2020 Pilot Research Project (PRP) Symposium
University of Cincinnati NIOSH Education and Research Center
October 1-2, 2020
Whova Virtual Event

Contents

About the ERC and PRP

Welcome to the University of Cincinnati Education and Research Center's (ERC) **21st Annual Pilot Research Project (PRP) Symposium** on October 1-2, 2020 held virtually using the Whova event app. 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 2019-20 awardees will be presenting the results of their research and the 2020-21 awardees will make poster presentations of their proposed work. The keynote speaker on Thursday, October 1, 2020 is **Dr. Claire Caruso, Research Health Scientist, National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention on "Importance of Sleep Health and Workplace Strategies to Promote It."**

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 $1.5 million to support 256 pilot research projects. These projects have served as a catalyst in bringing over $42 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 64 new investigators from other fields of expertise to the area of occupational safety and health research.

Thursday, October 1, 2020

10:00am	**ABIH Ethics Training**	Glenn Talaska, PhD, CIH
11:00am	**Welcoming Remarks and Introductions**	Amit Bhattacharya, PhD, CPE, PRP Program Director *University of Cincinnati, Environmental Health*
11:05am	**Introduction of Education and Research Center**	Tiina Reponen, PhD, CIAQP, ERC Director *University of Cincinnati, Environmental Health*
11:10am	**Lead-Free X-Ray Shielding Personal Protection Equipment for Healthcare Workers**	Devika Chauhan *University of Cincinnati, Mechanical and Materials Engineering*
11:30am	**IoT based AI Application for Posture Recognition to Reduce Workplace Injuries**	Aditya Milind Deshpande *University of Cincinnati, Mechanical and Materials Engineering*
11:50am	**Dual-Functionality Heatable Carbon Nanotube Air Filters for Healthcare Workers**	Yanbo Fang *University of Cincinnati, Mechanical and Materials Engineering*
12:10pm	**Break**	
12:55pm	**Introduction of Keynote Speaker**	Amit Bhattacharya, PhD, CPE, PRP Program Director *University of Cincinnati, Environmental Health*
1:00pm	**Importance of Sleep Health and Workplace Strategies to Promote It**	Claire Caruso, PhD, RN, FAAN *Research Health Scientist, National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention*
1:45pm	**Designing Next-Generation Solid Electrolyte via a Multiscale Computational Scheme to Avoid Workplace Battery Hazard**	Mengze Ma on behalf of Yao Fu *University of Cincinnati, Aerospace Engineering and Engineering Mechanics*
2:05pm	**Heavy metal sensor for low wage workers based on 3D graphene**	Mahnoosh Khosravifar *University of Cincinnati, Mechanical and Materials Engineering*
2:25pm	**Assessing volunteer workers' exposure to dust, metals and bioaerosol during equine assisted activities/therapies: an exploratory study**	Kimberly Tumlin *University of Kentucky, Preventive Medicine and Environmental Health*
2:45pm	**Break**	
3:30pm	**Yoga Leela - Background and poses to benefit spine and joints**	Roy Nandyal, PhD *Founder, Yoga Leela, LLC*

Friday, October 2, 2020

8:00am	**Welcoming Remarks and Introductions**	Gordon Gillespie, PhD, DNP, RN, PRP Deputy Director *University of Cincinnati, Nursing*
8:10am	**Characterizing Fine and Ultrafine Particle Exposure Among Home Healthcare Workers**	Ashley Turner *University of Cincinnati, Environmental and Public Health Sciences*
8:30am	**Neurotoxicity of Polyfluoroalkyl Substance (PFAS) Mixtures in Firefighting Materials**	Ola Wasel *Purdue University, School of Health Sciences*
8:50am	**Role of firefighting-associated chronic stress factors in immune dysfunction**	Jagjit Yadav, PhD *University of Cincinnati, Environmental and Public Health Sciences*
9:10am	**Poster Session**	Devika Chauhan, Oyindamola Omotuyi, Kavitha Joseph, Magha Chitranshi, Yao Addor, Vishal Nathu *Poster presenter details on next page*
10:10am	**Voting session**	Attendees vote for favorite poster and podium presenters
10:20am	**Break**	
10:35am	**Panel Discussion of the Podium Presentation Topics** Moderator: Gordon Gillespie, PhD, DNP, RN	Amit Bhattacharya, Lynne Haber, Beverly Hittle, Jay Kim *University of Cincinnati*
11:15am	**BEST Award Presentations**	Jae Hong Park, PhD *Purdue University*
11:30am	**Closing Remarks and Program Evaluation**	

