The Midwest Center for Occupational Health and Safety

Research-to-Practice:

Selected Examples from the Midwest Center for Occupational Health and Safety (MCOHS) Education and Research Center (ERC), a Center of Excellence, that is extremely productive. Extensive collaboration among disciplines, involving faculty, staff, students and external stakeholders is integral to these efforts. (http://www.mcohs.umn.edu)

Below is a partial list of research projects that have and will continue to have an effect on occupational health and safety:

Incidence of and Risk Factors for Occupational Injury among Transit Bus Operators

Among a total of 2,095 bus operators, included in this study, designed and conducted by Dr. Chia Wei, former OIPRTP doctoral student (Dr. Gerberich, Advisor), the overall unintentional injury rate with 95% C.I. was 17.8 (16.1-19.7) per 100 FTEs. Multivariable analysis identified increased risks for operators who: were female, compared to male (HR=2.4; 2.0-2.8); worked <7, compared to 7-<12 hours per day (HR=4.6; 3.8-5.5); and drove <7 compared to 7-<12 hours per day (HR=3.2; 2.7-3.8). Operators who worked split, versus straight shifts, demonstrated a suggestive increased risk (HR=1.2; 1.0-1.4). Bus operators also tended to have an increased injury risk when driving limited versus regular bus routes (HR=1.36; 1.0-1.8).

The overall intentional injury rate was 1.4 (1.1-1.7) per 100 FTEs. Operators who commenced working between 3 p.m. and 6 p.m. (HR=2.4; 1.2-5.1) and 12 a.m. and 3 a.m. (HR=5.3; 1.6-18.2), had higher risks of intentional injury, compared to those who commenced work between 9 a.m. and 12 p.m. Moreover, those who worked overtime had 30% higher risks, compared to those who did not.

Results of this study serve as a basis for further studies and are used for the development and application of relevant targeted intervention strategies in a metropolitan transit system to reduce occupational injuries among bus operators.

[Wei, C. et al., Risk factors for unintentional occupational injury among urban transit bus drivers: a cohort longitudinal study. *Annals of Epidemiology*, 2017;*27*(12):763-770. https://doi.org/10.1016/j.annepidem.2017.09.011]

Nanoparticle Releases during Vehicle Recycling

Most parts from automobiles are reused or recycled at the end of the useful lives of the vehicles. Because car manufacturers now use nanocomposite materials in their vehicles, they are concerned that workers involved in recycling components from automobiles may receive harmful exposures to airborne nanoparticles emitted from the parts as they are shredded for recycling. Dr. Raynor and MPH student, Jessica Ingraham, IH, used a range of sampling instruments and analytical techniques to evaluate airborne particles generated as a granulator shreds nanocomposite test plaques and test plaques that do not contain nanoparticles. This work was performed in conjunction with Argonne National Laboratory and the U.S. Council for Automotive Research. The study suggested that recycling of nanoclay-reinforced plastics does not have a strong potential to generate more airborne nanoparticles than recycling of conventional plastics, nor does it have a strong potential to generate unique airborne nanoparticles of the composited nanomaterial.

IH – Industrial Hygiene Program
OIPRTP - Occupational Injury Prevention Research Training Program
OHSRP – Occupational Health Services Research and Policy Program
OEHN – Occupational and Environmental Health Nursing Program
OEE – Occupational and Environmental Epidemiology Program
OEM – Occupational and Environmental Medicine Program

Reducing the Burden of Injuries On Agricultural Operations

Dr. Gerberich, OIPRTP, and the team of other MCOHS program co-investigators and students, lead major injury prevention studies that are the basis of regional research-to-practice efforts. These include surveillance studies of the incidence and consequences of, and risk factors for, agricultural and other injuries in Minnesota, Wisconsin, North and South Dakota and Nebraska.

