The University of Cincinnati Education and Research Center Presents

19th Annual Pilot Research Project (PRP) Symposium

Thursday and Friday, October 11-12, 2018

University of Cincinnati

Kowalewski Hall and Kettering Lab Complex

Thursday, October 11th, 1:00pm-5:00pm

Friday, October 12th, 8:00am-12:00pm

This event is free and open to the public, please sign in at the registration desk

Keynote Speaker

Captain Lauralynn Taylor McKernan, ScD, CIH

Associate Director for Science

Centers for Disease Control and Prevention

National Institute for Occupational Safety and Health

Division of Surveillance, Hazard Evaluation and Field Studies

Podium and Poster Presentations by 2017-18 and 2018-19 Awardees, Networking Events, Panel Discussion and Q&As

University of Cincinnati
Education and Research Center

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University of CINCINNATI

Pilot Research Project Training Program and Symposium

Welcome to the University of Cincinnati Education and Research Center's (ERC) **19th Annual Pilot Research Project (PRP) Symposium** on October 11-12, 2018, held in the Kowalewski Hall Auditorium. The purpose of the PRP is to increase the research capacity of research trainees and young investigators in occupational health and safety and to encourage those in related disciplines to pursue occupational health and safety research.

Under the administrative direction of Dr. Amit Bhattacharya and Dr. Gordon Gillespie, research proposals are solicited and peer-reviewed annually by qualifying faculty and graduate students from the **University of Cincinnati and the following PRP partnering institutions – Air Force Institute of Technology, Bowling Green State University, University of Toledo – Health Science Campus, Central State University, Purdue University, University of Kentucky, Western Kentucky University, Eastern Kentucky University, Murray State University, Ohio University and Kentucky State University.**

At this symposium, the 2017-18 awardees will be presenting the results of their research and the 2018-19 awardees will make poster presentations of their proposed work. The keynote speaker on Thursday, October 11, 2018 is **Captain Lauralynn McKernan from the CDC/NIOSH Division of Surveillance, Hazard Evaluation and Field Studies, presenting on "Listen to the Music: How Rock 'n' Roll Provides Touchstones for the Evolution of Occupational Health."**

The University of Cincinnati's Education and Research Center is one of 18 national centers funded by the National Institute for Occupational Safety and Health (NIOSH). Dr. Tiina Reponen serves as the director of the ERC, which is based in the University's Department of Environmental Health within the College of Medicine. The purpose of the ERC is to train professionals in the didactic and research skills necessary to lead in occupational safety and health disciplines. Results of research are translated into action through an outreach program and shared with professionals and practitioners in the region via continuing education.

Since 1999, the PRP program has allocated over $1.4 million to support 239 pilot research projects. These projects have served as a catalyst in bringing over $41 million in additional research support to the region from sources independent of the PRP program, such as, the National Institute for Occupational Safety and Health (NIOSH), National Institutes of Health (NIH), United States Department of Agriculture (USDA), National Science Foundation (NSF), and the Centers for Disease Control and Prevention (CDC). Additionally, the PRP has brought 55 new investigators from other fields of expertise to the area of occupational safety and health research.

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Symposium attendees are eligible for:

- ABIH (IH) CM Points; apply online at http://www.abih.org/
- Meets BCSP criteria for continuation of certification credit

The 19th Annual PRP Symposium is free and open to the public

For more information about the PRP program, please contact
Dr. Amit Bhattacharya, PRP Program Director at (513) 558-0503 or email Amit.Bhattacharya@uc.edu

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History of the UC ERC

NIOSH is mandated to provide an adequate supply of qualified personnel to carry out the purposes of the Occupational Safety and Health Act (1970). The Education and Research Centers (ERCs) are one of the principal means for meeting this mandate. In 1976, Dr. Eula Bingham was in a NIOSH study section when the upcoming request for proposals for ERCs was announced. She immediately informed the then Director of the Department of Environmental Health, Dr. Raymond Suskind. He submitted a successful application, and UC was among the nine institutions who were awarded an ERC training grant in 1976. The others included Harvard University, Johns Hopkins, University of Texas Houston, University of Minnesota, University of North Carolina, University of Washington Seattle, University of Illinois Chicago and University of Arizona. Currently, there are 18 ERCs across the country.

ERCs are academic institutions that provide high-quality interdisciplinary graduate training, research training, continuing education, and outreach in occupational safety and health disciplines. Research and research training are integral components of ERCs, with ERC faculty and NIOSH trainees conducting research on issues related to the NIOSH National Occupational Research Agenda (NORA) and Healthy People 2020. The ERCs also serve as regional resources for industry, labor, government, and the public.

Currently, UC ERC includes four core disciplines: Environmental and Industrial Hygiene, Occupational Health Nursing, Occupational Medicine Residency and Occupational Safety Engineering as well as one allied program in Biomonitoring. Other main programs include Continuing Education, Targeted Research Training, and Evaluation core. The directors and the timeline of main program changes are summarized in Table 1.

UC ERC has been very successful in recruiting, training, and graduating high-quality practitioners and scientists who assumed leadership roles in government, industry, labor, and academia. The programmatic focus of this training is to help fill the ever-expanding shortage of environmental and occupational safety and health experts.

Table 1: Short History of the UC ERC

Director	Years	Main Programs
Raymond Suskind	1977-1985	Industrial Hygiene, Occupational Medicine, Occupational Health Nursing, Continuing education
Roy Albert	1985-1994	Occupational Safety and Health Engineering added in 1986 Hazardous Substances Academic Training Program added in 1994
Scott Clark	1994-2008	Biomonitoring added in 1996 Pilot Research Project Programs added in 1999
Carol Rice	2008-2012	Targeted Research Training added in 2011 Hazardous Substances Academic Training Program ended in 2012
Tiina Reponen	2012-current	Evaluation core added in 2016

Captain Lauralynn Taylor McKernan, ScD, CIH

"Listen to the Music: How Rock 'n' Roll Provides Touchstones for the Evolution of Occupational Health"

Associate Director for Science
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health
Division of Surveillance, Hazard Evaluation and Field Studies

Dr. Lauralynn Taylor McKernan, ScD, CIH, is the Associate Director for Science in the Division of Surveillance, Hazard Evaluations and Field Studies at the National Institute for Occupational Safety and Health. Dr. McKernan received a Doctor of Science (ScD) degree in industrial hygiene from the Harvard School of Public Health and a Master of Science in Public Health (MSPH) degree from the University of North Carolina at Chapel Hill. She has conducted a variety of industrial hygiene field studies and has published articles on topics ranging from bioaerosols on commercial aircraft, blood lead monitoring techniques, diacetyl sampling methods and lessons learned for first responders. Since 2013, Dr. McKernan has been a valued leader and continuing team member for the NIOSH Occupational Exposure Banding Initiative. She is certified in the comprehensive practice of industrial hygiene.