2020-21 PRP Awardee Posters & Invited Posters

Poster Session

Title	Presenter	Program
Home healthcare workers' exposure to bacterial and fungal bioaerosols	Yao Addor	*University of Cincinnati* *Environmental and Public Health Sciences*
A Novel Wearable Carbon-Based Material to Shield Aircrews from Cosmic Radiation	Devika Chauhan	*University of Cincinnati* *Mechanical and Materials Engineering*
CNT Hybrid Fabric Facemask to Filter and Deactivate Virus	Megha Chitranshi	*University of Cincinnati* *Electrical Engineering and Computing*
Flexible and low-voltage Carbon Nano Tube heaters to combat cold weather -- For fire fighters and first responders	Kavitha Joseph	*University of Cincinnati* *Mechanical and Materials Engineering*
Real-Time Automated Vehicle Crash Detection and Reporting System	Oyindamola Omotuyi	*University of Cincinnati* *Mechanical and Materials Engineering*
Evaluating Exposure to Biological Aerosols in Home Healthcare using a Real-Time Fluorescence-Based Direct-Reading Instrument	Vishal Nathu	*Targeted Research Training Program* *University of Cincinnati* *Environmental and Public Health Sciences*

Important Links

Whova app instructions

- App includes speaker bios, agenda, abstracts, locations/maps, and all other event information
- If you registered ahead of time, use the email you registered with to access the event in the Whova app
- If you did not register in advance you can download the app in your app store or visit the desktop version and use the code **"aprcm"** to access the event
  - Mobile app link
  - Desktop link
- Review the attendee event guide here or watch a brief video to learn all the features of the PRP Symposium event app

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Continuing Education

Attendees are eligible for the continuing education options below, certificates will be emailed after the event after you complete the event registration.

- ABIH (IH) CM hours, www.abih.org
- Meets BCSP criteria for professional development conference CSP recertification points, www.bcsp.org
- ABIH ethics training points claimable for participating in 1 hour ethics session on 10/1/20 at 10am
- Application has been submitted for continuing education contact hours for nurses. Please contact Gordon Gillespie at 513.558.5236 to obtain information regarding approval status.

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CERKL

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2019-20 PRP Awardee Podium Abstracts

Lead-Free X-Ray Shielding Personal Protection Equipment for Healthcare Workers

Devika Chauhan
University of Cincinnati, Mechanical and Materials Engineering

Currently, the most effective radiation shielding available to the radiography healthcare worker is the pure lead-based personal protective equipment (PPE). Lead is toxic and an environmental hazard source. Moreover, pure lead-based PPE is cumbersome, causing fatigue and injuries associated with wearing bulky PPE by healthcare workers. This research aims to an innovative, lead-free lightweight solution to limit occupational radiation exposure of radiography healthcare workers. Here, we explore the novel application of carbon nanotubes (CNT)-metal (such as tin, bismuth) hybrid fabric towards lightweight, lead-free x-ray radiation shielding PPE for healthcare workers. Carbon nanotubes render themselves as a lightweight matrix with large surface area to embed non-lead high atomic number metals. The x-ray shielding effectiveness of the CNT-metal hybrid material is compared with lead shields and heavyweight lead-free polymer-based shields available commercially. The metal embedded CNT hybrid material is flexible enough to be integrated into the fabric.

IoT based AI Application for Posture Recognition to Reduce Workplace Injuries

Aditya Milind Deshpande (PI), Manish Kumar
University of Cincinnati, Mechanical and Materials Engineering

Lifting heavy items is one of the leading causes of injury in the workplace. U.S. Bureau of Labor Statistics reported that over 36 percent of injuries involving missed workdays were the result of shoulder and back injuries in 2001 [1]. As per the U.S. Bureau of Labor Statistics 2017, the cases of workers taking a day away from work involving overexertion in lifting or lowering rose to a total of 97,990 [2]. These injuries can be short term pains due to accidental events such as workers getting struck by objects or equipment fell. But most of these injuries are due to work with overexertion during manual heavy object transportations. Ignoring weightlifting pain can result in additional inflammation and trauma to the tissue in and around the joints. It can also lead to more chronic degenerative issues over time including wear and tear of the joints and cartilage, degeneration of the tendons, and early-onset arthritis [3, 4, 5]. Awkward, repetitive, and extreme human postures during work are some of the many causes of these injuries and health problems. In monotonous work conditions, the body of a worker might deviate from the neutral position which can cause injuries. It is of high priority to protect the health and safety of these workers by preventing injuries and allow safe and comfortable working conditions. This can be accomplished by ensuring that worker safety and health are addressed systemically during the working hours in the factory by monitoring the body postures and suggesting appropriate corrective steps for incorrect postures during work.

