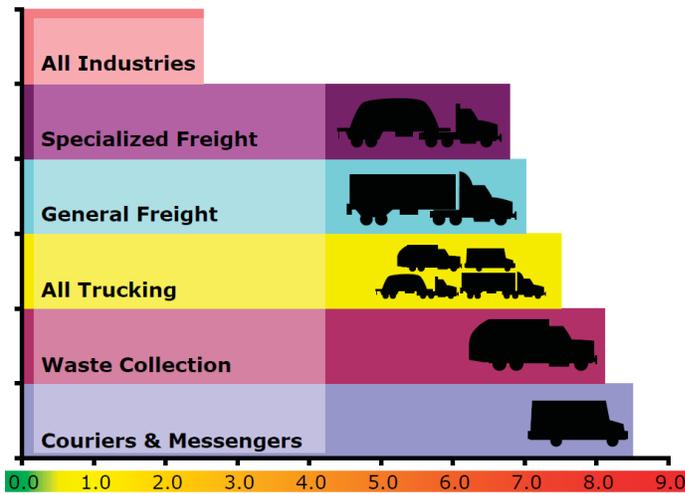
NAICS 5621 Waste Collection

562111 Solid Waste Collection

562112 Hazardous Waste Collection

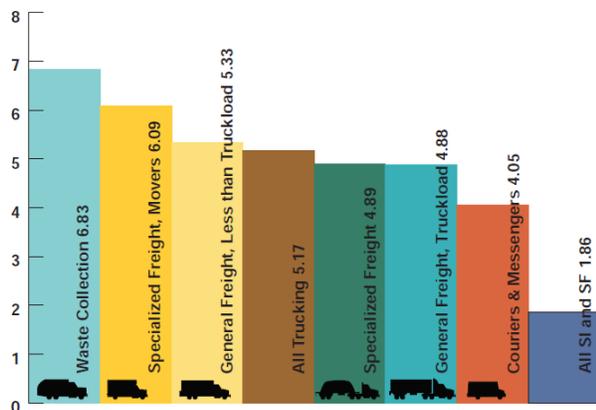
562119 Other Waste Collection

Figure 2. Compensable claims rates in the trucking industry from 1997 through 2005, (rates per 100 full-time equivalent (FTE) workers, compared to All Other Industries).



Results

On average, one out of 5 trucking industry employees had a medical only claim accepted in Washington State from 1997-2005. One out of every thirteen employees in trucking had a lost work time claim in the same period, averaging \$30,000 per year/per claim. Although claims rates in the trucking industry fell over time from 1997 through 2005, injury rates in the trucking industry in Washington exceeded all other industries combined.



Discussion

Musculoskeletal Disorders were the most common trucking injury and placed the largest burden on the workers' compensation system. Given the importance of the trucking industry to our economy, an emphasis on preventing work related injuries needs to be fostered at each trucking company.

Every employer needs to take steps to build a positive safety culture. This begins with a comprehensive safety plan. Employers need to work with employees to make their work environment better and safer. Everyone in the trucking industry needs to identify unsafe conditions and work towards reducing or eliminating the hazards in the work place.

Specific Aims 3 through 5:

These specific aims address the major surveillance system goals of the TIRES program. These included; 3) developing the surveillance system to track injuries within the industry, 4) implementing updated protocols to identify risk factors associated with the six priority conditions, and 5) continue to refine and expand surveillance activities as the needs, barriers and issues, relevant to the trucking industry arose.

Methods

Utilizing our rich workers’ compensation data, along with our understanding of epidemiologic methods, and with assistance from our steering committee of subject matter experts, we developed and modified the TIRES injury and illness surveillance system to track and assist us with identifying injury and illness rates, trends, and activities that are closely associated with injuries.

Results

Over 450 claimants were interviewed over the course of the TIRES surveillance program. General demographics are listed in Table 2 and Injury categories are listed in Table 3.

Table 2. General characteristics from case follow interviews

<i>Characteristic</i>	<i>N=465</i>
Male	93%
Average Age (in years)	48
Trucking sector	
General freight	55.2%
Specialized freight	25.4%
Waste collection	5.4%
Couriers and messengers	14.0%

Table 3. Injury categories from case follow up interviews

<i>Injury type</i>	<i>N=465</i>
Musculoskeletal	46.9%
Fall	34.2%
Struck by or against	11.4%
Other	4.9%
Caught in	1.7%
Motor vehicle related	0.9%

Discussion

Over the course of TIRES 15 year history, the surveillance system has been invaluable in identifying activities associated with the most common injuries in the industry. The surveillance system and subsequent case follow-up interviews allowed us to target the activities associated with injuries and address them with our educational and outreach efforts.

Specific Aim 6: Conduct industry-wide surveys of employers and employees

Surveys were conducted at two points in time. In 2005 and 2006, and again in 2010 and 2012.

Methods

Employer surveys

The employer survey, sent to Washington State trucking companies reporting in NAICS 484, 492, and 5621, with at least five full-time equivalent (FTE) in the 6 quarters prior to survey deployment.

Employee Surveys

The surveys were sent to random samples of drivers identified by the presence of a Commercial Drivers' License (CDL), as accessed via a data sharing agreement with the Washington State Department of Licensing, and cross-referenced with data from the Washington State Employment Security Department to identify those who worked at a trucking company.

Results

Employee and Employer survey counts from the four surveys are listed in Table 4.

Table 4. Survey Responses for Employee and Employer Surveys by NAICS.

Industry Sub-Sector (NAICS)	Truck Driver Respondents		Employer Respondents	
	2006	2012	2005	2010
General Freight (4841)	589	332	207	142
Specialized Freight (4842)	454	259	72	162
Waste Collection (5621)	166	82	25	25
Couriers & Messengers (492)	146	98	20	22
Owner operator (2006 only)	51	-	na	na
Total	1406	771	324	351

Discussion

While there was concordance between truck drivers and trucking companies regarding the injury types that were most prevalent and/or most important (musculoskeletal disorders, falls, struck by, motor vehicle related, etc.), the causes and solutions varied. Based upon the results from the 2005-2006 surveys, the TIRES program devoted most of our resources to determining 'root causes' of the injuries within the industry.

Specific Aims 7 and 8: Involve the development and dissemination of educational materials (multiple formats), for the trucking industry.

Methods

Utilizing multiple data sources (workers' compensation data, case follow up interviews, statewide surveys, and discussions with our steering committee, the TIRES Program developed and disseminated a large library of educational material. These safety and health messages included tip sheets, true stories, blog posts, and interactive training media accessible via the internet.

Results

The TIRES Surveillance Program has been very productive in developing and disseminating educational material, overall TIRES has created 74 posters, 72 injury narratives, 69 tip sheets, 43 eNewsletters, 11 company safety manager profiles, 10 training simulations, 9 eLearnings, 8 technical reports, 3 peer-reviewed journal articles, hundreds of social media posts, and several other miscellaneous publications. All of our products can be found on the KeepTruckingSafe website (www.keeptruckingsafe.org). We have received positive reviews from hundreds of people, statewide, nationally and internationally.

Discussion

TIRES successfully utilized multiple methods to reach trucking companies, and trucking employees, in order to provide the first online, free library of safety and health resources for the trucking industry.

Specific Aims 9 and 10: Development and evaluation of an online Safety Program Tool for Trucking companies.

Methods

After several false starts, the TIRES team worked internally with programmers at the Department of Labor and Industries to build and deploy a safety program tool, which allows trucking companies to create their own unique safety program. This required multiple years and multiple resources both within and external to the TIRES program staff.

The Safety Program is available on the Labor & Industries TIRES webpage, accessible [here](https://secure.lni.wa.gov/createtruckingsafetyprogram/#/) (<https://secure.lni.wa.gov/createtruckingsafetyprogram/#/>) and provides users with the ability to create, save, and modify their Safety Program, using a "pin" or identification number, specific to their program.

Results

The Safety Program Development Tool is available for use by companies

Our final product was the development and dissemination of a one-of-a-kind, free Safety Program Development Tool for use by small to medium sized Local/Regional trucking companies. The Tool was developed and tested in multiple iterations with the assistance of our Steering Committee and small trucking companies from around the State. Beta testers were asked to complete an evaluation form, and all possible improvements were made based upon that feedback.

Discussion

The TIRES program successfully created the first of its kind, safety program development tool that allows trucking companies without formal expertise in safety, to create a useful, customized safety program for their organization. This is an incredible feat for a small surveillance program. Unfortunately, due to the difficulty in completing such an ambitious final product with minimal resources, the TIRES Safety Program Development Tool was completed in 2021, leaving no time for a proper intervention and evaluation.