Day 1, October 11th, Schedule

Introductions	
1:00pm	**Welcoming Remarks and Introductions** Amit Bhattacharya, PhD, CPE, PRP Program Director *University of Cincinnati, Environmental Health* Shuk-mei Ho, PhD, Jacob G. Schmidlapp Professor and Chair *University of Cincinnati, Environmental Health* **Introduction of Education and Research Center** Tiina Reponen, PhD, CIAQP, ERC Director *University of Cincinnati, Environmental Health*
1:15pm	**Introduction of Keynote Lecturer** Amit Bhattacharya, PhD, CPE, PRP Program Director *University of Cincinnati, Environmental Health*
Keynote Address & Q&A	
1:20pm-2:00pm	**Listen to the Music: How Rock 'n' Roll Provides Touchstones for the Evolution of Occupational Health** Captain Lauralynn McKernan, ScD, CIH *Centers for Disease Control and Prevention*
Presenters (Moderator: Vijay Golla)	
2:00pm-2:20pm	**Immunotoxicity of PFCs (perfluoroalkyl compounds) Found in Fire-Fighting Foams** Alison Pecquet *University of Cincinnati, Environmental Health*
2:20pm-2:40pm	**Comparing Health Status and Exposure Risk in Career Vs. Voluntary Firefighters** Cody Morris, PhD *University of Alabama at Birmingham, Kinesiology*
2:40pm-3:10pm	**Poster Session I: Mohammadreza Radmanesh, Amanda Miller, Brijesh Yadav, Katherine Barlow, Rachel Chicchi**
3:10pm-3:20pm	**Break**
3:20pm-3:50pm	**Poster Session I Q&A** Moderator: Gordon Gillespie, PhD, DNP, RN *University of Cincinnati, Nursing*
3:50pm-4:10pm	**Negative Responses to Workplace Incivility in Home Care Workers** Claire Smith presenting on behalf of Haylee Min *Bowling Green State University, Industrial Organizational Psychology*
4:10pm-4:30pm	**Microbiome Changes as Markers of Exposure and Stress in Firefighters** Jagjit Yadav, PhD *University of Cincinnati, Environmental Health*
4:30pm-4:50pm	**Well-being of Youth Caregivers and its Effect on Pursuing a Career in Geriatrics** Jennifer Perion *University of Toledo, Health Education*
4:50pm-5:10pm	**Assessment of Diesel Particulates in Fire Departments using Different Exposure Metrics** Weylin Gilbert presenting on behalf of Jooyeon Hwang, PhD *Western Kentucky University*
PRP Networking Picnic, Kettering Lab Room G23	

Day 2, October 12th, Schedule

Introduction and Speakers	
8:00am-8:10am	**Welcoming Remarks** Gordon Gillespie, PhD, DNP, RN, PRP Deputy Director *University of Cincinnati, Nursing*
Presenters (Moderator: David Wilbanks)	
8:10am-8:30am	**Establishment of an Aerosol Sampling Protocol using Passive Air Sampler (PAS) and Scanning Electron Microscopy (SEM)** Jurate Virkutyte, PhD *University of Cincinnati, Environmental Health*
8:30am-8:50am	**Lightweight, Wearable Energy Storage Devices for Firefighters and First Responders** Paa Kwasi Adusei *University of Cincinnati, Mechanical and Materials Engineering*
8:50am-9:10am	**Fabric Integrated Gas Sensors for First Responders and Miners** Sathya Narayan Kanakaraj *University of Cincinnati, Mechanical and Materials Engineering*
9:10am-9:30am	**Flame Resistant Nanofabric to Protect Firefighters Against Heat and Toxins** Vianessa Ng *University of Cincinnati, Mechanical and Materials Engineering*
9:30am-10:00am	**Poster Session II: Christine Uebel-Niemeier, Danielle McBride, Dawna Rutherford, Robert Leonard, Michael Benjamin, Elizabeth Bien**
10am-10:10am	**Break**
10:10am-10:40am	**Poster Session II Q&A** Moderator: Gordon Gillespie, PhD, DNP, RN *University of Cincinnati, Nursing*
Panel Discussion, Awards, and Closing	
10:40am-11:00am	**Voting for Favorite Poster & Presenter**
11:00am-11:45am	**Panel Discussion of the Podium Presentation Topics** Moderator: Gordon Gillespie PhD, DNP, RN *Panelists: Diana Schwerha, James Klyza, Nicholas Newman, Jeremy Slagley*
11:45am-11:55am	**BEST Award Presentations** Diana Schwerha, PhD *Ohio University, Industrial and Systems Engineering*
11:55am-12:00pm	**Closing Remarks and Program Evaluation**

2018 PRP Awardee Posters

Title	Presenter	Program
Unmanned Aerial Vehicles (UAVs) for Information Gathering during Urban Disaster Situations	Mohammadreza Radmanesh	*University of Cincinnati Mechanical and Materials Engineering*
Development of a Sensor Frame Based Gait Assessment Device For Occupational Health In Nursing	Amanda Miller presenting on behalf of Tamara Lorenz, PhD	*University of Cincinnati Psychology*
Effect of Heat Stress on Immune Function in Firefighters	Brijesh Yadav, PhD	*University of Cincinnati Environmental Health*
Gender Differences in Nursing Job Demands and Resources	Katherine Barlow	*Bowling Green State University Industrial-Organizational Psychology*
Fragility Analysis of Steel Buildings in Fire	Rachel Chicchi, PhD	*University of Cincinnati Civil and Architectural Engineering and Construction Management*
Exposure to Traffic-Related Air Pollution, Home Dust, and the Respiratory Mycobiome	Christine Uebel-Niemeier	*University of Cincinnati Environmental Health*
Neuromotor Effects of Manganese Exposure in Adolescents Entering Workforce	Danielle McBride	*University of Cincinnati Environmental Health*
Educational Intervention to Mitigate the Effects of Bullying in the Student Nurse Population	Dawna Rutherford	*University of Cincinnati College of Nursing*
Predicting Changes in Driving Safety Performance on an Individualized Level Under Naturalistic Driving Conditions	Robert Leonard, PhD	*Miami University Information Systems and Analytics*