[1] U.S. Bureau of Labor Statistics. Materials Handling: Heavy Lifting. https://www.osha.gov/SLTC/etools/electricalcontractors/materials/heavy.html. Accessed August 19, 2020.
[2] U.S. Bureau of Labor Statistics, 2018. Employer-reported workplace injuries and illnesses – 2017. https://www.bls.gov/news.release/osh.nr0.htm. Accessed August 19, 2020.
[3] Johanning, E., 2000. Evaluation and management of occupational low back disorders. American journal of industrial medicine, 37(1), pp.94-111.
[4] Felson, D.T., 1994. Do occupation-related physical factors contribute to arthritis?. Bailliere's clinical rheumatology, 8(1), pp.63-77.

[5] Chaffin, D.B., 2007. Human motion simulation for vehicle and workplace design. Human Factors and Ergonomics in Manufacturing & Service Industries, 17(5), pp.475-484.

Dual-Functionality Heatable Carbon Nanotube Air Filters for Healthcare Workers

Yanbo Fang
University of Cincinnati, Mechanical and Materials Engineering

Currently, there is a significant global shortage of Personal Protective Equipment (PPE), particularly face masks, due to the COVID-19 pandemic. Our team designed, fabricated, and tested a heatable carbon nanotube (CNT) air filter incorporated into an N95 respirator, as well as other types of face masks for healthcare workers dealing with pathogens. The scientific challenges in filtration and simultaneous inactivation of airborne pathogens (particularly viruses) on the surface of face masks have been addressed by achieving the following: First, designed and fabricated a breathable CNT heater. Second, integrated the CNT heater into commercial N95 respirators and also into surgical masks, thus converting them to reusable protective equipment. Third, tested the breathability and the effectiveness of the mask to eradicate virus surrogates or other airborne pathogens. The inactivation temperature of 85 °C is easily achievable by the CNT heaters via a low DC power supply of 4.5 V at a current of 0.68 A. Besides, another mode of the mask operation is tested here when the protective equipment is not in use. This includes activating the heater just for 30 seconds which will disinfect the stored mask for reuse.

Designing Next-Generation Solid Electrolyte via a Multiscale Computational Scheme to Avoid Workplace Battery Hazard

Yao Fu
University of Cincinnati, Aerospace Engineering and Engineering Mechanics

Motivated by designing stable and safer solid-state electrolytes to replace flammable liquid electrolytes currently used in Lithium batteries, this project aims to increase the ion conductivity and mechanical properties in solid polymer electrolyte through understanding the ion transport properties of ionic polymers, via a seamless integrated computational framework across nano- to meso- scales. This project will focus on 1) understand the mechanical properties as a function of charge ratio and volume of fractions of diblock copolymers using the coarse-grained molecular dynamic simulation, 2) demonstrate a scale-briding framework for modeling the electromechanical responses of copolymers under the applied electric field. It has been found that the dynamic hysteresis loss and permanent displacement has strong dependence on the fraction of charged block and charge ratio. It is likely that the charged monomers and counterions contribute to the stronger crosslinking effect in charged copolymers, reducing the chain slippage and thus hysteresis loss. Moreover, the multiphysics model based on phase field model for describing the electromechanical responses shows good qualitative consistency as its fine scale counterpart. It is expected that the scientific discovery and modeling framework will contribute to the accelerated design of stable and safer solid-state electrolyte for lithium batteries in general, benefiting workers in most occupations due to the prevalence of lithium batteries in the workplace.

Heavy metal sensor for low wage workers based on 3D graphene

Mahnoosh Khosravifar
University of Cincinnati, Mechanical and Materials Engineering

Due to the harmful effect of heavy metal ions on human body, the importance of fabricating highly sensitive sensors has raised over years. This work focuses on developing and providing highly sensitive sensors based on 3D graphene

structures as a portable device that could be used for low wage workers, especially construction workers, who are potentially in danger of lead exposure in their working environment. In addition, the sensor will find applications in cities and communities where lead is found in drinking water due to old water distribution infrastructure. Herein, a porous nitrogen-doped 3D graphene-based structures with different variations were synthesized for electrochemical detection of Pb2+ using square wave stripping voltammetry (SWSV) technique. Scanning electron microscopy (SEM) and Raman spectroscopy were conducted on the samples and future tests will involve x-ray photon spectroscopy (XPS), cyclic voltammetry (CV), electrical impedance spectroscopy (EIS) and Square Wave Stripping Voltammetry (SWSV). We are aiming towards achieving a nM to pM detection limit for lead, which is going to be a major difference in sensitivity compared to previous studies.