Conclusions

The TIRES Program addressed occupational injury and illness surveillance from an industry, rather than occupation, or specific injury perspective, allowing the program to address multiple occupational safety and health issues affecting the entire landscape of trucking. The program grew from a relatively small surveillance project to encompass new technologies, new health communication channels, and ultimately created a safety program development tool, that can and should outlive the TIRES program.

From working with industry and labor leaders, to interviewing hundreds of employees and employers, TIRES took a holistic approach to find areas where both employees and employers could come together to create safer, healthier workplaces. This is the ultimate goal for surveillance, and the TIRES program can provide others with a blue print for success using an industry based surveillance approach.

Section 2: Occupational Respiratory Disease Surveillance in Washington State

PI: Carolyn Whitaker, MS, CIH

Background

The Safety & Health Assessment & Research for Prevention (SHARP) Program at the Washington State Department of Labor and Industries (L&I) has conducted surveillance for work-related asthma since 2001. Over the current reporting period, we greatly expanded our surveillance capacity from the single condition of work-related asthma to three new respiratory diseases, workers' compensation claims filed for toxic inhalation, and hazardous airborne exposures. Our inclusion of hazardous exposures and toxic inhalation is unique among state-based respiratory surveillance systems. Taken together, our systems can identify hazardous exposures and inhalations that may lead to unreported 'near-miss' injuries, occur before disease sets in, and can result in latent disease manifestation that may or may not be recognized and reported. Additionally, during the pandemic, we applied our existing surveillance capacity to track occupational COVID-19 beginning in March 2020. Our respiratory disease surveillance program involves four main activities: 1) surveillance; 2) creation and dissemination of prevention materials; 3) case- and industry-based prevention efforts; and 4) program evaluation.

L&I is a state agency and conducts three major activities central to our surveillance: 1) administers the state's workers' compensation system which covers approximately 3 million workers; 2) administers the state's occupational safety and health (OSHA) laws, hereafter referred to as WA-DOSH; and 3) is home to the SHARP program. SHARP has direct in-house confidential access to our primary data source: L&I's workers' compensation system, which includes administrative data (e.g. injury coding), record-level medical data, and employer administrative data (e.g. industry, occupation, address). SHARP has direct access to WA-DOSH staff, inspection records, and the rulemaking process. SHARP's close relationship with WA-DOSH and workers' compensation system play a large role in the successful function and impact of our surveillance system. The surveillance team includes an industrial hygienist, epidemiologist, safety and health specialist, and data manager. An occupational physician and industrial hygienist provide additional support.

Specific Aims

The specific aims of Washington's Occupational Respiratory Disease Surveillance Program are:

1. Conduct surveillance for respiratory disease and toxic inhalation.
2. Conduct surveillance of airborne exposure data from Washington DOSH (OSHA) enforcement inspections. Use the data in prevention activities.
3. Increase the type and number of cases brought into the surveillance systems.
4. Conduct case- and industry-based investigations aimed at disease prevention.
5. Evaluate the newly proposed toxic inhalation surveillance system.

Methodology

We operate four stand-alone surveillance systems: respiratory disease, toxic inhalation, WA-DOSH chemical exposures, and COVID-19 (Table 1). We capture potential cases for three of the surveillance systems monthly from L&I's industrial insurance data warehouse using: a) keyword search; b) Occupational and Injury and Illness Classification System (OIICS) codes; and c) diagnoses following International Classification of Disease, Tenth Revision, Clinical Modification (ICD-10-CM) codes. The three case capture strategies are not exclusive to each other; we use them in combination. We review injured worker medical records for statements about exposure, safety data sheets, work performed, and diagnoses. We query personal air sampling data from WA-DOSH enforcement inspections in the Washington Information Network (WIN) on a periodic basis.

Table 1. Surveillance systems with health conditions and data sources

	Toxic Inhalation and Exposures			
	Respiratory Disease	Toxic Inhalation	WA-DOSH Chemical Exposures	COVID-19
Aim	Aim 1a	Aim 1b	Aim 2	Aim 1c
Conditions under surveillance	Work-related asthma, silicosis, asbestos-related disease, Valley fever	Priority conditions: ammonia, beryllium, carbon monoxide, chlorine, chromium, methylene chloride, welding fume, wildfire smoke. All 'other' inhalations	Airborne chemical hazards sampled during enforcement inspections	COVID-19
Data sources	Workers' comp. data & physician reporting of asthma	Workers' comp. data	WA-DOSH inspection data	Workers' comp. data

Detailed case capture criteria, with codes, as well as case definitions for each condition under surveillance are published on SHARP's [website](#) in technical reports for [asthma](#), [toxic inhalation](#), and [COVID-19](#). In brief, the process for validating potential cases for respiratory disease, toxic inhalation, and COVID-19 involves systematic review of the claim record by three research staff members including an industrial hygienist, safety specialist, and epidemiologist. Case review and validation involves: a) removal of

potential cases that do not involve a respiratory event (false capture) from further work-up; b) telephone interviews for workers with work-related asthma; c) case referrals to DOSH for follow-up inspection; and d) notation of emerging or unusual cases. Because it may take months for the injured worker to complete their medical referrals and for L&I to obtain all necessary workers' compensation records, final case ascertainment is not given until claims reach 'claim maturation'. Claim maturation is six months from the date the claim is established at L&I for asthma, toxic inhalation, and COVID-19 and 12 months for all other respiratory diseases. Work-related asthma ascertainment uses the NIOSH SENSOR validation & classification methods and requires worker telephone interview. We use the NIOSH case definition for silicosis, and we derived the case definition for Valley fever based on WA State's Department of Health's case definition. We developed case definitions for toxic inhalation and COVID-19 internally. Toxic inhalation cases are validated for work-relatedness and a primary exposure route of inhalation; health outcomes are not characterized.

We published detailed methods for the WA-DOSH chemical exposure surveillance in a 2018 [technical report](#). In brief, we capture all possible airborne chemical data from enforcement inspections out of L&I's WIN database. Data elements that are most valuable for surveillance are: inspection type, unique inspection identifier, industry codes, chemical substance codes, exposure values, Permissible Exposure Levels, exposure severity, job title, number of exposed workers, frequency of exposure, and citations issued. We extract inspection data based on the closed conference date. At least two industrial hygienists in the SHARP program review and clean the data in consult with DOSH inspectors as needed. A subset of data was validated by a manual cross-check between the WIN data and original inspection files. We have written protocols for calculating mixed (multiple) exposures and for collapsing highly specific substance codes into common umbrella categories for ease of data sorting.

We maintain the data in a Microsoft Access data dashboard available to all WA-DOSH inspectors and this database is refreshed as yearly data is cleaned.

Our surveillance is deemed research with minimal risk, under the Office for Human Research Protections, Expedited Review Category 7b, by the Washington State Institutional Review Board (WSIRB) and is reviewed by the WSIRB annually.

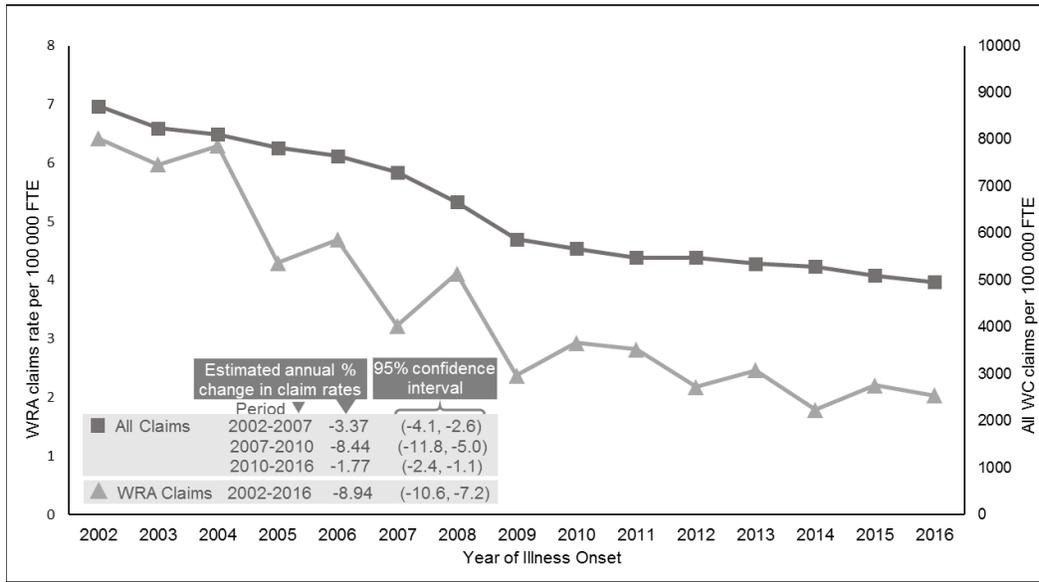
Results and Discussion

Specific Aim 1a: Conduct surveillance for respiratory disease and toxic inhalation.