Invited Posters

Title	Presenter	Program
Development of a Risk Prioritization Framework to Evaluate Consumer Cleaning Product Chemical Ingredients	Michael Benjamin	*University of Cincinnati Environmental Health*
Healthcare Workers in the Home Environment: What are the Hazards? Developing an Observation Tool	Elizabeth Bien	*University of Cincinnati College of Nursing*

2017-18 PRP Awardee Podium Abstracts

Immunotoxicity of PFCs (Perfluoroalkyl Compounds) Found in Fire-Fighting Foams

Alison Pecquet (PI), Jagjit Yadav, and Andrew Maier

University of Cincinnati, Environmental Health

Purpose: The purpose of this experiment is to investigate the immunotoxicity of PFCs (perfluoroalkyl compounds) found in fire-fighting foams. PFCs, including perfluorooctanoic acid (PFOA), are utilized heavily in fire-fighting foams and in manufacturing processes, leading to high exposures in both firefighters as well as those working in manufacturing sectors. As PFOA is a known immunotoxicant but little data currently exist on innate immunotoxicity, we sought to investigate the innate immunotoxicity of PFOA.

Methods: We utilized the zebrafish embryo (ZFE) as an established model for innate immunotoxicity studies. ZFE were exposed to various concentrations of PFOA in water for 48 hours to establish a lethal concentration (LC50). Next, PFOA innate immunotoxicity at 5.0 or 0.5 mg/L was investigated using the neutrophil chemotaxis assay. In this assay, fish were wounded at the tip of the tail triggering neutrophil chemotaxis to the wound site. The assay was coupled with in situ hybridization for the myeloperoxidase gene, which enabled visualization of the neutrophil migration to the wound site and allowed for quantitative comparison between treatment groups and control. Labeled neutrophils were counted in pseudo-blind and blinded procedures, and statistics using ANOVA and Tukey test were performed. Chemical concentration was confirmed for the neutrophil chemotaxis assay using LC/MS at an outside laboratory.

Results: The 48-hour LC50 was calculated at 300 mg/L, which was comparable to other LC50s generated in the published literature. This confirmed the doses tested in the neutrophil chemotaxis assay were well below those causing overt toxicity to the ZFEs. Sublethal developmental effects were identified in ZFEs exposed to 30 mg/L. The neutrophil chemotaxis assay showed a significant reduction in neutrophil recruitment to the wound site in both PFOA treatments as compared to control (at 0.5 mg/L, $p = 0.00337$; at 5.0 mg/L, $p < 1e\text{-}04$). Chemical concentrations were calculated and were essentially as predicted: the 0.5 mg/L treatment group was quantified at 0.7 mg/L and the 5.0 mg/L group was quantified at 6.0 mg/L.

Conclusion: This study was the first to investigate innate developmental immunotoxicity and the only study investigating neutrophil chemotaxis effects of PFOA. Our study identified overt innate immunotoxicity in ZFEs exposed to doses of PFOA in the range of humans exposed occupationally. These data suggest that humans could be experiencing immunotoxicity effects at the current exposure level and could warrant increased PPE or increased biomonitoring of highly exposed populations. These data specifically suggest that developmental (in utero) exposure to PFOA could be a potential window of susceptibility and suggests pregnant women may need additional precautions to avoid high exposure. It is not currently clear if this result is related to overall neutropenia in the developing organism or if the mechanism involves altered chemotaxis. Current studies are being conducted on the molecular basis of this effect, including targeted genomics and whole genome sequencing.

Impact Statement: These data can be utilized to protect the health of highly exposed occupational populations, and suggest mitigation and minimization of exposures in workers, particularly pregnant women. They also show the utility of the ZFE model system for investigating immunotoxicity, which can be used to screen additional chemicals that might also cause similar effects.

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Comparing Health Status and Exposure Risk in Career vs. Voluntary Firefighters

Cody Morris (PI)[1], Scott Arnett[2], and Lee Winchester[2]

[1]The University of Alabama at Birmingham, Human Studies; [2]Western Kentucky University, Kinesiology, Recreation, and Sport

Purpose: The purpose of this study was to assess the potential similarities and differences in health and physical fitness profile between career firefighters and volunteer firefighters.

Design: To the best of the author's knowledge, no studies to-date have directly compared the physical fitness or health status of firefighters from professional departments versus those firefighters who are members of a volunteer department. This will be a key research question to answer as it could have potential workplace safety and policy-altering ramifications.

Methods: The research protocol consisted of three testing days, with the first dedicated to a health and physical fitness assessment and the second and third dedicated to a biomechanical evaluation during a simulated fire stair climb (SFSC). The health and physical fitness assessment involved testing the 5 components of health-related fitness (body composition, cardiovascular fitness, muscular strength, muscular endurance, and flexibility) using previously published and accepted protocols. The participant population consisted of career firefighters (CFF) who were all members of the Bowling Green Fire Department in Bowling Green, KY and voluntary firefighters (VFF) were all members of the Warren County Fire Department (Warren County, KY). The total sample size consisted of 140 firefighters comprised of 121 CFF and 18 VF. The biomechanical evaluation during the SFSC consisted of evaluating and monitoring firefighters while completing a 6-min SFSC in one of two conditions: standard athletic attire or full personal protective equipment (PPE). An independent *t*-test was used to compare all dependent variables for each participant within their respective group [height, body mass, fat mass (FM), fat-free mass (FFM), aerobic capacity, push-ups completed, plank time, flexibility, grip strength)].

Results: An independent *t*-test showed evidence of a significant difference between groups for the following variables: FM ($p = 0.002$), BF ($p < 0.0005$), push-ups completed ($p = 0.023$), plank time ($p < 0.0005$), and absolute grip strength ($p = 0.029$). There were not shown to be any significant differences between groups for the following variables: age ($p = 0.299$), body mass ($p = 0.161$), FFM ($p = 0.292$), flexibility ($p = 0.097$), or relative grip strength ($p = 0.934$).

Conclusion: In regards to the physical fitness testing of the current sample, the VFF had a significantly worse health and fitness profile across a number of variables compared to the CFF. Despite the financial and commitment status of volunteer firefighting departments, they perform an equally dangerous and important job as firefighters of professional/career firefighting departments and more attention should be directed at developing the fitness and performance of these firefighters as well.

Impact Statement: This project aimed to assess a key question as to the degree to which the physical fitness training that is implemented by professional firefighting organizations leads to improvements in physical fitness and health status. Also, a secondary aim was to assess to what degree a simulated firefighting task lead to alterations in gait patterning.