The study results and identification of intervention efforts are translated to practice through collaboration with regional Agricultural Extension leaders who work directly with operators and communities. Dissemination has also been accomplished through numerous peer-reviewed publications and presentations in local, national and international arenas.

Protecting the Protectors: Violence-Related Injuries to Hospital Security Personnel and the Use of Conducted Electrical Weapons

Occupational and Environmental Health Nursing (OEHN) doctoral student, Joshua Gramling, MS (Advisor: Dr. McGovern) conducted a novel investigation of violence-related injuries among all security and emergency department nurses at an urban, Level I Trauma Center. As hospitals are increasingly arming their security workers with tools of law enforcement to prevent violent injuries, this study is the first to examine whether the use of the tools -- conducted electrical weapons — reduces the risk of injury. While study findings do not demonstrate a decrease in the overall rates of violence-related injuries to hospital staff after security officers began carrying conducted electrical weapons, the severity of the violence-related injuries may have been reduced. [Gramling,J. et al., Effectiveness of conducted electrical weapons to prevent violence-related injuries in the hospital. *Journal of Emergency Nursing*, 2018; 44(3):249-257.] [Funding: NIOSH Pilot Project: T42 OH008434]

Assessing Exposures during the Deepwater Horizon Spill Clean-Up

Dr. Ramachandran and PhD student Tran Huynh have developed new statistical methods to analyze the inhalation exposures to several volatile organic chemicals including total hydrocarbons (THCs) and BTEX chemicals (benzene, toluene, ethylbenzene, and xylene). The exposure assessment results will be used in an epidemiological study being conducted by NIEHS.

Cigarette Smoking, and Workplace Smoke-free Policies among an Urban American Indian Population

Genelle Lamont, MPH (OHSRP PhD student; Dr. McGovern, Advisor and Dr. Jean Forster, Co-Advisor) investigated the association of the presence of a workplace smoke-free policy on current smoking in a representative sample of urban American Indian adults using data from the 2011 Tribal Tobacco Use Prevalence Study. Study findings revealed lack of a workplace smoke-free policy was significantly associated with an increased risk of being a current smoker compared to a former smoker or a nonsmoker. Interventions tailored to the American Indian population are urgently needed and enforcement of complete smoking bans are recommended.

Preventing Violence Against Teachers

Dr. Gerberich, MCOHS research team colleagues, and students have been providing translation of research data from the Minnesota study of "Violence Against Teachers: Etiology and Consequences," to practice throughout the school systems, in collaboration with their dedicated advisory board of teachers. Risk factor identification, which serves as a basis for development of relevant interventions, includes consideration of various environmental factors, assault deterrents, violence policies, and school financial resources. To date, results have been disseminated in several peer-reviewed publications and at numerous major professional meetings, nationally and internationally, including audiences involving teachers.

Important factors associated with student perpetrated Physical Assaults (PAs) against a large population of K-12 grade educators were identified through a case-control study. It is important that school administrators recognize the increased risks to less experienced educators with advanced degrees who teach in public schools in elementary grades with small numbers of students, who have disabilities or developmental impairments, and in classes where students are of a different race/ethnicity from the teachers. Based on the strong evidence of an inverse relation between parental involvement and risk of PA to the educator, it appears essential to address this issue rigorously. Moreover, attention to environmental factors, including lighting, accessible exits, school resources, and an environment focused on safety is key. These results provide a basis for development and testing of effective methods for controlling the substantial risk of PA among elementary and secondary school educators that may also benefit others within the school environments.

Characterizing the Risk of Chronic, Low Dose Ionizing Radiation Exposure on the Risk of Developing Cataracts

Drs. MacLehose and Alexander and former PhD student, Craig Meyer, are completing a study of cataract incidence in the U.S. Radiologic Technologists (USRT) study. Radiologic technologists are exposed to ionizing radiation from a variety of sources and there is considerable growth in the use of medical imaging procedures and radiotherapy, which has contributed to a six-fold increase in average annual population dose from medical radiation since 1980. This study characterized the risk of long-term, low dose ionizing radiation exposure on the risk of developing cataracts in a population of over 90,000 radiologic technologists. The results of this study will provide needed information for evaluating cataract risk from ionizing radiation exposure, something that is currently being debated by the International Commission on Radiological Protection.