Over the current reporting period, we identified 310 valid cases of work-related asthma, 52 cases of asbestos-related disease, six cases of silicosis, and three cases of Valley fever. In 2017 we created educational materials for [workers](#), [employers](#), and [clinicians](#) regarding endemic *Coccidioides* fungus and the risk for Valley Fever. In 2019 we published the key finding that work-related asthma incidence rates are declining in Washington State; they decreased 8.9% annually for the time period 2002-2016 (Figure 1) ([LaSee 2019](#)). The decline in asthma incidence rates is slightly faster than the incidence rate for all workers' compensation claims, which had its steepest decrease from 2007 to 2010 at an estimated annual 8.4% decrease (Figure 1). The trend for a

decline in work-related asthma is consistent with similar declines in occupational asthma and allergy published worldwide in the past decade. Despite declines in work-related asthma, our surveillance remains necessary and meaningful, as we recently detected an emerging case series for asthma-associated disease in the legalized cannabis grow industry ([Reeb-Whitaker 2021](#)).

Figure 1. Work-related asthma and all workers' compensation claim incidence rates per 100 000 FTE, by year of diagnosis, WA State



Specific Aim 1b: Conduct surveillance for respiratory disease and toxic inhalation.

During this reporting period, we launched a new system for claims filed for toxic inhalation, including case capture, case definitions, cluster detection, and establishment of surveillance protocols. A total of 4104 potential cases were captured and 2604 workers were deemed to have valid inhalation to at least one substance for the four-year period 2017-2020. There were 388 different exposure code categories associated with the cases.

We established inhalation from eight priority chemicals (Table 2) based on one or more of the following rationale: a) historic known high claim incidence in Washington; b) high chemical toxicity with potentially severe health outcomes; c) substances with chemical-specific OSHA standards with an opportunity to correct exposures through referrals; and d) known or suspected emerging hazard. The employers from seven cases were referred to WA-DOSH for inspection to control exposure to carbon monoxide (n=3), ammonia (n=2), hexavalent chromium and beryllium (one each). At surveillance outset, we did not know what the themes would be among all 'other' cases (n=1706). Top exposures included cleaning materials and disinfectants (n=295), unspecified dusts (n=137), paint (n=97), pesticides (n=80) and indoor air pollutants from building renovation (n=63).

Table 2. Cases identified in the Toxic Inhalation Surveillance System, January 1, 2017 – January 1, 2020

Exposure	# Valid Cases	Claimant Sex (% Female)	Median Claimant Age (Years)
Carbon monoxide	389	32%	41
Chlorine	298	44%	37
Ammonia	99	37%	43
Metal fume	80	8%	42
Wildland smoke	32	34%	40
Chromium	15	20%	37
Beryllium	9	11%	60
Methylene Chloride	2	0%	39
Other	1706	42%	41

We define inhalation clusters as two or more cases occurring at the same business location within two days of each other. We identified 161 clusters, with a median of two cases per cluster (range 2 to 30) and 40 clusters identified per year (2017-2020). Carbon monoxide followed by ammonia leaks were the leading exposure associated with clusters. Twelve clusters occurred among airline crews, with ill-defined exposure to jet fuel, carbon monoxide and bad odors that occur inside the aircraft. The largest clusters occurred with agricultural workers incidentally exposed to pesticide spray drift.

Future prevention work from our toxic surveillance will include the publication of case series and prevention materials regarding cleaning exposures associated with COVID-19 disinfection, and anhydrous ammonia exposure in fruit and vegetable preserving and specialty food manufacturing. Our toxic inhalation data is of interest to WA State occupational health researchers and has been published as [Surveillance of toxic inhalation for Washington workers 2017 – 2020](#); the [appendix tables](#) (50 pages) are detailed by industry and occupation.

Specific Aim 1c: Surveillance for COVID-19.

We established surveillance for known or suspected exposure to or disease from COVID-19 in March 2020. Valid occupational cases of COVID-19, established between Feb 26, 2020 and July 12, 2021 totaled 8323. Of these valid cases, 7863 underwent some type of quarantine, and 5121 were associated with a known positive laboratory or rapid test. Approximately 133 cases were hospitalized and 35 were fatal. Approximately 66% of the valid workers' compensation cases were filed from workers in the Health Care and Social Assistance sector. Monthly data reports are posted to [SHARP's COVID-19 webpage](#). We published our [surveillance methods for identifying COVID-19](#) in August 2020 and received positive feedback from several states who consulted our methods. Our data brief on [nursing care](#) was used by OSHA consultants to inform prevention materials for nursing homes, and we published one data brief on [health care](#) at the request of the home-healthcare industry. Under-reporting in workers' compensation is a major limitation of our COVID-19 data.

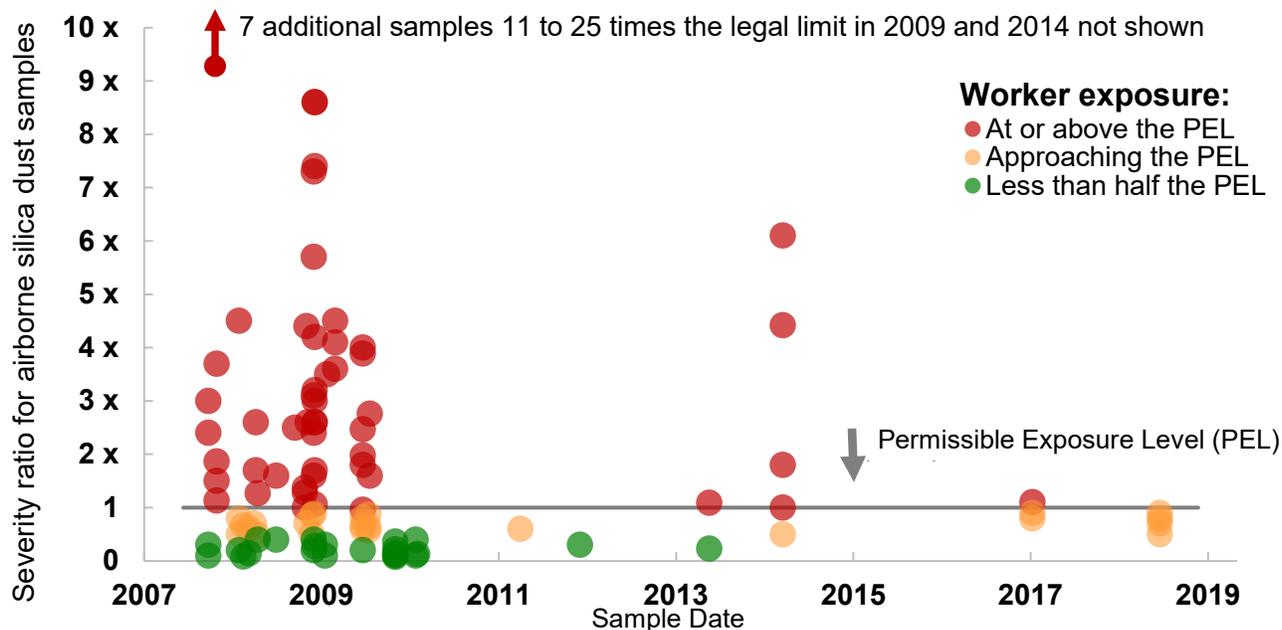
Specific Aim 2: Conduct surveillance of airborne exposure data from Washington DOSH (OSHA) enforcement inspections. Use the data in prevention activities.

These efforts culminated in a query database that contains chemical air samples and noise samples collected by WA-DOSH during enforcement inspections. A summary of the data is available as [Industrial hygiene exposure assessment measurements in Washington State, 2008 – 2016](#), which characterizes the 8-hour time-weighted average (8-hr TWA) personal exposure monitoring for chemicals and noise by industry and exposure severity. Beginning in 2016, the database continues to be used in DOSH’s annual training to educate new compliance officers about the airborne hazards they can anticipate during inspections. Without our surveillance efforts, this data would not be cleaned and compiled for use as a data source.

The first prevention application of this data was an analysis of all methylene chloride samples, including a summary of the products and processes in use at the time of DOSH sample collection. The WA State Department of Ecology used the analysis to inform their regulatory decision process on methylene chloride.