Assessing volunteer workers' exposure to dust, metals and bioaerosol during equine assisted activities/therapies: an exploratory study

Kimberly Tumlin (PI)[1], Sa Liu[2], Jae Park[2], and Erin Haynes[1]

[1]University of Kentucky, College of Public Health; [2]Purdue University, College of Health and Human Services

Purpose: Although volunteerism is valued in practice, there is a dearth of research on volunteer work practices in equine assisted activities/therapies (EAAT) and specifically how personal exposures to air pollutants are potentially influenced by facility design, particulate matter sources, air flow, and climate conditions.

Design: Our hypothesis that volunteers working in arena spaces during EAAT will have higher dust, metals on respirable dust, and bioaerosol exposures than those working in barn microenvironments was evaluated in a three-part study. Parts 1 and 2 were completed and part 3 is in progress. Part 1 was conducted using a single-sample semi-quantitative survey of EAAT programs. A single-sample site visit of working equestrian facilities was conducted to evaluate footing (i.e. arena surface) soil metals concentrations in part 2.

Methods: In part 1, a survey was developed to collect information on environmental, program, volunteer, and horse factors that would contextualize how time spent in two microenvironments would impact volunteer exposure. The voluntary survey was distributed over 5-months in two pushes a) internationally and b) through personal contact with regionally targeted centers. Descriptive analyses and frequencies of work practices were conducted with comparisons made using the Chi-square or Fisher's exact test, as appropriate. Relationships of climate determined by location of the center were evaluated. In part 2, we conducted a field assessment of equestrian facilities in Kentucky and Ohio. Facilities were evaluated for indoor arena size, age, and footing type. The objectives were to a) determine if metals present in the arena footing were in sufficient concentrations to affect health if liberated from the arena surface via respirable dust, and b) evaluate if type of metals varied by type of footing. Data were analyzed using ANOVA or Chi-square analysis to address relationships between age and metals of interest (Mn, Fe, Pb, Sb, or Cd), type of footing, and if self-reported respiratory conditions varied with footing type.

Results: For part 1, mixed-humid climates (where participating Kentucky and Ohio centers are located) offer services year-round, in facilities that have a cover and four walls, and have services comprised predominantly of therapeutic riding activities. Although centers did not report human respiratory conditions, 22% did recognize their volunteers have allergies to horses. Number of volunteers did not vary by climate and annually over 100 volunteers work in each center. 77% of volunteers work up to 5 hours a day, with no relationships to climate. Volunteers in the mixed-humid climate worked more than 2 hrs weekly in the barn area as opposed to other climates. On average, three volunteer horse units

(VHU) are in the arena at one time, and more VHU are reported in cold/very cold climates than other locations. 26% of horses were reported to cough in the arena, although there were no relationships by climate. For part 2, footing type used in the arenas did vary by age, with 100% of samples over 10 yr were comprised of sand, and in the less than 5 yr category 80% were sand/fiber mixtures ($p=0.0015$; $df=4$; $X^2=17.566$). Fe was highest in concentration in sand ($p=0.0002$), Pb highest in rubber ($p=0.0004$), and Mn highest in sand with fiber footing types ($p=0.0172$).
Conclusion: We demonstrated that future exposure studies should focus on volunteer work in the arena environment, particularly in cold/very cold and mixed-humid climates. While work in barn microenvironments is individually completed, on average, three VHU are present in the arena microenvironment per hour represents a higher rate of footfalls and movement that could increase PM and bioaerosol release from surfaces. Volunteer workers in EAAT do not follow traditional work schedules. To calculate time weighted averages, volunteer workdays are not based on an 8-hr day/40-hr work week, rather a 5-hr day/20-hr work week. Metals on respirable PM in equestrian environments have not be assessed as a potential contaminant, and this study confirms that Fe, Pb, and Mn, though present, levels are not likely a risk in healthy volunteers.