Use of Advanced Air Nozzles to Reduce Noise Levels

MS students Nancy Bergman and Kurt Prieve and Dr. Raynor (IH) studied the use of advanced air nozzles to control noise levels in industrial settings. Ms. Bergman found that installation of advanced air nozzles on a punch press reduced noise dose by 50-75%. Mr. Prieve measured average sound level reductions of about 9 dB when air guns with advanced nozzles replaced existing conventional air guns. In both cases, the greatest reductions were observed for frequencies greater than 1,000 Hz, to which human hearing is most sensitive and where the greatest damage from excessive noise occurs. Honeywell and 3M Company are using these findings to make changes in air nozzles in their manufacturing environments in order to reduce noise exposures.

Violence Against Nurses: The Next Step

Identification of risk factors for work-related physical assault by Drs. Gerberich, Nachreiner, Church, McGovern, their MCOHS colleagues, and students, are particularly important to application of relevant interventions. These risks include working in environments with low lighting, not carrying cell phones or alarms, working in emergency and psychiatric departments and long-term care facilities, and increasing hours of patient contact. Dissemination to professionals has been accomplished through *numerous peer-reviewed publications and professional presentations.* Some results from this and other studies have been incorporated into an online violence prevention course for which Dr. Gerberich participated in the development: Workplace Violence Prevention for Nurses CDC Course No. WB1865 http://www.cdc.gov/niosh/topics/violence/training_nurses.html

*Aids **for** Decision-Making in Industrial Hygiene*

The Industrial Hygiene Exposure Scenario Tool (IHEST) developed by a team led by Dr. Susan Arnold is recommended by the U.S. EPA Expobox website for documenting the tasks and environmental conditions leading to worker or consumer exposure.

The "Qualitative Checklist Tool" improves the accuracy of initial, qualitative exposure assessments that are made without the benefit of exposure measurements. Developed and evaluated by Dr. Arnold, it has been incorporated into global exposure assessment programs at Fortune 100 companies including 3M, Shell and Exxon Mobil. Dr. Arnold and collaborators have begun work to incorporate additional algorithms into the tool that predict airborne concentrations of chemical mixtures, which have previously proven too complex to assess effectively.

Taconite Workers Health Study

Drs. Ramachandran and Raynor and doctoral student, Jooyeon Hwang (IH)

Minnesota houses one of the world's largest bodies of iron ore, and supplies 65% of the ore needed for North American steel production. This state ranked sixth in the nation for total mining of taconite, a type of iron ore, adds thousands of jobs and over $1.8 billion to the Minnesota economy. The Taconite Workers Health Study was formed in response to an apparent excess of mesothelioma among taconite workers discovered by the Minnesota Department of Health. Tasked with investigating this finding and addressing growing concerns from citizens and legislators representing the Iron Range, several studies were conducted by University of Minnesota researchers. The intent of these investigations was to address three questions:

1) Is working in the taconite industry associated with mesothelioma and other diseases, respiratory and non-respiratory?
2) What factors, particularly exposures to dust from taconite operations, are associated with mesothelioma and other respiratory diseases?
3) Are spouses of taconite workers at risk for respiratory diseases as a result of their partners working in the industry and, if so, does this risk extend to the general population?

An important beginning element of the investigation involved the determination of worker exposures to three components of the dust from taconite operations: elongate mineral particles (EMPs), silica and respirable dust. Over 2000 current, on-site samples were collected by study investigators.