A second prevention application of the data was an analysis of WA-DOSH airborne crystalline silica samples (n=106) taken from 29 stone fabrication businesses shows that 65% of these employers had one or more air sample exceed the permissible exposure level for crystalline silica (Figure 2). The exposure analysis, combined with two cases of severe silicosis identified in our silicosis surveillance, shows the weight-of-evidence for exposure severity and disease manifestation.

Figure 2. Silica exposures frequently exceed the legal limit in stone fabricators. WA-DOSH air sampling, 2007-2018.



Specific Aim 3: Increased the type and number of cases brought into our surveillance systems.

We successfully added the conditions of silicosis and occupational hypersensitivity pneumonitis to Washington State's Notifiable Conditions Rule ([WAC 246-101](#)). Health care providers will report these cases directly to the SHARP program beginning January 31, 2022.

Specific Aim 4: Conduct case- and industry-based investigations aimed at disease prevention.

We completed three industry-based prevention efforts under this aim.

Prevention effort #1: Work-related asthma from hop dust exposure.

Prior to the current reporting period, we published a case-series of respiratory disease associated with occupational inhalation to hop dust during harvest and processing. We translated this finding to hop growers in eastern Washington through a technical alert for employers, a pictorial and Spanish alert for workers, and a clinical alert for regional health care providers. In 2015 we gave a presentation to growers on the risk of work-related asthma at one trade association meeting and attended one trade show. Thereafter we toured two farms during the fall harvest where we learned that hop growers had adopted our educational materials to improve their safety programs. Growers were receptive to the knowledge that dust control practices already in place could be adapted to reduce the risk of respiratory disease. The WA Hop Commission subsequently requested an ergonomic assessment for hop bale sampling, the results of which they subsequently used to draft new language to their Hop Inspection Manual. In partnership, we successfully introduced both respiratory and musculoskeletal best-practices across the hop industry.

Prevention effort #2. Risk of bronchiolitis obliterans from diacetyl exposure in coffee roasting

In 2016, in partnership with NIOSH through a technical assistance request, SHARP and NIOSH conducted four week-long exposure assessments at a large coffee roasting facility. The assessments included both personal and area sampling for diacetyl and carbon monoxide. The assessments concluded that personal airborne exposure to diacetyl frequently exceeded NIOSH's Recommended Exposure Level for diacetyl. In 2017 the company improved the ventilation in their flavoring room, in an effort to reduce the risk of diacetyl exposure. We conducted the assessment in part due to a worker with asthma-like symptoms at the plant; no cases of bronchiolitis obliterans has been reported from the facility.

Prevention effort #3: Severe silicosis in engineered stone workers

We published a single case of accelerated silicosis in a countertop fabrication worker as part of a larger U.S. case series ([MMWR 2019](#)). Dissemination of the article included a visual abstract created by NIOSH, radio interviews with National Public Radio, and news stories in the Associated Press. Additionally, our WA-DOSH exposure surveillance showed historic over-exposure to silica dust in countertop fabricators, which greatly added to the weight of evidence for this hazard (see Aim 2). The DOSH program adopted the findings from both of our surveillance systems and launched an

emphasis program regarding silica exposure in 2020. To-date, approximately ten inspections have been completed in the countertop fabrication industry, with at least two worksites obtaining medical surveillance for their workers. Our surveillance efforts were directly used to reduce silicosis risk in engineered stone workers through a highly publicized journal article, enforcement inspections with exposure assessments for airborne silica dust, and subsequent medical surveillance for workers found to be over-exposed to silica dust.

Specific Aim 5: Evaluate the newly proposed toxic inhalation surveillance system

Our [Supplementary Report: Methods and evaluation for Washington State's toxic inhalation surveillance system, 2017 – 2020](#), details the program evaluation we conducted for our toxic inhalation system. Modifications to our case-capture strategy based on keyword text search, injury codes, and diagnosis codes were identified and will be implemented in 2022. The case-capture modifications will improve the capture of true cases and will reduce the capture of false cases, thus improving overall system efficiency.

Conclusions

Washington's occupational disease surveillance system includes surveillance for respiratory diseases, toxic inhalation, and hazardous airborne exposures. We created a surveillance system for COVID-19 in response to the pandemic. We work with employees, employers, clinicians, safety and health professionals, trade groups, government agencies and others in our prevention efforts. We provide timely and relevant data through reports, presentations and publications, all of which serve to reduce the burden of occupational disease and injury. The major prevention activities recently undertaken are in the domains of asthma associated with hop dust exposure, exposure assessment for diacetyl in coffee roasting, and silicosis in workers engaged in engineered countertop fabrication.

Section 2: Characterizing the Burden of Work Related Musculoskeletal Disorders (WMSDs)

PI: Ninica Howard, MSc, CPE

Background

Many aspects of health care delivery are migrating into the home, resulting in a growing demand for those who provide care in this setting. These workers include home health aides, home care aides, and personal care aides, all considered direct support workers. The home-based health (HBH) industry is expansive and expected to grow by 34% between 2019 and 2029, which is higher than most other industries. Despite this growing demand, HBH aides are one of the most undervalued and marginalized segment of the health care industry.

The shift of locus of health care to the home has created challenges, unique to home-based health care, that present risks for work-related musculoskeletal disorders (WMSDs) and other injuries (DHHS, 2010) and perhaps provides some explanation of the scarcity of occupational research in this working environment. In Washington state it was shown that between 1998 and 2007, HBH workers had a workers' compensation (WC) claims rate of 1,375 claims/10,000 workers while the rate for all industries was 862 claims/10,000 workers (Howard, & Adams, 2010). The most common body region injured is the back (Lee & Yang, 2016; Quinn et al, 2015). Meyer and Muntaner (1999) found home health workers had 2.5 times more lost workdays due to injury than nursing home workers.

Historically, however, the focus of worker injuries in the health care industry has been the clinical setting (hospitals, nursing homes). Additionally, in health care, the priority is placed on patient injury prevention. The study of care practices, medical devices and workplace policies and programs intended to improve the health and safety of both care providers and patients in the clinical settings has been much more extensive. However, the efficacy of these same practices in the home environment is not clear (NRC, 2011).

The factors of the work environment that contribute to HBH provider injury are not fully understood. Human- system models developed for this environment encompass components for the worker, the patient, the tasks, the organization and external environments, such as social, community and policy (NRC, 2011; Beer et al, 2014). The human system approach to assess home-based health care provides an understanding of the interactions between the different components. There as been little application of the human system approach in the home-based health environment.

Specific Aims

The delivery of health care functions within a system that can impact the health and safety of the health care worker. A human-systems approach was adopted to identify and characterize musculoskeletal risks of HBH aides, using both primary (interviews and site visits) and secondary (workers' compensation claims) data sources. Specific goals of this research were:

1. **To characterize the overall burden of WMSDs across all Washington State industries and specific to home-based health aides.** Analyses of workers compensation claim data describe the burden of WMSDs and other injuries.
2. **To identify common tasks and processes that may contribute to WMSDs risk.** Common tasks and processes that may contribute to WMSD risk are identified through interviews and surveys of home-based health agency representatives and HBH caregivers. Additionally, organizational interviews will determine the impact of organizational factors on worker safety and health.
3. **To determine WMSD risk factors in the home health environment through site visits.** Targeted site visits will assess the physical demands of the tasks and activities performed by HBH aides, describe the attributes of the work environment within the home and estimate the exposure to WMSD risk factors.
4. **To develop WMSD prevention tools for different audiences.** An assessment tool for HBH aides will be developed and distributed. An assessment tool will be developed for HBH agencies to help them identify organizational factors that may contribute to WMSDs. Educational materials for patients and clients will be developed to help inform them of potential risks for HBH aides.
5. **To evaluate the effectiveness and impact of the risk assessment tools and educational materials.**

Methodology

Specific Aim 1a: Analysis of Washington State Workers' Compensation Claims: All Industries

Workers' compensation claims data and employment data from the Medical Information and Payment System (MIPS), which contains all billing information generated by provider medical bills for state funded, and the Labor and Industries' Industrial Insurance System (LINIIS), which contains all data necessary for the administration of State Fund (SF) claims were extracted. Accepted state fund and self-insured claim data between 2006 and 2015 were extracted. Claim data included claim status, demographics, body area, date of injury, nature of injury, event type, cost of claim, missed workdays, ICD-9 codes, 4-digit Washington Industrial Codes and 4 digit NAICS codes. The classification of WMSDs within the workers' compensation system has been used previously and is described elsewhere (Anderson et al, 2015). To eliminate unstable rates, those NAICS codes with less than 100 full-time equivalents reported for each year of the reporting period or less than 50 claims total in a WMSD category for the 10 year reporting period (2006-2015) are excluded from these analyses.

