as other chronic conditions or illnesses not identified elsewhere in the program portfolio. Evidence of burden, need, and impact are used to identify priorities to help guide research efforts towards preventing occupational disease.

Occupational carcinogens include single agents, complex mixtures, and high-risk occupational groups. Numerous epidemiological studies of specific exposures or specific industries have documented elevated risks for cancer among workers. Data for exploring occupation-related cancers is available via surveillance systems. For example, the NIOSH National Occupational Mortality Surveillance System allows investigators to identify associations of cause-specific mortality with occupation and industry. A vast number of carcinogens possess either unknown or understudied cancer risk. Cohort tracking can assess how interventions succeed to reduce exposures and subsequent effects. New data on emerging hazards, such as nanomaterials, are continuously sought after by the CRC to evaluate for cancer risk. Exposure, mechanism(s) of adverse effects, and risk from studies of high-priority agents are provided for quantitative risk models and recommendations. NIOSH continues to identify links between workplace exposures and cancer. A recent study of 30,000 firefighters reported higher rates of several cancers compared to the whole US population. Subsequently, a National Firefighter Registry was initiated in 2018 to improve understanding of cancer risk among firefighters.

Occupational exposures and the potential effects on reproductive health are of significant public health concern. Heavy metals, solvents, sterilants, gases, and pesticides are known agents that can impact reproductive outcomes in workers. Currently, 10% to 20% of pregnancies result in spontaneous abortion with 3% of live births possessing major malformations. Toxicant, multiple factors, and unknown causes are attributed to these effects. Some progress has been made to identify and separate occupational hazards from other etiologic factors associated with adverse reproductive outcomes. Many substances have suspected detrimental effects on reproductive processes, however, sufficient data are lacking. Laboratory studies inherently cannot keep pace to identify potential hazards and the underlying biological mechanisms. Recent advances in technology and methodology in reproductive health research are improving researchers' ability to 1) overcome obstacles, 2) improve understanding of causation, mechanism, and affected populations, and 3) reduce reproductive adverse outcomes.

Heart disease is the largest contributor to mortality in the U.S. totaling >647,000 in 2017. Little information exists, however, on how occupational hazards contribute to CVD risk and mortality rate. Although several agents in the workplace can affect heart health, clear links between occupational factors and disease development are not clear. For example, elevated rates of CVD death exist in non-smoking workers exposed to environmental smoke. More epidemiological research with available worker populations and collected biological specimens is clearly needed to identify occupational factors contributing to CVD among workers. Improved monitoring and measures of stress were recently shown to identify and improve understanding of key factors in the work environment contributing to CVD risk. New method development in exposure measurements, Quality of Work Life Surveys, and laboratory effects studies continue to improve detection of exposure and identify sub-clinical effects on the cardiovascular system. Research is improving our knowledge on how occupational factors impact biological mechanisms underlying workplace-associated CVD development.

Neurotoxicity leading to clinical syndromes represents one of the leading occupational disorders in the U.S, with a large proportion of hazardous agents possessing potent neurotoxic effects. Neurodegenerative diseases, peripheral neuropathies, and chronic encephalopathies have known associations with occupational exposures, such as pesticide and welding fume exposures. Also, a global epidemic of chronic kidney disease with unknown cause (CKDu) is occurring. Agricultural and other high work load industries are the most affected and factors including heat stress, dust, and pesticide exposures may play a role. Both exposure and chronic effects studies are needed that span across job tasks, genetic susceptibilities, and pesticide class. Evidence-based interventions, such as practices and programs, is needed to help minimize and prevent pesticide exposures. NIOSH-sponsored surveillance programs are beginning to elucidate the level of CKDu burden and etiologic mechanisms in U.S. workers. Partnerships, including researchers, workers, and industries, are starting to make progress in basic etiology, prevention, and translation research to reduce morbidity in affected occupational sectors.

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H-6

NIOSH—Development of the National Occupational Research Agenda (NORA) for the Immune, Infectious and Dermal Disease Prevention Program

Stacey Anderson (NIOSH)

NORA is a program sponsored by NIOSH to stimulate innovative research and workplace interventions. NORA councils are a venue for individuals and organizations with common interests to come together to identify national occupational safety and health research objectives. These build from advances in knowledge, address emerging issues, and are based on council member and public input.

The Immune, Infectious and Dermal Disease Prevention Program (IID) focuses on work-related diseases such as irritant and allergic contact dermatitis, allergic rhinitis, asthma and infectious disease, caused by work-related exposures. Also included are exposures to chemicals that can be absorbed from contact with skin that may result in adverse health impacts.