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Negative Responses to Workplace Incivility in Home Care Workers

Hanyi Min (PI)[1], Yisheng Peng[2], Claire Smith[1], Steve Jex[3], and Michael Valigosky[4]
[1]Bowling Green State University, Industrial Organizational Psychology; [2]Hofstra University;
[3]University of Central Florida; [4]University of Toledo, Population Health

Purpose: Poor working environment has been reported as one of the reasons for the difficulty in retaining home care employees. Aiming to improve working environment for home care workers, the current study applies the Stressor-emotional model to investigate home care workers' emotional and behavioral responses to workplace incivility. This study also examines whether the relations between incivility and its consequences differ for majority versus minority group members.

Design: The current study included a pilot study and a survey study. The pilot study consisted of interviews with home care workers. The survey study used a cross-sectional self-report survey to study research questions. The sample for the survey study consists of employees who are currently working as home care workers.

Methods: Only one participant was recruited for the pilot study. By asking the home care worker a list of questions, the pilot study was used to understand the nature of work for home care workers and adjust the questionnaire to better reflect the job. 447 participants were recruited for the survey study. Participants accessed the survey by clicking a link over email.

Results: Perceived workplace incivility was associated with increased negative emotional and behavioral responses. Negative emotions mediated the relation between perceived incivility and negative behaviors. However, the results did not demonstrate any group differences in these relationships.

Conclusions: The results of the current study demonstrated the negative consequences of workplace incivility in home care workers. Also, the results supported the mediation role of negative emotions between incivility and CWB. The results provide theoretical and practical implications to reduce negative impact of incivility and improve working environment for home care workers.

Impact Statement: The results of the current study call for organizations' attention to a type of workplace mistreatment with low intensity -- incivility -- by demonstrating its negative consequences. Also, the findings provide implications to potential interventions that are effective in reducing those negative consequences of incivility and improving the working environment of home care workers. This can help employee retention in home care occupation and meet the increasing market demand for home care workers.

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Microbiome Changes as Markers of Exposure and Stress in Firefighters

Jagjit Yadav (PI)[1], Harish Chandra[1], Jooyeon Hwang[2], Vijay Golla[2], and Ritchie Taylor[2]

[1]University of Cincinnati, Environmental Health; [2]Western Kentucky University, Public Health

Firefighters are challenged with extremely stressful and hazardous conditions in their occupational settings. This may involve exposure to heat, dust, and/or toxic chemicals. The dangerous stresses and injuries from the fire environment may cause perturbations in physiological homeostasis. In this pilot study, we aimed to investigate changes in the microbiome homeostasis in firefighters in relevance to their occupational health risks. The study involved the use of cutting-edge techniques of molecular biology and nextgen sequencing (NGS) coupled with bioinformatics analysis. Sampling on the identified firefighters' cohort was carried out in association with our collaborators. Metadata was collected based on a questionnaire and the collected samples were used for microbial DNA extraction. Next generation sequencing targeting the V4 region in the 16SrRNA gene of the microbiome DNA was performed at the Cincinnati Children's Hospital Medical Center's (CCHMC's) DNA Sequencing core facility. Bioinformatic analyses on the DNA sequence data led to identification of both qualitative and quantitative changes in the microbiome from the firefighters as compared to the control subjects. Further work on integration of metadata with mucosal microbiome from differing compartments is in progress. Identification of altered microbiome species may serve as biomarkers indicative of stress-related changes in firefighters' physiological homeostasis and/or impending health risks.

Impact Statement: This study on interaction of the occupational exposure and microbiome is expected to benefit the firefighters in terms of health risk assessment and potential identification of biomarkers of stress and/or impending health risks.

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Well-Being of Youth Caregivers and its Effect on Pursuing a Career in Geriatrics

Jennifer Perion (PI), Victoria Steiner, and April Ames

University of Toledo, Population Health

Purpose: The National Alzheimer's Association estimates that 250,000 youths under the age of 18 help support a family member with dementia, but few studies exist to explain their experience in caring. This study seeks to understand the influence that dementia caregiving has on the psychological health and well-being of adolescents who provide care for a non-parental family member with memory problems, identify opportunities for support and training, and the likelihood that caregiving has influenced their interest in a future geriatrics career.

Design: Adolescents between the ages of 12-17 who provided care for a family member with memory problems were recruited to complete a survey and participate in focus groups. The study included the completion of a survey by an adult family member who shared in caregiving duties with the adolescent to provide additional information about the family structure.

Methods: Adolescent participants completed a survey that collected demographic information, previous educational opportunities, and typical caregiving tasks performed. The survey ended with a modified Perceived Stress Scale. After completing the survey adolescents participated in one of three focus groups lasting about 60 minutes that were organized by age groups. An adult family member completed a survey that collected additional family background including details about the care recipient. Transcribed data were analyzed using a qualitative thematic process. The data from the adult and adolescent surveys were analyzed using descriptive statistics.

Results: Five males and six females living in Northwest Ohio with an average age of 15 participated in the study. Four participants were African-American, seven were White; one identified as Hispanic/Latino. All but one were attending school, and most reported their health as excellent or very good. Caregiving was provided for three grandmothers, five grandfathers, two great-grandfathers, a great-grandmother, a great-uncle and an uncle. A qualitative thematic analysis of the data revealed themes related to the experience of adolescent caregiving.

Six themes related to psychological health and well-being were identified: Feeling sad but understanding it's not their fault; 2) Helping even though it's not always pleasant; 3) Feeling good inside about helping family do stuff; 4) Believing no one can do it like family; 5) Finding connection through humor and fun and 6) Reflecting that caregiving is just something that I do. Participants indicated they felt low stress related to their caregiving responsibilities, which was supported through the analysis of the Perceived Stress Score results.

Four themes were identified related to training and education: Seeking knowledge by watching others and asking questions; 2) Perceiving that you gotta have patience; 3) Recognizing that they are going through stuff; 4) Reflecting that I've gotten more helpful to older people.

The focus group discussion included questions related to future interest in a career related to aging, but not enough data were present to develop themes. While some of the adolescents felt that caregiving tasks helped them develop an interest in future careers, none of them expressed an interest in entering the geriatrics healthcare field.

Conclusion: Youths who engaged in caregiving tasks were generally empathetic toward their older family members, and appreciated the difficulties associated with developing memory problems. The participants expressed an appreciation for the importance of family support, did not think the caregiving tasks interfered with other social aspects of their lives, and most held positive views of their caregiving experiences.