Analyses of claim data were performed by 4-digit NAICS, Prevention Index (PI), and NORA sector. The NORA sectors were 1) Agriculture, Forestry and Fishing, 2) Construction, 3) Health Care and Social Assistance, 4) Manufacturing, 5) Services, 6) Transportation, Warehousing and Utilities, and 7) Wholesale and Retail Trade.

Specific Aim 1b: Analysis of Washington State Workers' Compensation Claims: Home-Based Health Care Industry

Washington state WC compensable and medical-only claims from January 1, 2012 to December 31, 2016, for those providing HBH services were examined. The analyses

were restricted to those claims covered by Washington state's Department of Labor and Industries (L&I) industrial insurance (state fund claims). Claims within the HBH sector were identified using the Washington State risk classification system. Under this classification system, industries and occupations are grouped based on the type of work performed and the risk for insurance loss. Claims from HBH sector were identified using the risk classifications of 6110 (Home Health Services, Nursing Care NOC), 6511 (Chore Services/Home Care Assistants) and 6512 (Home care services/home care referral registry). Within each risk class, analyses were performed for all accepted claims, time loss or compensable claims (a subset of all accepted claims) and medical only claims (a subset of all accepted claims). All state fund claims are coded for nature, body part affected, primary and secondary source, and the event or exposure for injury or illness using OIICS as described above for the workers' compensation claim data for all Washington industries. OIICS codes are assigned at the beginning of the claims and represent an initial description of the injury or illness. The data extracted were the same as that for the analyses of all industries (described above). Claims data were examined by seventeen injury types, based on OIICS coding that are relevant to home-based health services. The injury types were: 1) Work-related Musculoskeletal Disorders (WMSDs), 2) Fall on Same Level, 3) Struck By/Against, 4) Fall from Elevation, 5) Transportation Accidents, 6) Overexertion (not a result of cumulative exposure), 7) Caught In/Under/Between, 8) Violence, 9) Bodily Reaction, 10) Exposure to Loud Noises, 11) Respiratory Disease, 12) Exposure to Toxins, 13) Exposure to Extreme Temperature, 14) Abrasion, 15) Electrical, 16) Explosion, and 17) All Others. The All Others category was comprised of claims that lacked sufficient detail to discretely classify them upon initial report. Previous analyses of Washington state WC data have used the same injury groupings (Anderson et al, 2013; Howard et al, 2016). Claim rates, costs, and rate of time loss were determined. Analysis of specific WMSDs was performed. These WMSDs were rotator cuff tendinitis, sciatica, elbow epicondylitis, hand/wrist tendonitis, carpal tunnel syndrome, and knee bursitis.

In addition to examining Washington WC claim data, Washington Behavioral Risk Factor Surveillance System (WA BRFSS) data for HBH support workers were analyzed and compared to other health care support occupations, and all other occupations. Using SOC codes to identify these workers, data from 2011 to 2016 were extracted and analyzed.

Specific Aim 2: Home-Based Health Care Aide Interviews: Injured and Uninjured Aides

Interviews of injured and uninjured aides were aimed at gaining a better understanding of the HBH aides' perceptions of injury risk. Uninjured worker interviews provided a differing perspective of injury risk from that of injured workers. Interviews, which were recorded, were conducted over the phone in the language most comfortable to for the participant. For recruitment of the uninjured aides, a snowball approach was adopted. Uninjured aides were first identified by an advisory committee, which was established to inform and guide research activities. Researchers then allowed word to spread from either the advisory committee or fellow participants. Injured worker interviews involved aides (non-family members) who filed a workers' compensation claim that involved lost workdays for WMSDs of the back, shoulder, hand/wrist, or knee. Potential cases were

first sent introductory letters, followed by a phone call within 5 days of the letter being sent. Audio files were transcribed and a single researcher performed qualitative analyses.

Specific Aim 3: Home Health Care Agency Representative Focus Groups

Questions for the focus group were aimed at gaining a better understanding of the perceptions of agency representatives with regard to HBH aide injuries and WMSDs. Potential participants were identified by an advisory committee, which was established to help inform and guide research activities. Potential participants were then contacted via phone or email. Advisory committee members were also eligible to participate. Two focus groups were held, one on the Eastern side of Washington State and one in the Seattle-area.

Specific Aim 4: Industry-Wide Home-Based Health Care Aide Survey

Worker interviews and agency focus groups informed the development of the development of industry-wide survey, in addition to previous research of HBH aides. Three recruitment methods were used to reach HBH aides. The first method sent emails directly to HBH aides. To identify these workers, employers assigned the NAICS code 621610 (Home Health Care Services) were identified from the Washington State employment security data. Using these reports, specific employees working for these employers were identified. These employee names were matched with the Washington State Department of Health (WA DOH) certification records of certified and registered nursing assistants, which include email addresses. An initial participation email was sent, followed by three additional email reminders (1-week, 3-weeks and 5-weeks post initial email). The second recruitment method utilized a listserv of home health agencies maintained by WA-DOH. Using this listserv, WA-DOH sent emails to home health agencies supporting the research and requested employers forward information about the survey to their employees. The last recruitment method involved targeted advertising on Facebook. The audience identified were Washington residents, in the healthcare and medical services industry, having the job title of home health aide. Surveys were completed through three vehicles: 1) Online via Survey Monkey, 2) over the phone with a SHARP researcher and 3) a hard-copy of the survey, either sent to or printed by the participant. As an incentive of prize drawings of 10 \$100 cash cards was offered.

Results

Analysis of Washington State Workers' Compensation Claims: All Industries

The analyses of WC claims between 2006 and 2015 across all industries found 159,633 state fund and self-insured accepted compensable WMSD claims, which accounted for 39.3% of all accepted claims for this period. Direct costs from WMSD claims totaled \$3.7 billion. Medical aid costs for WMSD claims were \$1.7 billion – an average of \$172 million/year. A decline in WMSD claims was observed across the compensation period. The WMSD claims incidence rate (CIR) for all Washington industries was 69.5 claims per 10,000 FTEs, compared to a CIR of 176.92 claims per 10,000 FTEs for all compensable claims. Though back WMSDs had the highest CIR among the body areas (back, shoulder, elbow, hand/wrist and knee) with 29.55 claims/10,000 FTES, on

average, shoulder WMSDs were the most costly (an average of \$65,053/claim).

From the examination of workers' compensation claims by industry sector, back WMSDs were the most prevalent WMSD type in each of the seven NORA sectors.

Table 1. ALL INDUSTRIES: Workers' Compensation Compensable Claims, 2006-2015: Work-Related Musculoskeletal Disorders

	Shoulder	Elbow	Hand / Wrist	Back	Knee
Total Compensable Claims, SF+SI	31,366	10,696	25,275	67,810	19,910
% of ALL Compensable Claims	7.7%	2.6%	6.2%	16.7%	4.9%
Indemnity Costs, SF+SI (\$Million)	\$1,014.60	\$333.60	\$549.60	\$1,624.20	\$430.40
Medical Costs, SF (\$Million)	\$471.60	\$187.40	\$269.70	\$777.60	\$204.50
Average Number Claims per Year, SF+SI	3,136.6	1,069.6	2,527.5	6,781.0	1,991.0
Percent Female, SF+SI	38.2%	44.3%	55.6%	36.8%	28.8%
Median Age, SF+SI	47	43	46	41	47
Median Body Mass Index*, SF	28.3	28.2	28.3	27.8	29.4
Median Tenure Months+, SF	38	36	47	24	36
Claims Rate (Claims per 10,000 FTE‡), SF+SI	13.7	4.7	11	29.5	8.7
Severity Rate (Time Loss Days per 10,000 FTE), SF	3,808.7	1,750.5	2,446.3	6,518.7	1,478.8
Average Time Loss Days per Claim, SF	368.4	364.6	285.4	290.3	237.6
Median Time Loss Days per Claim, SF	125	109	74	37	57
Average Total Direct Costs per Claim, SF	\$65,053	\$56,705	\$45,769	\$49,678	\$43,728
Median Total Direct Costs per Claim, SF	\$30,836	\$19,401	\$15,102	\$6,984	\$15,342

SF=State Fund; SI=Self-Insured, FTE=full-time equivalent

*Body Mass Index =weight (kg) / height (meters²); Hgt / Wt were available for 91.1% of SF Comp

+Tenure was available for 90.0% of SF Comp

‡ 1 FTE= 2,000 hours worked/year

Across all sectors, back WMSDs accounted for the greatest proportion of accepted compensable claims at 16.7% (Table 1). The youngest claimants in each sector were for back WMSDs, as well (37-44 years). Median age was less than 40 years for back claimants in the Construction sector (median age=37 years) and the Wholesale and Retail Trade sector (median age=39 years). The median age in the sectors remaining were greater than 40 years. Shoulder WMSDs was the second most common claims across the industry sectors, accounting for 7.7% of all accepted compensable claims. Among the body regions, elbow WMSDs had the smallest proportion of all accepted compensable claims, 2.6%.