Impact: Protecting equestrian workforces are a vital issue in Kentucky and regionally. Characterizing PM exposure differences will lead to development of best-practices in facility design, such as demonstrating dispersion of PM with strategic air flow. Time-activity patterns of horses and humans in the arena will influence personal exposures and this study established baseline relationships of volunteer workers in these spaces and how each activity patterns are impacted by climate. These data are essential for developing variables used in scaling future studies with non-standard volunteer workers.

Characterizing Fine and Ultrafine Particle Exposure Among Home Healthcare Workers

Ashley Turner
University of Cincinnati, Environmental and Public Health Sciences

Demographics within the United States are rapidly shifting towards an aging population, increasing the need for home health care workers (HHC). The hallmark of successful healthcare delivery is dependent upon the health of its workers; however, the health of HHC workers is relatively understudied despite higher than average injury rates among healthcare workers. Serious and life-threatening hazards to HHC workers include exposure to secondhand smoke, sharps injuries, blood-borne pathogens, violence, drug administration, ergonomic risks, and even air quality (Agbonifo 2017, Czuba 2012, Galinsky 2001, Markkanen 2017, Quinn 2009). The daily routine of HHC workers is unique, involving multiple patient home visits (Derrick 1998, Irani 2018). These employees spend a significant amount of time in vehicles driving to patients, increasing their risk of air pollution exposure; however, these risks have not been quantified. Several studies have identified higher exposures to various air pollutants such as nitrogen dioxide, ozone, particle number concentration, black carbon, and fine particulate matter occur during transit times over other microenvironments (home or work) (Carvalho 2018, Koehler 2019). A recent review among commercial drivers revealed several negative health effects were associated with greater air pollution exposure (Lawin 2018).

It has been suggested in toxicology studies that ultrafine particles (UFPs, i.e., particles ≤ 0.1 micrometers (µm) in diameter) are more toxic than larger particles (PM2.5, i.e., particles ≤ 2.5 µm in diameter) and subsequently promote greater health risks (HEI). Their ability to create reactive oxygen species and deposit into the alveolar region of the respiratory system supports these theories, but epidemiological results are conflicting as many lack concurrent measurements to identify UFP-specific outcomes (HEI, Cho 2018, Oberdorster 1990). In addition, a lack of a standard

exposure metric (mass concentration (MC), particle number concentration (PNC), or lung-deposited surface area (LDSA)) creates confusion among results (U.S. EPA 2009). Besides respiratory effects, PM in general has shown considerable evidence for increased cardiovascular morbidity (Kunzli 2005, Laden 2006, Pope 2002, Wellenius 2006). Specifically, studies have shown PM exposure, including UFP's, are associated with a change in cardiac autonomic function including decreased heart rate variability, increased blood pressure and even changes in vascular tone (Breitner 2019, Chan 2004, Cole-Hunter 2018, Dong 2018, Forastiere 2005, Ohlwein 2019, Park 2005, Peters 2015, Samet 2009, Weichenthal 2014). Lower heart rate variability is a marker for increased risk of cardiovascular disease (Cole-Hunter 2018).

Therefore, I propose to address a knowledge gap regarding exposure to PM2.5 and UFPs among HHC providers. To my knowledge, the proposed study will be the first to concurrently measure both PM2.5 and UFPs in HHC workers during daily activities. Using personal PM exposure monitors, we will provide novel time-series measurements and assess concurrent exposures to PM2.5 and UFP in individual participants. In addition, we will characterize UFPs using multiple exposure metrics and compare these to heart rate variability results. Consistent in the literature is the limitation of simultaneous personal exposure monitoring of UFPs and other pollutants. This proposal intends to combat these limitations and reduce measurement errors using real-time, personal air pollution monitors. This will address current research gaps in assessing how UFP exposure patterns differ from PM2.5 by measuring personal doses across multiple microenvironments specific to the individual. My hypothesis is that HHC workers experience an increased risk of UFP exposure due to the amount time spent in their vehicles, and that this exposure pattern is different than PM2.5 exposures and influences cardiovascular functioning.