Impact Statement: The findings of this study provide new insight into the experience of dementia caregiving that can be used to develop supportive and enriching programs aimed at increasing the wellbeing of caregiving youths. Future research that compares the level of understanding and compassion that non-caregiving youths have for the older population to that of caregivers may advance the understanding of this potential benefit. Additionally, educational programs specifically tailored to the developmental level and caregiving tasks most commonly associated with young caregivers bears investigation.

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Assessment of Diesel Particulates in Fire Departments Using Different Exposure Metrics

Jooyeon Hwang (PI)[1], Ritchie Taylor,[2] and Vijay Golla[2]

[1]University of Oklahoma, Health Sciences Center; [2]Western Kentucky University, Public Health

Purpose: This study assessed exposures to diesel particulate matter (DPM) contaminated-particles using different metrics in the common areas of small, rural Kentucky fire departments.

Design: We selected common areas in which firefighters spend the most time, based on our previous survey study. The duration of sampling in each area was approximately 6–8 hours per sample.

Methods: We used integrated-based measures that quantify elemental carbon (EC) and organic carbon (OC) mass concentrations. The samples were analyzed using a thermal optical procedure for determining EC and OC content by NIOSH Method 5040. The direct reading-based measures determined the number of particles (TSI NanoScan SMPS 3910, Optical Particle Sizer 3330) and the mass concentrations (TSI DustTrak DRX 85533) from 10 nm to 10 μm.

Results: The concentrations of EC, which is widely used as a surrogate measure of DPM, were less than the limit of detection (0.9 $\mu g/m^3$) in most areas except for the engine bays. Based on our study, the particles in the engine bay had a greater likelihood of being fine or nanoparticles (<2.5 μm). The exposure patterns indicated that idling diesel-powered fire apparatus significantly contribute to exposures in fire departments.

Conclusion: Our preliminary results demonstrated the process of DPM monitoring using different particle metrics in small, rural fire departments. Future comprehensive exposure studies will need to collect more samples to confirm our results.

Impact Statement: This study revealed that exposure to DPM presents health hazards to firefighters in small, rural cities in Kentucky. Using integrated and direct-reading instruments, we assessed the feasibility of conducting an occupational epidemiological exposure study in this firefighter cohort. The results of the larger epidemiological study will supplement the cohort studies of exposure surrogates while lowering the likelihood of exposure misclassifications. The comprehensive assessment of DPM exposure both in the fire department and during fire suppression will improve our understanding of the carcinogenic risks faced by firefighters. Firefighters save lives in our communities. This research on occupational safety and health will move us one step closer to saving theirs.

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Establishment of an Aerosol Sampling Protocol using Passive Air Sampler (PAS) and Scanning Electron Microscopy (SEM)

Jurate Virkutyte (PI) and Sergey Grinshpun
University of Cincinnati, Environmental Health

The state-of-the-art for personal sampling devices for aerosol particles is constrained by issues of personal sampler cost and complexity of operation. These issues have limited the adoption and use of some samplers by professionals in the field. Aerosol exposure assessment is important for the overall assessment of health risks to various work populations, including health care workers (HCW). Inhalation or skin contact with aerosols generated during drug administration, cleaning procedures in health care environments have been linked to a variety of health effects. While studies have been conducted to address exposure of HCWs to airborne particulate hazards, there is a need for developing a reliable sampling protocol, which would adequately account for the environmental factors and the workplace specifics of health care settings. To address limitations of current approaches, a new protocol utilizing the scanning electron microscopy (SEM) and the passive air sampler (PAS) has been developed in the proposed pilot study. The new protocol leading to a development of a new passive sampler is designed to be more cost effective and user-friendly than currently available approaches. A sampling setup included an SEM stub with Formvar sticky carbon for passive sampling of aerosol particles. Samplers were placed in one of the bathrooms of a residential home to mimic real-world conditions. Saline, one of the most widely used solutions in the health care settings has been aerosolized and collected by the PAC after 1 to 12 hours and 1 week of exposure. The samples were analyzed by environmental SEM under low-vac conditions for the particle distribution, their size and shape. SEM images were obtained manually, particles were identified subjectively, and binary images were created. An image analysis program (ImageJ) was used to count and size the identified particles. To confirm that the sampling protocol is adequate, the control samples with 0.1 M NaCl concentrations dispersed on the stubs were analyzed on environmental SEM for particle distribution, size and shape and compared to the aerosolized sample.

Distance from the source to the sample collector was 10 cm and 100 cm to imitate real world scenario for nurses and aids who administer aerosols to patients. Humidity was kept at 45% and 80% to determine the effect of moisture on aerosol particle distribution. For particle size distribution and frequencies, 150 to 4500 particles for each sample of saline particles were analyzed from electron micrographs for each experimental condition. Results from SEM analysis indicate that the particle retention on sticky carbon and SEM stub developed in this research is applicable to the analysis of the collected saline aerosol particles. There was no significant difference in particle shape and sizes with distances from the source, however, particles were more aggregated, when the humidity was 80% due to deliquescence humidity (above 75%) of sodium chlorine. In conclusion, this pilot research demonstrated the combined power of SEM particle analysis with low-cost passive sampling to assess spatial distribution of aerosolized particles at two distances from the source and two humidity conditions. Information gained from this type of sampling approach could be used to improve estimates of exposure to particles within a hospital and/or home healthcare setting with heterogeneous compositions of aerosolized particles, particularly in exposure-health outcome studies. It may also be valuable in attributing observed concentrations to specific sources. Sticky carbon and SEM analytical approach along with ImageJ software guaranteed the accuracy of the measurement. However, speedy calculations and faster acquisition of results from more samples could be improved using automated SEM analysis. Unfortunately, this study had several limitations. Results were limited to one week in one season and may not represent particle concentrations more generally. Additionally, no federal reference method (FRM) samples were available in this study for validation of passive sampler results.