With the exception of Agriculture and Construction, knee WMSD claimants were the oldest among the industry sectors. Health Care and Social Assistance had the highest prevalence of women claimants, 89.1%, while Construction had the lowest prevalence, 8.7%. The Construction sector saw the highest average number of time loss days per claim for all WMSD types.

For all WMSDs combined, the Health Care sector scored the worst Prevention Index (PI), indicating a sector with a high risk for all WMSDs. For Back WMSDs, the sectors of Construction, Health Care and Wholesale/Retail trade had the worst PIs. The construction subsector of Foundation, Structure and Building Exterior Contractors (NAICS 2381) ranked highest by PI for each of the individual WMSDs (back, shoulder, elbow and knee).

An interactive data visualization tool, using Tableau, was developed for WMSDs, which allows users to select a specific industry and quickly map it against other comparable industries. This presentation tool includes data from previous hard copy WMSD reports. The data cover aggregate WMSDs, injuries by body part and specific disorders. Data are available for counts, costs, rates and severities (measures per full time equivalents) as well as comparative rankings of other industries covered by the state fund. Users may produce top 10 reports of hazards or injuries based on various aspects of their industry claim profile

The comparison of WA BRFSS data found significantly more HBH workers who suffered from arthritis (33.2%, 95%CI: 27.0, 39.4), and diabetes (9.4%, 95% CI: 5.7, 13.2). Similar to the results from the workers' compensation claim data, many HBH workers were obese by BMI (35.8%, 95%CI: 28.9, 42.7). This was significantly more than workers from all other occupations. Twice as many HBH workers (31.3%, 95%CI: 24.2, 38.4) than non-HBH workers were current smokers. Significantly more HBH workers reported serious mental illness than all other occupations (6.8%, 95%CI: 2.8, 10.7)

Analysis of Washington State Workers' Compensation Claims: Home-Based Health Care Industry

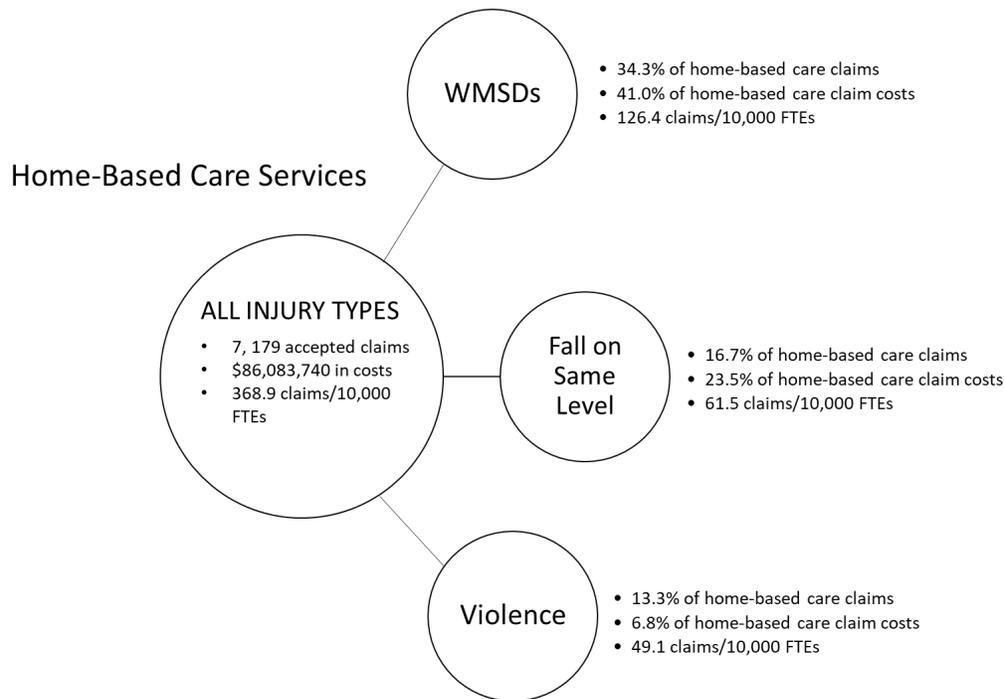
Among the state fund workers' compensation claims between 2012 and 2016, WMSDs accounted for the majority of claims within each claim type (34.3% of all accepted claims, 38.1% of time loss claims and 28.9% for medical only claims). These claims also accounted for 41.0% of the costs. Figure 1 summarizes the claim data for the most common injury types of all accepted claims. The second and third most common injury types differed among the claim types. For time loss claims, these injury types were overexertion (35.2% of time loss claims) and falls from elevation (33.6% of TL claims). For medical-only claims, the injury types were struck by/against (16.1%) and violence (15.9%). Total costs for WMSD claims for all accepted claims was \$34.6 million. Back WMSDs were the most frequent medical only claim (17.1%) and incurred the highest total costs (\$1.99 million).

Industry-Wide Home-Based Health Care Aide Survey

A total of 412 surveys were received, of which 37% were not considered direct care support workers. A quarter were identified as HBH aides (25.7%) while the remainder (37.1%) were identified as other home-based care workers. The majority of the direct care surveys were completed via SurveyMonkey (88.8%). The median age of the HBH aides was 50 years (range 25-70 years) and 73% were white. The majority those who worked at least 32 hours per week made less than \$50,000 per year (67%). While just over half (55%) of respondents reported moving, transferring or repositioning patients several times a day, only 17% reported always having patient handling equipment (including gait belts, slide boards and shower chairs) available for use. Most

respondents (86%) reported experiencing pain or discomfort in the past year and 41% reported at least one injury in either the back, shoulder, arms, hips, knees or ankles in the past year. Only 12% of the HBH aides reported their symptoms to their supervisors every time but 23% reported their injuries every time. The most common reason (35%) for not reporting symptoms or injuries was that aides were able to continue doing their job. Finally, only 28% of the aides reported having no hesitancy in informing their supervisors about their symptoms and injuries. When asked about seeking treatment for their symptoms or injuries, less than a third (29%) reported seeing a doctor within 1 week. A quarter of the HBH aides reported experiencing verbal abuse from their patients; however, 43% reported physical abuse from their patients. They also reported physical abuse from other household members (18%). Although over a third of respondents (37%) reported the physical abuse from patients every time, only 15% reported the verbal abuse every time.

Figure 1. Summary of most common injury types among all accepted Washington State’s state fund workers’ compensation claims, 2012-2016.



Home-Based Health Care Aide Interviews: Injured and Uninjured Aides

Thirty-one interviews were completed with injured HBH aides, who were predominantly female (87%). The majority of injured workers were White (71%), followed by Black (16%). The median age of the injured workers was 53 years (range 22-68 years), having a median of 6 years (range 0.2-33 years) as a HBH aide. Most injuries were of the back (58%), followed by shoulder (26%) and the knee (13%). Five female uninjured HBH aides were interviewed. Identified risk factors of injury fell into a number of themes and included difficult spaces to work in, such as cramped rooms or showers/baths; physical limitations of the patient; lack of knowledge of the patient in how to assist aides; demands by patients and families beyond the care plan; and an acceptance of

risk, as the priority is placed on ensuring a patient's safety and satisfaction. Exemplary care was highly linked to patient happiness and satisfaction.

Home Health Care Agency Representative Focus Groups

Five agency representatives participated in the 2 focus groups (3 females, 2 males). All participants were white, ranging in age from 30-56 and having an average of 13 years experience (range 2-28 years) in the home-based health industry. Injuries were attributed to several constructs including inconsistent working environments (each home is different). The lack of communication between aide and manager was also a common theme but manifested in different ways that involved aides not feeling empowered to share their expertise, aides not being informed about changes in the health or special needs of a patient, and the development of care plans without consultation with the aides, who must meet the demands of the care plan. Hesitancy in reporting injuries and symptoms was another theme identified. Focus group participants stated that aides did not recognize the seriousness of the symptoms or injuries, or they accepted symptoms as a part of the job. Aides also feared scrutiny of how they perform their job if an injury was reported.