The NORA Council for IID has identified 6 objectives. (1) Investigate effects of recurring low-level occupational exposures on dermal, immune, and infectious diseases, including the role of perturbations on skin microbiome in maintenance of skin barrier function and toxicity resulting from xenobiotic metabolism by the skin and skin microbiome. (2) Investigate the contributions of skin exposure to the overall body burden of toxic substances including advancements in skin permeation measurements, modeling and refinement of skin exposure and risk assessment strategies. (3) Improve current skin exposure measurement methods including the quantification of chemical loading on the skin surface, characterization of dermal absorption or permeation, efficacy of workplace controls for dermal exposures and skin and surface decontamination methods. (4) Reduce the incidence and transmission of infectious disease in the workplace though assessment of exposure pathways, quantitative models, surveillance and intervention and preparedness. (5) Reduce the incidence of allergic disease in the workplace through the identification of allergens, understanding of the mechanisms of allergic disease and through surveillance, intervention and dissemination. (6) Investigate autoimmune disease risk associated with occupational and environmental exposures through

increased workplace hazard evaluations, development and improvement of animal models, and identification of biomarkers of disease.

Potential impact resulting from these objectives include: identification of occupational hazards; identification of factors that can influence occupational exposure to chemicals which will help to determine the most appropriate ways to prevent or minimize exposure; an understanding of the mechanisms of occupational diseases which will allow for proper treatment and/or prevention; and hazard identification that will lead to risk assessment which will ensure safe working environments.

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H-7

NIOSH—Traumatic Injury Prevention Program

Christine Schuler (NIOSH)

The National Institute for Occupational Safety and Health's (NIOSH) Traumatic Injury Prevention (TIP) Program aims to reduce and prevent work-related injury and death, across all industries, due to acute trauma or violence. To achieve this mission, we conduct high-quality research using the public health approach to identify the most compelling risks to workers through surveillance, analytic epidemiology, and field investigations. We also leverage protective technology, and engineering science as a means to improve personal protective equipment, tools, and workspaces, to keep workers safe on the job.

The TIP Program is committed to the development of practical solutions to address the complex problems that cause traumatic injuries and deaths among workers. To do this, the TIP Program's research is focused on:

- Preventing injuries and deaths from falls at work, on-the-job motor vehicle crashes, workplace violence, and the use of machines and industrial vehicles to perform work duties.
- Recommending strategies and solutions to reduce risks associated with work-related injury and death from falls, motor vehicle crashes, workplace violence, and contact with machines.
- Identifying and evaluating ways to reduce traumatic injuries among high-risk jobs and vulnerable worker groups.
- Addressing emerging issues such as robotics and drug overdoses.

There are three key research activities that support the TIP Program's aim to reduce worker injury and death. Those activities are:

- Surveillance to identify and track traumatic injury problems in specific worker populations, prioritize research needs, target prevention efforts, and monitor work-related injury and death trends.
- Field research to determine the causes of and risk factors for work-related injuries, and evaluate the efficacy of interventions, best practice solutions, and engineering controls.
- Lab research to examine everything from workplace equipment to human behavior and decision-making skills in a safe and controlled environment.

Some examples of the TIP Program's recent research efforts include:

- Publishing findings on the effectiveness of a no-cost-to-workers slip-resistant footwear program to reduce falls among food services workers.
- Publishing a Morbidity and Mortality Weekly Report on suicide rates by major occupational groups.
- Contributing surveillance data from the National Electronic Injury Surveillance System-Occupational Supplement (NEISS-Work) and Childhood Agricultural Injury Surveys to a Government Accountability Office report with recommendations for improving Department of Labor efforts to keep children who work safe.
- Convening the 7th National Occupational Injury Research Symposium (NOIRS) in October 2018 with more than 330 researchers, safety professionals, and students in attendance.

In addition to conducting research, the TIP Program works closely with partners from industry, labor, trade associations, professional organizations, other government agencies, and academia. Through our program partnerships we are able to address the difficult challenges facing today's workforce. Our partners contribute to building a safer workforce by providing:

- Valuable input for setting research priorities through the National Occupational Research Agenda (NORA).
- Specialized expertise to support the research, analysis, interpretation, and communication of results.
- A means of putting information into every day practice at the worksite.

Individuals and organizations interested in reducing and preventing work-related traumatic injuries are encouraged to join the NORA TIP Program Council, which serves as the venue to bring those with similar interests together to address the national agenda through information exchange, collaboration, and enhanced dissemination and implementation of solutions that work.

Collective efforts from the TIP Program's research activities and partnerships are vital to ensuring the effective promotion and transfer of findings into practices, products, and technologies that keep workers safe on the job. Some examples of how the TIP Program has worked to support adoption of our research—or move research to practice—includes the development of:

- A free mobile app to help workers who use ladders set up a ladder at the appropriate angle,
- A toolkit that includes 40 safety messages to promote safe driving practices among law enforcement patrol officers,
- An online, interactive training course to aid healthcare workers in better understanding the scope and nature of violence in the workplace, and
- A hazard alert prepared by the Washington State FACE Program, a TIP Program partner, to notify employers and workers of the dangers involved in using remote-controlled demolition robots.

To learn more about the TIP Program, visit our website: https://www.cdc.gov/niosh/programs/ti/default.html. To join the NORA TIP Program Council, please contact Dr. Christine Schuler at CSchuler@cdc.gov

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H-8

NIOSH—An Overview Of The NIOSH Healthy Work Design And Well-Being Cross Sector

Jeannie Nigam (NIOSH)

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