Samples included personal and area types for elongate mineral particles (EMPs), silica and respirable dust. Area samples for EMPs included the use of a cascade impactor with size fractions ranging from 36 nanometers to 56 microns in length. These dimensions were measured by phase contrast and electron microscopy and counted using several dimension-based definitions of elongate mineral particles (EMPs).

The initial results of the study indicate that taconite workers have a greater risk of mesothelioma, lung cancer, and heart disease when compared to the state of Minnesota population. The length of employment in the taconite industry and cumulative exposure to EMPs was associated with mesothelioma risk, but not the risk of lung cancer. Length of employment and cumulative EMP exposure was also associated with prevalence of pleural abnormalities on x-ray. The spouses of miners did not appear to have elevated rates of respiratory diseases.

This study has provided some long sought after answers about the risks of working in Minnesota's taconite industry and has led to several recommendations that the companies, unions, and regulatory agencies can use to better understand exposure-disease relations in this industry and to ultimately protect the health of miners and community members.

The study was led by several MCOHS investigators (Drs. Mandel, Alexander, Ramachandran, Raynor, Perlman), and involved students (Jooyeon Hwang, Christine Lambert, Elizabeth Allen, Nnameka Odo, Jinny Johnson, and Monika Vadali)

Physical Fitness Program for Law Enforcement

It is essential for law enforcement officers to be physically fit in order to perform their jobs safely and effectively. Despite this, there are no national fitness standards for law enforcement. Unfortunately, the literature suggests that law enforcement officers have lower than average physical fitness levels. This and other factors associated with their occupation place them at an increased morbidity and mortality risk. OEM MPH student, Christina Cusic, MD, designed a framework for developing fitness programs for law enforcement and used this framework to help develop a structured physical fitness program for the Plymouth, Minnesota Police Department. Over 55% of the officers participated in baseline fitness assessments and continue to exercise at the newly remodeled on-site facility. This framework is being used in other public safety departments for implementation of similar programs. Her work supports the need for national fitness standards for law enforcement.

Midwest Emerging Technologies Public Health and Safety Training (METPHAST) Program

With funding from NIEHS, Dr. Raynor collaborates on the Midwest Emerging Technologies Public Health and Safety Training (METPHAST) Program with colleagues from the University of Iowa and Dakota County Technical College. The goal of the program is to ensure that emerging technologies grow without causing illness or injury to workers and the public. The program's primary current objective is to develop a comprehensive web-based curriculum on occupational hygiene, with emphasis on applications to worker health and safety in emerging technologies. Instructors will use the curriculum to create lessons and courses for skills development in academic and continuing education settings.

The METPHAST Program has created 17 on-line continuing education modules to train professionals to work safely with engineered nanomaterials and an academic course on nanotechnology health and safety at the University of Minnesota. Content is freely available to instructors and learners in several ways, including through the METPHAST Program's YouTube at http://youtube.com/METPHASTProgram.

Comparison of Emissions between Self-Generated Vacuum and Conventional Sanding Systems

Conventional abrasive sanding generates high concentrations of particles. MPH student David Liverseed and Dr. Raynor (IH) conducted research at 3M Company to understand the differences in particle

emissions between a conventional random orbital sanding system and a self-generated vacuum random orbital sanding system with an attached particle filtration bag. Particle concentrations were measured for each system in a controlled test chamber when the sanders were used on oak wood, chromate-painted steel panels, and gel-coated fiberglass panels. Higher concentrations were always measured during conventional sanding. Depending on the substrate being sanded, concentrations were between 300 and almost 5000 times greater for the conventional sanding system than the self-generated vacuum sanding system. The data suggest that workers using conventional sanding systems could utilize the self-generated vacuum sanding system technology to reduce exposure to potentially-hazardous particles.