Discussion

Analyses of the Washington State workers' compensation claims has shown the continued high burden of WMSDs across all industries. Currently, the pilot of the WMSD interactive data visualization tool is used internally, and has been shared with key stakeholders. As L&I's technology stack has evolved, a redeveloped release, using a new product such as Power BI, is recommended.

Analyses of workers' compensation claims of home-based health workers from 2012 – 2016 also showed a significant burden of WMSDs among this working population. However, WC claims has proven to provide an underestimation of prevalence of workplace injuries. In the analysis of HBH worker claims, self-insured claims were omitted. The most prevalent injury types (WMSDs, Falls on the Same Level, Violence) remained unchanged from a previous analysis workers' compensation claims from 2010-2014 (Howard et al 2016). Examination of surveillance data (workers' compensation, WA BRFSS) suggests that aides are older, with most in their forties and fifties. This industry is already struggling with meeting the demands for home-based health workers through recruitment and retention. These findings suggest that recruitment and retention will continue to be problematic, as these workers grow older, and perhaps begin to struggle with the same impairments as their patients, or begin to reach retirement age. Additionally, older HBH workers may have more cumulative exposures than younger ones. Examination of the WA BRFSS data suggests that HBH workers may have differing underlying health issues or work environment issues from other occupational groups.

This research has suggested that the mitigation of injury risk cannot be addressed solely through the behavioral modification of the workers. Factors involving the aide-patient relationship and the aide-employer relationship may contribute to injuries and WMSDs. Interviews with injured and uninjured workers revealed that aides accept a level of risk for the sake of the safety and satisfaction of their patients. Several factors

may contribute to this attitude. WA BRFSS data indicate that these aides are employed in low status occupations, with low wages, lack of health coverage and low educational levels. Low wages and little opportunity for economic mobility due to low educational levels makes home-based health aides vulnerable to unsafe working conditions (Steege et al, 2014). These workers are among the lowest compensated occupations in direct care and hours of work can be unstable. Close to half of the WA BFRSS HBHWs' income were less than \$25,000, the 2018 national poverty level for a household of four. The estimated annual wage for HBH aides is between \$26,336 and \$26,614 (WA ESD, 2017). HBH aides may willingly face risks that clinical care workers may not. HBH aide wages are paid on an hourly basis and the number of patients cared for determines wages. As patients and patients' families are able to request another aide if dissatisfied, it is important that aides ensure patient satisfaction. Additionally, aides do not feel empowered to advocate for their own health and safety; either their complaints do not get addressed or job insecurity prevents them from speaking out. Aides feel that they have little choice by to meet the demands of their patients or patients' families. With respect to injuries and abuse, differences in attitudes make early intervention difficult. The willingness to endure discomfort, and delay medical treatment until they are no longer able to do their jobs contributes to the difficulties. Verbal abuse is also tolerated, either out of loyalty to their patients or excused due to the patient's impairment. The lack of recognition of behavior as verbal abuse may also play a role. Physical abuse is more often reported. This may be because the impact of this kind of abuse is immediate and visible, though reluctance to report this kind of abuse has also been attributed to the same reasons as for verbal abuse.

The emergence of the COVID-19 pandemic and its impact on the home-based health industry made accomplishing a number of the aims of this research project impossible. To protect the health of the researchers, the home-based health aides and their patients, and to respect the struggles that agencies were experiencing, further research activities were cancelled. The assessment of the physical demands of tasks and activities and the characterization of the work environment was not possible. Without these data, it was not feasible to develop WMSD prevention tools and evaluate their effectiveness.

Conclusions

The decline in the Washington State workers' compensation claim rate for WMSDs that has been observed for the past decade continues. Eligibility criteria for coverage by workers' compensation for occupational diseases with cumulative exposures, such as WMSDs, are typically more difficult to reach than the criteria for acute injuries. The result may be in a shift from the workers' compensation system to other health care programs. This suggests the need for improved surveillance of WMSDs. The utility of additional data sources, to be used in conjunction with workers' compensation data, such as syndromic surveillance systems or all-payer databases, should be assessed. The dissemination of WMSD surveillance data is imperative in developing interventions. In further developments of the data visualization tool, it will be important to consider further what data to present and how best present such data for full utilization.

The high burden of WMSDs and other injuries, revealed in the surveillance data, has shown that the health and risk factors faced by home-based health workers differ from that of those providing care in a clinical setting. As such, the focus and development of injury prevention programs should be specific to the home-based health care environment and not an adaptation of programs established in the clinical setting.

There is a need to assess the contributions of the aide-patient and the aide-employer relationships and policies further. This research has suggested that the improvement of home-based health workers health cannot be achieved solely through behavioural modification of the worker. A social ecological model is needed to address risk factor contributors that move beyond the individual care provider.

The home-based health industry is struggling to meet the demand for home health care aides. Retention is proving difficult as HBH workers age and diminish in their physical capacity. One solution consistently put forward to address this shortage is the sponsorship of foreign workers. This will not mitigate the injuries suffered by these workers. The physical and social factors that plague this industry, i.e. low pay, high physical demands, no empowerment, will still exist. The same risks will be present for a different population who may be less informed of their rights and workplace safety regulation and have less agency, as their presence in this country is dependent upon their employment.

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Publications

Washington Occupational Health Indicators Project

Co-PI: David Bonauto, MD, MPH

Co-PI: Sara Wuellner, PhD, MPH

Peer Review Journal Articles

1. Speir, C., Ridings, C., Marcum, J., Drexler, M., and Norman, K. (2020). Measuring health conditions and behaviours in fishing industry participants and fishing communities using the Behavioral Risk Factor Surveillance Survey (BRFSS). *ICES Journal of Marine Science*. <https://doi.org/10.1093/icesjms/fsaa032>
2. Hesketh M, Wuellner SE, Robinson A, Adams DA, Smith CK, Bonauto DK. Heat related illness among workers in Washington State: A descriptive study using workers' compensation claims, 2006-2017. *Am J Ind Med*. First published: 28 January 2020 <https://doi.org/10.1002/ajim.23092>

State Technical Reports

1. SHARP. 2021. SHARP Stats: Suicide rates by Employment. Safety and Health Assessment and Research for Prevention (SHARP) Program, Washington State Department of Labor and Industries, Olympia, Washington, USA. 76-26-2021
2. Anderson NJ, Wuellner SE, Bonauto DK. Washington State Occupational Health Indicators: 2000-2014 Trends. Safety and Health Assessment and Research for Prevention (SHARP) Program Technical Report #80-14-2019, Washington State Department of Labor and Industries, Olympia, Washington, USA. Available at [OHI Trend Report](#)
3. Washington Department of Health. COVID-19 Confirmed Cases by Industry and Occupation; July 23, 2020. Washington State Department of Health, Olympia, Washington, USA. Available at: [DOH COVID-19 Case Report](#).
4. SHARP. 2020. SHARP Stats: COVID-19: Initial 9 Weeks. Safety and Health Assessment and Research for Prevention (SHARP) Program, Washington State Department of Labor and Industries, Olympia, Washington, USA. Available at: [COVID Claims](#).
5. SHARP. 2020. SHARP Stats: Franchising in Janitorial Work. Safety and Health Assessment and Research for Prevention (SHARP) Program, Washington State Department of Labor and Industries, Olympia, Washington, USA. Available at: [Janitorial Franchising](#).

PFA: Washington Fatality Assessment and Control Evaluation (FACE) Program

PI: Todd M. Schoonover, PhD, CIH, CSP

We summarize the last two years publications. The general format for citation is:

SHARP. <<YEAR>>. <<TITLE>>. Safety and Health Assessment and Research for Prevention (SHARP) Program, Washington State Department of Labor and Industries, Olympia, Washington, USA. <<Pub. #>>

All publications are available at: <https://lni.wa.gov/safety-health/safety-research/ongoing-projects/work-related-fatalities-face>