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Lightweight, Wearable Energy Storage Devices for Firefighters and First Responders

Paa Kwasi Adusei (PI) and Vesselin Shanov
University of Cincinnati, Mechanical and Materials Engineering

Flexible and wearable electronic devices are of high academic and industrial interest. In order to power these devices, there is a need for compatible energy storage units that can exhibit similar mechanical flexibility. Fiber-based devices have thus become increasingly popular since their light-weight, and flexible structure can be easily integrated into textiles. Supercapacitors have garnered a lot of attention due to their excellent cycling durability, fast charge times and superior power density. The primary challenge, however, with electric double layer capacitors (EDLCs), which are part of the supercapacitor family, is that their energy densities are significantly lower compared to those of batteries. Pseudocapacitors, on the other hand, can be designed and created with large energy densities and other outstanding properties typical for supercapacitors. In this work, we fabricate and test supercapacitors based on Carbon Nanotube Fibers, Oxygen Plasma Functionalized Carbon Nanotube fibers and Carbon Nanotube-Polyaniline (PANI) composite fibers. These flexible and light-weight devices are assembled using different electrolytes for comparison. The PANI-CNT composite devices attained an energy density of 6.16 Wh/kg at a power density of 630 W/kg and retained a capacitance of 88 % over 1000 charge-discharge cycles whilst the OPFCNT devices attained up to 10.81 Wh/kg.

Impact Statement: This project will break new ground in the studies related to development of improved, multi-functional energy storage devices which will be used by firefighters and other first responders. It is environmentally safer, flexible and lightweight.

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Fabric Integrated Gas Sensors for First Responders and Miners

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With the continued reliance on coal as a fuel and the prevalence of plastics in household items, there is an increased need for first responders and miners to be equipped with highly accurate gas sensing devices. These have primarily been heavy metal-based devices rendering them non-wearable and a hindrance during quick motions. Carbon nanotubes (CNT) render themselves as a highly conductive substrate that can act as chem resistors for selective gasses. A novel deposition method was devised for the continuous deposition of “active materials” onto the CNT sheets that produced highly uniform composites. Palladium-CNT sheets were taken as a proof of concept and the composite showed high sensitivity to hydrogen, going as low as 10 SCCM Hydrogen flow. The sheet also showed a unique property of fast cyclability without the need of degassing the hydrogen, instantly shifting its resistance once the gas flow was altered. The composite sheet maintained its flexibility and could be very easily integrated into fabric as a wearable device.

Impact statement: This project will pave way for a scalable process to realize the use of CNTs as highly adaptable and sensitive gas sensors. This will progress the development of the new generation wearable, multi functional personal protective equipment (PPE) for the well being of first responders and other employees exposed to potential flammable & toxic fumes such as miners.

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Flame Resistant Nanofabric to Protect Firefighters Against Heat and Toxins

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Purpose: Firefighter's are developing cancer [1] possibly due to exposure to carcinogens contained in airborne fibers and toxic smoke [2], which could settle and contaminate personal protective equipment (PPE) [3]. In this research project, we are adding a filtering layer of fabric to existing flame-resistant materials. The new fabric is made of carbon hybrid nanomaterial to protect the wearer from abrasion, resist flame, and absorb toxins that can cause cancer.

Design: The manufacturing process for the garment was to: 1) synthesize the nanofabric sheet with select nanoparticles or micron carbon particles; 2) characterize the sheet (for quality of design of the garment system).

Methods: The nanofabric was produced at the University of Cincinnati (UC) Nanoworld Labs via gas phase pyrolysis. At high temperature, a fuel source comprised of an iron catalyst and hydrocarbons, is carried by gas through a reactor tube. The synthesis process generates an aerogel-like sock that is wrapped on a drum forming a sheet of nanofabric.

Results: The nanofabric manufactured is high quality (Raman G/D~100) and fire-resistant (decomposition T>700°C).

Conclusion: We successfully synthesized hybrid nanofabric which lasted longer in a flame test than most traditional flame-resistant firefighter apparel materials (e.g. Kevlar, Nomex).

Impact statement: The nanofabric is a newly hybridized material that integrates carbon nanotubes with nano-particles or micro-particles (e.g. granular activated carbon for filtering chemicals), which will add functionality to firefighter apparel.

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2018-19 PRP Awardee Poster Abstracts

Effect of Heat Stress on Immune Function in Firefighters

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Firefighters are a recognized higher occupational risk group for several health disorders such as neurological (cognitive and motor), cancers, cardiovascular problems, respiratory disorders, diabetes etc. Firefighters are regularly exposed to heat as well as stressful work environment. Heat stress has the potential to alter the immune function. In this investigation, we hypothesize that fire-associated heat exposure and stress may cause immune perturbations in firefighters which may interact with other prevailing physiological stress factors thereby increasing the risk for occupational diseases. We propose to compare the immune profiles of firefighters from their peripheral blood and serum samples using cellular and molecular analysis and identify the immune constituents associated with occupational heat stress. We will further correlate the immunological changes with the quantitative heat stress data in terms of induction of neuropeptide Orexin A and other metadata collected using a study questionnaire. Completion of the study is expected to identify heat stress-associated specific immune constituents and changes in the firefighters. This will open up the ways to provide insights into role of immune perturbations in predisposing firefighters to neurological and other occupational health risks.

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Neuromotor Effects of Manganese Exposure in Adolescents Entering the Workforce

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Manganese (Mn) is a potentially neurotoxic metal of increasing concern to communities located near industrial point sources. In excess, Mn preferentially aggregates in the basal ganglia, the main center of motor function. The negative effects of Mn on neuromotor function have been reported consistently, however the undue burden of adolescent environmental exposure needs further investigation. Adolescence is a critical time of development, as many begin to enter the labor force for the first time and health effects from prior exposures begin to manifest more significantly. Marietta, Ohio is home to the largest ferromanganese refinery in America, making it a model community to study exposure. In this study, we leverage our existing Communities Actively Researching Exposure Study (CARES) cohort to investigate the role of ambient Mn exposure on adolescent neuromotor function, and what role this may play in an occupational setting. Given the dual role of Mn, we hypothesize that biomarkers of Mn exposure will exhibit a negative association with motor function in a cohort of rural Appalachian teenagers. Our hypothesis will be tested by these specific aims: Specific Aim 1. Determine the extent of exposure to Mn in a cohort of adolescents as measured by internal dose biomarkers of manganese exposure in hair and blood. Specific Aim 2. Evaluate the effect of Mn exposure on adolescent neuromotor function as measured by postural balance and gait.