Evaluating Measures to Reduce Exposure to Mouse Urine Protein

IH MS students Joe Hexum and Ning Lee and MPH student Rebecca Burton have worked with Dr. Ramachandran and Dr. Raynor on projects to understand the best ways to control exposures to airborne mouse urine protein (MUP) among workers who transfer research mice between cages and dump bedding from dirty cages. Exposures to MUP can lead to severe allergic reactions, and preventing exposures is an important priority for the Research Animal Resources office and the Department of Environmental Health and Safety at the University of Minnesota.

Initial research indicated persistent problems in historical sampling for MUP because different methods were used at different times and sites, convoluting analyses of the effectiveness of different types of ventilation controls. After standardizing sampling procedures, later work indicated that biosafety cabinets and clean benches are not sufficiently protective for workers during cage changing. Respiratory protection should be required for animal care staff during cage changing even while using biosafety cabinets.

Reintegration of National Guard and Reserve Service Members after Deployment and Mental Health

As service members return home, our newest generation of veterans from Iraq and Afghanistan are reintegrating into potentially disrupted family, social, and occupational roles. Post-deployment mental health problems such as post-traumatic stress disorder (PTSD), depression, and alcohol or drug problems may complicate the reintegration process.

Military personnel returning from combat deployments are at increased risk of mental health problems which increases with time following combat deployment, suggesting experiences outside of deployment contribute to risk.

OHSRP PhD student, Tammy Schult, and Drs. McGovern, Dowd, Alexander and Nachreiner, identified that job concerns are present prior to deployment and are consistently correlated with symptoms of depression and PTSD up to two years post-deployment. Job stress and poor coworker support contribute to symptoms of depression in National Guard (NG) veterans over two years after returning from Iraq. Job stress may also contribute to an increase in symptoms of PTSD in some NG veterans not already experiencing symptoms in the early post-deployment time period.

Particularly for National Guard troops, whose military service is relatively part-time and who retain commitments to civilian jobs, issues and concerns surrounding the transition to and from civilian employment, this may represent an important topic area to incorporate into psychological resiliency training.

Health of Ammonium Perfluorooctanoate Production Workers

Ammonium perflurooctanoate (APFO) is a surfactant used in many industrial processes, including the manufacture of non-stick coatings like Teflon®. APFO converts to perfluorooctanoic acid (PFOA) in the body and is recognized as a persistent and pervasive global environmental contaminant.

The 3M Company developed APFO in the late 1940s and was producing it at a facility in Minnesota through 2002. Concerns about the potential human health effects from this compound have been raised in studies of the population at this facility and in other occupational cohorts.

To address these concerns, MCOHS investigators (Alexander, Ramachandran, and Church) and students (Katherine Raleigh, Elizabeth Allen, and Laura Scott) evaluated the mortality experience of the facility in comparison to another 3M worker population in the region, and linked the cohorts to the cancer registries in Minnesota and Wisconsin. With the aid of a detailed exposure reconstruction the risk of several cancers and other diseases were evaluated in relation to APFO

exposure. In this analysis there was no apparent association with APFO exposure and the diseases of interest. The linkage to the cancer registries substantially improved the ability to look at one cancer of particular concern, prostate cancer, as most diagnosed prostate cancers do not result in death. The study was completed and published to be used by an International Agency for Research on Cancer review of APFO and other compounds.

An Epidemiological Approach to Emergency Vehicle Advanced Warning System Development: A Two-Phase Study

Portable simulator utilized in Study Phase 2

Motor vehicle crashes involving civilian and emergency vehicles (EVs; police, fire trucks, ambulances, etc.) have been a known problem that contribute to fatal and nonfatal injuries; however, characteristics associated with civilian drivers had not been examined adequately. This two-phase study designed and conducted by former OIPRTP doctoral student, Dr. Chris Drucker, analyzed data from: Phase 1) The National Highway Traffic Safety Administration's Fatality Analysis Reporting System and the National Automotive Sampling System General Estimates System to identify driver, roadway, environmental, and crash factors, and consequences for civilian drivers involved in fatal and nonfatal crashes with in-use and in-transport EVs and Phase 2) design and examination of the impact (based on driving performance and distracting conditions) of two in-vehicle driver support systems which alert drivers to approaching EVs in a simulated urban environment.