Neurotoxicity of Polyfluoroalkyl Substance (PFAS) Mixtures in Firefighting Materials

Ola Wasel

Purdue University, School of Health Sciences

Abstract: Perfluoroalkyl substances (PFAS) are synthetic compounds that are composed of a fluorinated carbon chain. Firefighters and first responders are at high risk of being occupationally exposed to PFAS. The concerns of PFAS toxicity led to voluntarily phasing out of perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) by their manufacturer. PFOA and PFOS are both composed of an 8 carbon chain (C8). Shorter chain chemicals were used as a replacement to the longer chain PFAS. **Purpose:** This project aims to study developmental neurotoxicity of GenX, an emerging PFAS that replaced the longer chain compounds due to less overt acute toxicity, but for which there is a lack of information regarding the neurotoxicity. **Design:** An assessment of the developmental toxicity of GenX compared to the legacy PFAS and other shorter chain PFAS using the zebrafish biomedical model was completed. **Methods:** We compared the toxicity of K-PFOS, PFOA, K-PFBS, PFBA, and GenX using zebrafish (Danio rerio). To determine the LC50 of each chemical, zebrafish embryos were exposed to a range of concentrations of each chemical within 1 hour post fertilization (hpf) through 120 hpf. The toxicity of these compounds was assessed by monitoring the survivability every 24 hours through 120 hpf. 120 hpf-LC50 was determined using GraphPad Prism8.0 software. In addition, behavioral analysis using a visual motor response test was performed. For behavioral analysis, we used sublethal concentrations of 0, 4, 40, 400, and 4000 part per billion (ppb). The exposure was terminated at 72 hpf and the test was done at 120 hpf. Results: 120 hpf-LC50s showed that the toxicity ranking is K-PFOS>PFOA>K-PFBS>GenX>PFBA. Behavioral analysis showed that an embryonic exposure to K-PFOS, K-PFBS, GenX, or PFBA resulted in behavioral changes. Surprisingly, PFOA didn't cause any behavioral changes. **Conclusion:** Based on these results, we can conclude that toxicity of PFAS increases with increasing the chain length. Also, presence of a sulfonate group increased toxicity for PFAS of a given chain length. In addition, sublethal effects on behavioral outcomes are observed with exposure to short chain PFAS, indicating that those

compounds are not necessarily a safer replacement for longer chain PFAS. **Impact Statement:** The outcomes of this study showed that sublethal exposure to GenX and other shorter chain PFAS caused changes in behavioral outcomes compared to a lack of change in PFOA. These results highlight that using shorter chain PFAS as a replacement to PFOA and PFOS should be carefully reexamined, specifically supporting the need for further research into the neurotoxicity of these compounds.

Role of firefighting-associated chronic stress factors in immune dysfunction

Jagjit Yadav
University of Cincinnati, Environmental and Public Health Sciences

Purpose: To study the effect of firefighting-associated chronic stress factors on immune function in firefighters.

Design: The overall theme of our study on occupational health of firefighters has been focused on immunological impact of chronic stress factors including sleep deprivation (disruption of sleep/wake cycle), toxic exposure (e.g. to perfluorooctanoic acid/PFOA occurring in firefighting foams), among others in firefighting environments. The study design has focused on both human subjects (firefighters) and animal model. The study involved comparison of low exposure versus high exposure groups (based on their length of firefighting experience) for biomarkers of chronic stress, disrupted circadian rhythm disruption), and immune dysfunction.

Methods: We analyzed sleep/wake cycle disruption by analyzing for biological clock genes, chronic stress based on serum stress biomarkers (HSP, Orexin A) and immune dysfunction based on profiling of immune mediators. The immune biomarkers and biological clock markers were measured by qRT-PCR analysis using gene-specific primers. For validation, selected immune mediators were analyzed in serum using cytokine/chemokine-specific ELISA kits (eBioscience) and experimental findings were statistically analyzed using Graph pad software.

Results: Chronic stress induction in firefighters was indicated by perturbation of HSP70 and Orexin A. Higher exposure to fire-fighting led to changes in immune receptors (e.g. TLR9) and mediators (e.g. TNFa). Perturbation of the sleep/wake cycle which is integral part of shift work in firefighters is expected to lead to sleep deprivation causing disruption of biological clock. This was revealed by the expression levels of the biological clock genes in the low exposure versus the high exposure groups. Of these genes, Cry1 and Cry2 were significantly downregulated whereas the Clock gene was upregulated in the firefighters. The other genes namely Per1, Per2, BMAL1 and NR1D1 showed an upregulating trend in higher exposure group Since this project is extended through the end of 2020 due to COVID-19 shutdown, we are still in the process of investigating sleep/wake cycle and related trends in the mouse model.