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Exposure to Traffic-Related Air Pollution, Home Dust, and the Respiratory Mycobiome

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It is well understood that exposure to traffic-related air pollution (TRAP) in children is associated with incident asthma and exacerbation of existing asthma. A major component of urban PM is carbon nanoparticles, which can agglomerate, be retained by the lung tissue upon inhalation, induce pulmonary oxidative stress, and stimulate proinflammatory cytokine release from airway cells. Another study demonstrated that urban PM increases the adhesion of bacteria to human airway epithelial cells and that PM-stimulated adhesion is mediated by oxidative stress and the receptor for platelet-activating factors. Therefore, it is possible that chronic exposure to TRAP could increase the adhesion of microorganisms to the respiratory tract, altering the microbiome of the respiratory tract over time. There is also potential for significant microbial exposure from the indoor environment. This study aims to characterize the lower respiratory tract and home dust fungal microbiome (mycobiome), to determine the association between exposure to TRAP and the mycobiome of the lower respiratory tract, and to compare the taxa and diversity indices of the home dust mycobiome to those of the lower respiratory mycobiome.

We hypothesize that exposure to TRAP significantly alters the diversity of fungal communities in the lower respiratory tract, and that there is an overlap of taxa present in the lower respiratory tract and the home dust fungal communities. This study will be done in conjunction with an ongoing R21 study. Subjects were recruited from the Cincinnati Childhood Allergy and Air Pollution study (CCAAPS) cohort from two a priori TRAP exposure categories, high and low exposure. Sputum, saliva, and home dust were collected from each participant, and for the proposed study, the extracted DNA will be characterized using Illumina MiSeq for the amplification of the internal transcribed spacer region of fungal ribosomal DNA. Understanding the effect of TRAP exposure on the lower respiratory tract mycobiome and the taxa overlap of that fungal community with the home dust mycobiome could lead to further investigation of health outcomes and interventions.

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Unmanned Aerial Vehicles (UAVs) for Information Gathering during Urban Disaster Situations

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The objective of this research is to develop a system to demonstrate the benefits of an autonomous Unmanned Aerial Vehicle (UAV) as an effective tool to help first responders and emergency personnel in fire situations. Automating the pre-deployment phase will not only accelerate the help for the victims but will also ensure the safety for first responders. During this research, we aim to accelerate localization of victims and predicting their initial health status along with providing situational awareness of the affected area by using multiple UAVs. This is achieved by utilizing visual and thermal cameras on UAVs and processing the video feed using Convolutional Neural Network, which is a deep learning technique. Based on the location and health assessment information, the emergency crew should be able to provide an efficient and safe path for first responders crew to reach to victims with critical health situations. We propose to formulate this problem in a framework of a Traveling Salesman Problem with Time Windows (TSPTW) using Mixed Integer Linear Programming (MILP) solver. The results of this project would enhance the search mission and optimize rescuing victims in the fire-affected areas. This research advances the state of art via developing novel localization methods enabling UAV operation in indoor and GPS-denied environments. Additionally, the use of deep learning methods, which have found recent success in facial recognition, for identifying the health of victims is quite novel and will result into unique capabilities for the UAV which will find applications in other fields such as infrastructure assessment using UAVs.

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Development of a Sensor Frame Based Gait Assessment Device for Occupational Health in Nursing

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There are a high number of work related injuries within the nursing field related to lifting patients and walking. We present a novel approach to movement classification for injury prevention through applying deep learning to gait analysis with a goal of developing a system trained to detect safe and unsafe walking patterns in order to help reduce the possibility of injury. This will be accomplished by developing a sensor frame that can record the gait data of the user, which will be pre-processed with a Kalman Filter, and then be used to train a deep neural network with supervised learning. Once the training is complete, the neural network will be used continuously with the sensor frame, resulting in a system that can notify the user which movements are putting them at risk.

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Gender Differences in Nursing Job Demands and Resources

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Nurses balance the health and safety of multiple patients every day at work, relying on their own abilities, coworkers, and resources provided by the organization to consistently perform well in a demanding environment. While the stereotypical image of a nurse is female, a growing male presence in the field of nursing may shift norms and expectations for nurses, with male and female nurses experiencing different challenges as well as discrepancies in resources provided to them.

Demands including physical workload, time pressure, work environment, and incivility from coworkers or supervisors may ultimately lead to stress, burnout, and exhaustion for these nurses (Demerouti et al.1 2001). With effects on patient care quality, patient safety, nurse safety, and injury frequency, burnout and exhaustion must be understood and minimized (Nahrgang et al., 2011). Job resources provided by the organization, supervisors, and coworkers have been shown to buffer the detrimental effects of job demands (Demerouti et al., 2001). These resources vary from additional autonomy to social support and positive supervisor relationships. In assessing the differential impact of varying job demands on male and female nurses, this research seeks to determine areas for improvement and intervention for more equitable, safe, and efficient work. Furthermore, this research will indicate areas in which male and female nurses are being provided different quality, variety, and quantity of organizational and social resources, thus pointing to areas in which organizations should work to provide greater resources and equitable treatment. The ultimate goal of assessing these demands and resources is to create a more egalitarian environment in the field of nursing, with both male and female nurses being provided appropriate support in order to preserve patient care, nurse safety, and retention of trained professionals in a field with an increasingly severe shortage (Snavely, 2016).

By providing a survey assessing each of these components, this research can begin to piece together the complex issues facing male and female nurses, helping nurses and organizations alike.

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Educational Intervention to Mitigate the Effects of Bullying in the Student Nurse Population

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The aim of the proposed pilot study is to measure the effectiveness of the educational program in increasing the participants' knowledge of bullying in the nursing profession and measure the participants' ability to administer safe patient care when exposed to bullying behavior. Bullying is pervasive in healthcare and unfortunately nurses are often the perpetrators as well as targets of this type of behavior. The American Nurses Association defines bullying as recurrent, unsolicited harmful actions that are intended to demean, and cause distress in the targeted individual. As many as 89% of student nurses in one study experienced at least one incident of bullying behavior. These actions pose a danger to the targeted individuals as well as a threat to patient safety. The proposed educational intervention will: discuss what bullying behaviors in the clinical setting look like, provide instruction and methods of how to manage bullying in the clinical setting and provide participants an opportunity to try these methods. A simulation event will be used to test the effectiveness of the educational intervention to help students to mitigate bullying while performing a routine nursing task.

The proposed study will use an exploratory randomized controlled trial using three groups. A convenience sample of 45 participants will be recruited from matriculated junior and senior-level undergraduate and accelerated nursing students using convenience sampling. Students will be randomly assigned to one of 3 groups. The first group will serve as a control group. Participants in the control group will participate in a simulation where they are asked to perform the task of administering medications safely integrating the six plus one rights of medication administration while various non-bullying distractions occur. The second group will serve as the non-intervention group. Participants in the non-intervention group will be asked to perform the same task of medication administration utilizing the rights of medication administration and the scenario will introduce bullying behaviors as the key distraction. The third group will serve as the intervention group. Participants in the intervention group will attend a 60-minute education session regarding methods to mitigate and lessen the effects of bullying behaviors one-week prior to participating in the simulation. The simulation containing bullying as the distraction will be provided to the intervention group. Outcomes measured will include bullying knowledge and safe administration of medication. Differences between pre- and post-bullying knowledge survey scores of intervention group participants only will be analyzed using Wilcoxon signed-rank test. Differences in safe administration of medication among all three groups will be analyzed using Mann-Whitney-U test. Results of the study will be used as pilot data for a larger randomized controlled trial.