Phase 1 identified drivers were involved in crashes with EVs more often when driving: straight through intersections (vs. same direction) of four-points or more (vs. not at intersection); where traffic signals were present (vs. no traffic control device); and at night (vs. midday). For nonfatal crashes, drivers were more often driving: distracted (vs. not distracted); with vision obstructed by external objects (vs. no obstruction); on dark but lighted roads (vs. daylight); and in opposite directions (vs. same directions) of the EVs. Consequences included increased risk of injury (vs. no injury) and receiving traffic violations (vs. no violations). Fatal crashes were associated with driving on urban roads (vs. rural), although these types of crashes were less likely to occur on dark roads (vs. daylight).

Phase 2, using a portable driving simulator, indicated improved driver responses and roadway safety among drivers presented with the designed driver support system compared to drivers presented with no driver support system. Most notably, drivers were at decreased risk of collisions with EVs when given a driver support system and that the presence of the systems did not increase in-vehicle distractions. In addition, drivers indicated a moderate level of trust and lower mental workload scores when driving with the driver support systems and reported the systems to be somewhat useful and satisfying.

The findings of this two-phase study suggest drivers may have difficulties in visually detecting EVs in different environments and that the use of technology may be beneficial as an intervention to mitigate roadway crashes between civilian drivers and EVs. Future research must continue to examine interactions between civilian drivers and EVs to identify methods to improve roadway safety.

Healthcare Workers Exposed to Chemical Compounds

Despite an estimated 8 million healthcare workers worldwide at risk of being exposed to antineoplastic drugs through direct or indirect contact and epidemiologic evidence of excessive risk of breast cancer and adverse reproductive outcomes, several critical knowledge gaps remain related to these exposures. Starting in 2019, policy mandates will require routine sampling for these drugs.

Dr. Susan Arnold and PhD student Hannah Kaup conducted a pilot study which indicated that antineoplastic drugs may be dispersed widely across surfaces in healthcare workplaces based on observations of patterns of contact from the contaminated hands of clinical staff. Dermal exposures among the staff and other workers are likely. In addition, Dr. Arnold and Ms. Kaup are collaborating with colleagues at the University of British Columbia to address knowledge gaps related to exposure by collecting and analyzing thousands of samples in clinics. A website is being developed to make the data publicly available.

Preventing Zoonotic Disease in Agriculture Exposed Populations

In collaboration with the NIOSH-funded Upper Midwest Agriculture Safety and Health Center (UMASH), Drs. Alexander and Bender and occupational epidemiology student, Evan Sorely, are working with the Minnesota Department of Health on the epidemiology of infectious diseases acquired from agricultural exposures. Agricultural workers, their families and visitors to their farms are potentially exposed to a number of zoonotic agents, including cryptosporidium, E. coli, salmonella, and campylobacter. The incidence of these conditions appears to be higher in populations exposed to agriculture; but, the exact rates are difficult to estimate. This project will also characterize antibiotic resistant patterns in these infections that occur to people working in agriculture.

CONTACT INFORMATION:

Marizen Ramirez, PhD, Director
Midwest Center for Occupational Health and Safety
Division of Environmental Health Sciences
School of Public Health, University of Minnesota
420 Delaware Street SE – MMC – 807
Minneapolis, Minnesota 55455
Telephone: 612-624-3143
E-mail: mramirez@umn.edu

Andrew D. Ryan, Manager
Midwest Center for Occupational Health and Safety
Division of Environmental Health Sciences
School of Public Health, University of Minnesota
420 Delaware Street SE – MMC – 807
Minneapolis, Minnesota 55455
Telephone: 612-625-1443
E-mail: ryanx029@umn.edu

Website: www.mcohs.umn.edu

MCOHS