Conclusion: In this study we found chronic stress and associated perturbation of immune biomarkers (ligand receptor TLR9 and proinflammatory cytokine TNFa) as well as biological clock genes suggesting a perturbation of immune function and biological clock in firefighters in the backdrop of a chronic stress.

Impact Statement: As the Firefighters experience chronic stress including sleep deprivation and are prone to developing many immunological diseases, it was considered worthwhile to study the biological clock disruption and immune dysfunction in this occupational group. An understanding of impact of chronic stress on immune function will help in devising strategies to mitigate the deleterious effects of chronic stress and sleep deprivation in firefighters and use these

findings as prototype for investigating other similar cohorts like night shift workers and nurses, who usually experience sleep deprivation in their occupational setting.

2020-21 PRP Awardee Poster Abstracts

Home healthcare workers' exposure to bacterial and fungal bioaerosols

Yao Addor

University of Cincinnati, Environmental and Public Health Sciences

Due to the aging population in the United States, the number of people living with morbidity and who need continuous care, is increasing. At the same time, healthcare costs keep soaring to the extent that receiving care in the comfort of one's own home has become the preferred choice for most families. As a consequence, home healthcare (HHC) is booming and one of the fastest growing industry. Unlike other healthcare delivery settings such as hospitals, nursing homes and hospices, HHC is provided in private homes which are not considered workplaces, and consequently are not subject to any occupational standard and/or regulation. Yet, home health care workers (HHCWs) face various challenges including ergonomic issues, psychological, verbal and physical abuses, and exposure to physical, chemical and biological hazards. One of the health concerns in health care professionals is the increase in the prevalence of respiratory symptoms. Airborne microbial particles could be a contributor to the development or exacerbation of respiratory problems including asthma. The viability and sustainability of the HHC industry depend upon maintaining healthy workers to care for the clients/patients. However, studies on HHCWs' exposure to occupational hazards other than ergonomic are scarce. No study has ever investigated the exposure to bioaerosol in this population of workers. Therefore, in this proposed study, we propose to assess HHCWs' occupational exposure to bacteria and fungi using cutting-edge techniques. This study will advance our knowledge of the risk of respiratory health issues among those workers. Ultimately, this project's outcomes will help prevent HHCWs' exposure to bioaerosols, protect HHCWs against potential adverse respiratory health effects, and allow policy makers to establish guidelines, standards and regulations for this industry.

A Novel Wearable Carbon-Based Material to Shield Aircrews from Cosmic Radiation

Devika Chauhan

University of Cincinnati, Mechanical and Materials Engineering

Commercial aircrews are subject to occupational radiation exposure from galactic cosmic radiation (GCR) and the sun. The National Council on Radiation Protection (NCRP) reports that US commercial aircrews receive the highest average annual effective radiation dose among all US radiation workers. Although this dose does not exceed regulatory limits, recommendations have been made to monitor the radiation dose received US aircrews, especially for pregnant aircrews who may exceed the prenatal radiation dose limit to the fetus. Presently, the only method to limit radiation exposure to the fetus is to restrict the work schedule for the pregnant air crew.

We propose to develop a novel wearable lightweight radiation shielding material for aircrews that can be fabricated as an apron or smock and is an excellent alternative to a work restriction for air crew who need to reduce fetal exposure during pregnancy.

The material we propose for shielding uses a carbon nanotube (CNT) boron matrix that incorporates high atomic number (i.e., Z) elements. CNTs are very lightweight, flexible materials having a high surface area. The carbon and boron in the CNT exhibit a functional neutron absorption capacity making them ideal for the shield matrix system. The high surface

area of the CNT-boron matrix will be used to deposit high atomic number metals (Bi, W), which can absorb gamma radiation produced from neutron capture interaction in the CNT-boron matrix. The resulting CNT-boron-metal composite material will be flexible enough to be easily integrated into a fabric for making a smock or apron. Properties of the CNT-boron-metal composite material will be characterized using SEM, TGA, XRD, XPS, and BET at UC. Post fabric integration, tests will be performed at UC to evaluated determine the neutron and gamma shielding properties. The composite fabric will also undergo durability tests using multiple wash and stretch cycles. An ultrafine particle counter will be used to monitor particle release. The success of this research will result in a safe, lightweight wearable shielding material for aircrew members.