WA FACE Publications by Year

Year	Publication Title	Pub. #
2021	Retail Worker Hazard Alert: Women Victims of Homicide	47-29-2021
	Retail Worker Hazard Alert: Women Victims of Homicide-Korean	47-29-2021
	Suicides at Work in Construction, 2018-2020	47-30-2021
	Chip Truck Driver Struck by Passing Truck	52-47-2021
	Operator Falls from Boom Lift while Tree Trimming	52-48-2021
	Roofer Falls 30 Feet from Rain Slick Roof	71-203-2021
	Techador cae de un techo resbaloso ocasionado por la lluvia, desde 30 pies de altura-Spanish	71-203-2021
	Operator Electrocuted while Performing Maintenance on Center Pivot Irrigation System	71-204-2021
	Delivery Driver Dies when Forklift Overturns While Delivering Landscape Paving Blocks	71-205-2021
	Operator Run Over by Combine Harvester when Engine Started by "Hot-wiring"	71-206-2021
	2020	Top five work-related fatality incidents by industry, 1998-2019
Construction Hazard Alert: Using Reach Forklifts as Cranes		47-28-2020
Roofer Falls 20 Feet through Rotten Roof		71-190-2020
Operator Dies When Orchard Tractor Rolls Down Embankment		71-191-2020
Service Technicians Receive Electrical Burns When Electricity Arcs from Power Line to Boom Lift		71-192-2020
Laborer Falls 24 Feet from Roof Deck		71-193-2020
Carpenter Falls from Ladder-Supported Extension Plank		71-194-2020
Framer Struck by Falling Wall Section		71-195-2020
Laborer Partially Buried when Trench Wall Collapses		71-196-2020
Truck Driver Crushed by Hay Bales		71-197-2020
Framer Falls 20 Feet through Stairwell Opening		71-198-2020
Construction Supervisor Dies by Suicide		71-199-2020
Laborer Struck by Temporary Steel Shoring Tower Parts		71-200-2020
Ironworker Falls 42 Feet through Hole when Cover Fails		71-201-2020
Painter Dies from Accidental Drug Overdose		71-202-2020
Workplace Homicide by Gender		76-22-2020
Truck Driver: A Deadly Occupation		76-25-2020
Pre-Commercial Thinning Foreman Injured by Chainsaw		92-32-2020
Timber Cutter Killed When Struck by Alder Snag Top		92-33-2020
Washington State Work-Related Fatalities Report		93-05-2020

PFA: Trucking Injury Reduction Emphasis through Surveillance (TIRES) Program

PI: Caroline Smith, PhD, MPH

We summarize the last two years publications. The general format for citation is:

SHARP. <<YEAR>>. <<TITLE>>. Safety and Health Assessment and Research for Prevention (SHARP) Program, Washington State Department of Labor and Industries, Olympia, Washington, USA. <<Pub. #>>

Educational documents, simulations, and other online accessible publications are available on www.keeptruckingsafe.org

Year	Publication Title	Pub. #
2021	Tip sheet: Avoiding a Pallet Jack Set Back	90-158-2021
	Tip sheet: Safe Cab, Safe Driver	90-157-2021
	Tip sheet: Be an Ace with Jacks	90-156-2021
	Tip sheet: Taking Charge of Batteries	90-155-2021
	Tip sheet: Never Fool with an Air Tool	90-154-2021
	Tip sheet: Staying Safe at the Pump	90-153-2021
2020	It Really Happened: 3 Pointers Get Wins	90-150-2020
	Tip sheet: Drowsy Driving is Dangerous Driving	90-151-2020
	eLearning: Workplace Hazard Reporting and Response System	90-152-2020
	Tip sheet: Now Hear This!	90-149-2020
	Tip sheet: No Space? Cover Your Face	90-148-2020
	Tip sheet: Teaming Up Keeps Disease Down	90-146-2020
	It Really Happened: No Distance, Know Pain	90-147-2020
	Tip sheet: Handling the Pressure	90-145-2020
	It Really Happened: Don't Get It Twisted	90-143-2020
	Tip sheet: Spotting Hazards	90-144-2020
	Tip sheet: Handwashing is Protection Against Germs and Infection	90-139-2020
	Tip sheet: Don't Let a Cough or Sneeze Spread Disease	90-140-2020
	Tip sheet: You Can't Touch This	90-141-2020
	Tip sheet: Keeping Truck Drivers Safe from COVID-19	90-142-2020
	Tip sheet: Yard Tractors and Harm Factors	90-133-2020
	It Really Happened: Always Expect a Train	90-134-2020
	Tip sheet: Guard Your Yard	90-136-2020
	Tip sheet: Social Distancing for Truck Drivers	90-137-2020
	Tip sheet: Managing COVID-19's Impacts on Driver Stress	90-138-2020
	Tip sheet: Got a Backup Plan?	90-132-2020
	Tip sheet: These Trucks Carry Big Risks	90-131-2020
	eLearning: What is a Safety Committee?	90-135-2020

PFA: Occupational Respiratory Disease Surveillance In Washington State

PI: Carolyn Whitaker, MS, CIH

Peer Review Journal Articles

1. Reeb-Whitaker CK, LaSee CR: [2021] Surveillance of work-related asthma including the emergence of a cannabis-associated case series in Washington State. *Journal of Asthma*. Published on line: 16 Aug 2021.
2. Rose C, Heinzerling A: [2019] Severe silicosis in engineered stone fabrication workers – California, Colorado, Texas and Washington, 2017 – 2019. *MMWR Morbidity Mortality Weekly Report* 68:813-818.
3. LaSee CR, Reeb-Whitaker CW: [2019] Work-related asthma surveillance in Washington State: time trends, industry rates, and workers' compensation costs, 2002-2016. *Journal of Asthma* 57(4):421-430.

Technical Reports

SHARP. <<YEAR>>. <<TITLE>>. Safety and Health Assessment and Research for Prevention (SHARP) Program, Washington State Department of Labor and Industries, Olympia, Washington, USA. <<Pub. #>>

All publications are available at: <https://lni.wa.gov/safety-health/safety-research/ongoing-projects/occupational-respiratory-disease>

Year	Publication Title	Pub #
2021	SHARPstat: Toxic Inhalations	76-28-2021
	SHARPstat: COVID-19 in Health Care	76-27-2021
	SHARP Research Finding: Asthma and Cannabis Exposure	75-44-2021
	Workers' Compensation Claims for COVID-19 (Sep 2021)	64-33-2021
	Workers' Compensation Claims for COVID-19 (Aug 2021)	64-29-2021
	Workers' Compensation Claims for COVID-19 (Jul 2021)	64-28-2021
	Workers' Compensation Claims for COVID-19 (Jun 2021)	64-27-2021
	Workers' Compensation Claims for COVID-19 (May 2021)	64-26-2021
	Workers' Compensation Claims for COVID-19 (Apr 2021)	64-25-2021
	Workers' Compensation Claims for COVID-19 (Mar 2021)	64-24-2021
	Workers' Compensation Claims for COVID-19 (Feb 2021)	64-23-2021
	Workers' Compensation Claims for COVID-19 (Jan 2021)	64-22-2021
	Surveillance of toxic inhalation for Washington workers, 2017-2020.	64-30-2021
	Supplementary Report: Methods and evaluation for Washington State's toxic inhalation surveillance system	64-31-2021
	Appendix Tables: Surveillance of toxic inhalation for Washington workers, 2017-2020	64-32-2021
2020	SHARPstat: COVID-19 Initial 9 Weeks	76-23-2020
	SHARPstat: Cannabis 2020 Update	76-21-2020
	SHARPstat: Silica Dust Exposure	76-17-2019

Year	Publication Title	Pub #
	Nursing Care Facilities: Occupations affected by COVID-19	64-18-2020
	Workers' Compensation Claims for COVID-19 (Dec 2020)	64-21-2020
	Workers' Compensation Claims for COVID-19 (Nov 2020)	64-20-2020
	Workers' Compensation Claims for COVID-19 (Oct 2020)	64-19-2020
	Workers' Compensation Claims for COVID-19 (Sep 2020)	64-17-2020
	Workers' Compensation Claims for COVID-19 (Aug 2020)	64-16-2020
	Methods for COVID-19 Surveillance in Washington Workers' Compensation Data	64-15-2020

PFA: Identifying Risk for Musculoskeletal Disorders in Home Health Care in Washington

PI: Ninica Howard, MSc, CPE

Peer Reviewed Publications

Howard N, Marcum J: [2020]. Comparison of BRFSS Data Between Home-Based Care Providers and Health Care Support Workers in Clinical Environments in Washington State. *Workplace Health & Safety* 68(2):92–102.

Technical Reports

Brigham CJ, Davis KG, Howard N, Macomber MS, McGlothlin JD: [2021] Home Health Care Aides: Occupational Health and Safety Challenges and Opportunities: White Paper. AIHA 2021, Version1.

SHARP: [2021] SHARP Stats: COVID-19 in Health Care. SHARP Publication 76-27-2021. https://lni.wa.gov/safety-health/safety-research/files/2021/76_27_2021_COVIDHealthCareIndustry.pdf

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Howard NL: [2021] Using Two Administrative Databases to Characterize the Health and Safety of In-Home Care Providers in Washington State: A Look at Workers' Compensation and Behavioral Risk Factor Surveillance System (BRFS) data. 7th Edition of Virtual Conference on Nursing Education & Practice, 37, March 22-23.