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Fragility Analysis of Steel Buildings in Fire

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Building collapse due to fire can lead to significant loss of life for the occupants of the building and the first responders. After the World Trade Center buildings collapsed due to impact and fire, the structural engineering community focused research efforts on understanding and minimizing structural damage due to fire. Performance-based fire analysis is a procedure that emerged after 9/11, which allows the engineer to simulate and evaluate the extent of potential damage to the structure. In particular, incremental fire analysis (IFA) is a specific type of analysis which studies a range of fires at different intensities. These fires are incrementally scaled by an intensity measure (IM) to capture a range of potential hazard intensities, acknowledging that temperatures and durations of fires can vary greatly.

The overarching goal of this study is to provide recommendations and guidance on IFA that can be implemented in the design industry to understand overall building behavior to fire. To date, most IFA studies have been conducted at the member-level only. By better understanding building behavior, structural damage can be reduced, thereby increasing safety of the occupants and first responders. This work fits well into the objectives of NORA's Public Safety sector and, more specifically, the Fire Service subsector. Three case-study buildings will be modeled and analyzed in a parametric study using finite element method modeling in order to determine an effective IM factor that can be used to scale fires. This project will provide a necessary stepping stone to link research findings and procedures in fire to building analysis and application within the design industry. Through this link, occupant and first responder life safety can be improved.

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Predicting Changes in Driving Safety Performance on an Individualized Level Under Naturalistic Driving Conditions

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Despite marked improvements in the rate and severity of traffic incidents in recent years, trucking safety remains a leading public concern with significant impacts. Each year there are approximately 400,000 truck incidents that result in ~4000 lives lost and over $20 billion in costs. Improving trucking safety requires an understanding of the contributing factors to crash occurrence. These include: (a) weather conditions; (b) traffic flows; (c) highway characteristics; (d) individual truck drivers; (e) other commuters on the road; etc. While the effects of these factors have been examined independently, it remains unclear how these different risk factors interact to contribute to trucking crashes, limiting the utility and subsequent adoption of current risk assessment/mitigation techniques. To address these gaps, this project will investigate the aggregate effect of these factors (using disparate but publically available datasets). Using insights from the crash datasets, our goal is to provide a real-time “crash risk score" for the entire U.S. highway network based on existing driving conditions. **To achieve this goal, two specific aims are proposed**. In Aim 1, we identify a subset of predictors/interactions that contribute to crash risk using a “variable selection” methodology. The identification of important predictors allow us to group the segments of the highway system using a largescale clustering approach. Segments in the same cluster have similar hazards, and thus, we can compute the crash probability per cluster instead of per segment. In Aim 2, a dynamic crash risk prediction (DCRP) model will be developed based on combining information captured from the Federal Motor Carrier Safety Administration (FMCSA) crash dataset with that extracted from online platforms (e.g., Google Weather/ Maps and HERE). The DCRP will account for both crash likelihood and severity, and will be computed on the cluster level to avoid over-fitting of the model. **To translate our research-to-practice (r2p), we will develop web-based and desktop applications (apps) which will allow practitioners to**: (a) quantify crash risk for their potential trips based on current driving conditions; and (b) mitigate risk by selecting “safer" routes while meeting their delivery requirements.

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Invited Poster Presentation Abstracts

Development of a Risk Prioritization Framework to Evaluate Consumer Cleaning Product Chemical Ingredients

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Introduction: Use of cleaning product chemicals has been associated with occupational asthma in hospital workers. Home healthcare workers perform similar tasks but in residential environments, which have lower ventilation rates than hospitals and long-term care facilities. With a wide range of products available for use, it is difficult to prioritize which chemical ingredients pose the greatest risk to users. The American Industrial Hygiene Association (AIHA) developed Exposure Control Categories to rank exposures, but we used it to prioritize ingredient risk under the same set of worst-case conditions.

Objective: To prioritize cleaning product chemical ingredient risk by comparing hazard ratios (HRs) for volatile ingredients under the same set of realistic, worst-case conditions.

Methods: Consumer cleaning product sprays currently available in stores were inventoried, and safety data sheets (SDSs) were collected for ingredient information. For each volatile ingredient with an occupational exposure limit, the highest ingredient concentration was used to calculate a predicted air concentration (PAC) based on 95th percentile usage information, a 10 m3 room volume, and no ventilation. The PAC was then divided by the occupational exposure limit (OEL) to calculate the HR. The resulting HRs were then ranked by the AIHA Exposure Control Categories.

Results: Of the 108 cleaning product sprays found, about 20% did not have SDSs available, about 20% had no chemicals listed on the SDS, and the remaining products had HRs calculated for comparison. Using this framework, cleaning product ingredients produced HRs ranging from Category 0 (less than 1% of OEL) to Category 4 (over 100% of OEL). High HRs were usually due to the ingredient having a relatively low OEL, with the exception of one ingredient which was present in high concentrations.

Conclusion: This risk prioritization project has ranked volatile cleaning chemical ingredients by HR, identifying chemicals with the greatest potential risk and warranting further focus in future exposure assessment studies.

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Healthcare Workers In the Home Environment: What are the Hazards? Developing an Observation Tool

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Home healthcare workers (HHCWs) are among the fastest growing industries and have an unpredictable work environment with multiple hazards such as environmental respiratory, chemical, ergonomic, biological, and violence exposures. The need for more home healthcare workers has increased due to more complex patient care being delivered in the home as a result of improvements in technology and medical advancements. A comprehensive integrative review of the literature was conducted. The findings reflect that study designs for this occupational group are primarily limited to self-reports (e.g., surveys, focus groups, interviews). Future research needs to focus on using quantitative data to provide objective data of HHCWs exposures detailing the occupational environment. Based on this need, an observation tool has been developed to document the occupational hazards HHCWs are encountering in the home care environment. The components of the tool will address environmental hazards within the unpredictable work place including musculoskeletal hazards, biological exposures, sharps, chemical exposure, and violence.

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