CNT Hybrid Fabric Facemask to Filter and Deactivate Virus

Megha Chitranshi
University of Cincinnati, Electrical Engineering and Computing

Carbon nanotube (CNT) hybrid fabric is a multifunctional material with light weight, good strength, excellent electrical and mechanical properties, porosity for filtering, and it also has antimicrobial property. CNT fabric is synthesized in a high temperature gas phase pyrolysis synthesis method. To improve the antimicrobial property of CNT fabric, anti-viral nanoparticles (CuO, Tio2, etc) are injected during synthesis process. The synthesis process can run all day and produce Kg/day material which is enough for approximately 4000 respirator facemasks. This project will examine the CNT hybrid fabric facemask for filtering and deactivating virus.

Flexible and low-voltage Carbon Nano Tube heaters to combat cold weather -- For fire fighters and first responders

Kavitha Joseph
University of Cincinnati, Mechanical and Materials Engineering

This research project proposes to utilize the unique properties of Carbon Nanotubes (CNTs) such as low density, electrical conductivity and strength for designing light, flexible and low-voltage heating material. The goal is to fabricate highly efficient and flexible CNT heated shoe insoles and to integrate them into the boots of the firefighters and first responders, thus helping them to combat cold weather during their missions. Recent years have witnessed extreme cold weather conditions due to climate changes and if unequipped cold weather usually brings a host of health problems such as hypothermia, frostbite and flu to name a few. During cold weather, it is the extremities of the body which experiences poor blood circulation and results in a cold feet. Longer exposure causes poor oxygen supply to the feet and toes may turn bluish out of stress. Hence the heated shoes can be a big comfort to combat the low temperatures especially for the firefighters when they are in an emergency outdoors in the snow saving lives. The project proposes a CNT heated shoe insole which stands out from other currently available similar products in the market in that the employed CNT heater is ultra-light weight, highly flexible and energy efficient with a faster heating rate.

Real-Time Automated Vehicle Crash Detection and Reporting System

Oyindamola Omotuyi
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The signalized intersections are a key component in road transportation system. One of the major causes of traffic congestions is vehicular crashes which can cause a halt in traffic operations at these intersections. About 40% of the reported accidents in the United States are due to intersection-related crashes. More so, broad range of crash configurations results from the varying nature of intersection geometries and the number of vehicles. According to World Health Organization, the number of deaths caused by road traffic crashes is approximately 1.35 million people

around the world each year and between 20 and 50 million people with non-fatal injuries. A faster rescue response has the potential to not only save lives but also result in faster clearing of accidents and lesser congestions. Recent advances in IoT (Internet of Things) devices and associated Artificial Intelligence for fast, accurate data processing provide a unique opportunity to develop efficient system for detecting and reporting crashes at traffic intersections.
Hence, an autonomous system which can detect and report vehicular crashes in the traffic intersection region is proposed. We propose to develop this system based on real-time video analytics using innovative algorithm that combines Convolutional Neural Network (CNN) and kinematic time-series analysis. In particular, the system will include a real-time traffic monitoring video analytics software that uses specifically trained convolutional neural networks for vehicle detection, and allow multi-object tracking and crash detection in the traffic intersection region. The video analytics solution also will detect single or multiple vehicle crashes, including detecting near crashes as well as impact crashes and the ability to differentiate between the two. Hence, this will help in minimizing the response time of the authorities for restoring the traffic operations after vehicular crashes and the obtained information can be utilized for post analysis of the crash. We will test the algorithm with video obtained to characterize the performance in terms of metrics such as True Positives (TP), True Negatives (TN), False Positives (FP) and False Negatives (FN). The testing of the video analytics software will not be limited to one intersection, rather it will be generalized for different locations, different camera angles, and camera zoom levels. Our system will be robust to varying weather conditions and varying structure of accidents based on the different geometries of the intersection.

TRT Poster Abstracts

Evaluating Exposure to Biological Aerosols in Home Healthcare using a Real-Time Fluorescence-Based Direct-Reading Instrument

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Home healthcare workers (HHCWs) are exposed to numerous hazards within the patient's residence. These workers have no control over residential workplace hazards such as safety, chemicals, second-hand smoke, biohazards, and bioaerosols, which are all contingent on a given home and its environmental conditions. This proposed project is aimed at understanding how HHCWs are exposed to bioaerosols and what types of bioaerosols are present within patient homes. The long-term goal is to help address the knowledge gap of HHCWs not aware of their occupational exposures to bioaerosols present in their workplaces. The objective of this project is to study residential bioaerosols exposures to HHCWs by simulating everyday activities in different ventilation (mechanical, natural, or mixed) conditions and applying novel technologies to measure occupational exposures which may pose adverse health risks.

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