

**UNIVERSITY OF CINCINNATI  
EDUCATION AND RESEARCH CENTER**

T42OH8432

**FINAL REPORT**

**July 1, 2016 through June 30, 2021**

Submitted by: Dr. Tiina Reponen, Professor  
Director of the University of Cincinnati Education and Research Center

9/7/2021

## A. PLANNING AND EVALUATION CORE (PE)

ERC DIRECTOR: TIINA REPONEN, PHD  
DEPUTY DIRECTOR: AMIT BHATTACHARYA, PhD, CPE

### A.1. ACCOMPLISHMENTS

#### A.1.1. Major Goals

The major goals of the Planning and Evaluation (PE) core were to assure frequent communication with the individual programs, assure effective functioning within each program, plan, implement and analyze program evaluations, and involve the Program Directors and Deputy Directors as an Executive Committee to determine and implement major policies of the ERC and to convene and be guided by an External Advisory Board (EAB). The goals did not change during the last project period.

The objectives of the Executive Committee were:

1. Coordinate and integrate activities; assure consistency with the mission; e.g., select annual workshop theme.
2. Support Targeted Research Training (TRT) and Pilot Research Program (PRP) for research skill development; e.g., assure participation from each program.
3. Review interdisciplinary projects for innovation and effectiveness; e.g., feedback on Workshop class.
4. Assure r2p; e.g., work with partners to apply results in practice.
5. Review results from evaluations (e.g., review evaluations of interdisciplinary trips, PRP symposia, and Topical workshops); identify problems; develop solutions; review remediation plans; monitor progress.

The key components of the PE core were Comprehensive Evaluation Program, Interdisciplinary Activities, and Developmental Program.

#### A.1.2. Accomplishments under These Goals

The Executive Committee met monthly to assure frequent communication with the individual programs and to assure effective functioning within each program. Many productive informal meetings occurred among faculty to exchange ideas and new information and facilitate student projects. The annual EAB meetings were held on January 4, 2017, January 31, 2018, February 26, 2019, January 2, 2020, and August 17, 2020. EAB members reviewed the status and plans within PE, Outreach, and TRT programs. Examples of the input from the EAB are: Suggestions for partners in the TRT home healthcare initiative, contacts for the TRT app developers, contacts for experts in organizational psychology (both to be used in the TRT program), recommendation to use the newer social media platforms (e.g., TikTok, Snapchat, Instagram), ideas for minority recruitment. Several members attended symposia and special seminars organized by the ERC, including serving as speakers and panel members.

The ERC website (<http://med.uc.edu/eh/centers/erc>) was frequently updated with upcoming events, requests for proposals for the PRP funding period, and, most recently, occupational safety and health (OSH) resources related to COVID-19 for the new NIOSH ERC Industrial Hygiene Webinar Series. The website also maintains health and safety videos, monthly seminar links to other department-wide seminars (environmental health, epidemiology, and biostatistics/bioinformatics) as well as the NIOSH ERC Ergonomics Webinar series (e.g., webinars by Drs. Bhattacharya and Davis; more details in the CE report), and links to all ERC social media pages (CERKL, Twitter, Instagram, YouTube, LinkedIn, and Facebook). The ERC Blog continued to provide a forum for disseminating information on our interdisciplinary activities and upcoming events. It can be viewed at <http://eh.uc.edu/erc/blog/>.

#### **Comprehensive Evaluation Program**

The current grant period began with a detailed review of the NIOSH reviewer comments of 3/2016 regarding the last grant period. Responses to weaknesses (categorized as "negligible or minor") were submitted in April 2016.

A Memorandum of Agreement was entered into with the UC Evaluation Services Center to conduct external evaluation activities (Focus Groups and Surveys) pertaining to alumni, community public health professionals, and employer experiences related to the Cincinnati ERC programs. The focus group activities were held during

year two of the NIOSH grant. A thematic analysis of qualitative data gathered from the three focus group discussions was conducted and reported (2018). The timing of the alumni focus group (early summer) may have been responsible for adjusting the format to be one-on-one interviews. However, many strengths of the UC ERC program were mentioned by all three groups, as well as some areas for continuous improvement (e.g., [1] improve OS&H professionals' ability to report data to upper management in order to add value to the profession; [2] how to work within an ever-changing funding landscape and achieve stable funding). The Community Public Health Professionals lauded the addition of a Master's of Public Health and the structure of the Cincinnati ERC program; employers valued interprofessional focus on training; and alumni felt "well prepared" for the workplace. In addition, the Public Health Professionals expressed the need for continuous improvement in research methods and epidemiology; employers expressed the need for business courses (e.g., ROI); and alumni expressed a need for incidence training and root cause analysis.

The online surveys for alumni and employers were completed and analyzed during the spring semester of the fourth year (2020). Unfortunately, our historically good response rates for the surveys were somewhat hindered due to the outbreak of COVID-19 simultaneous to the request for responses. Nevertheless, "overall, the responses from alumni and employers provided important feedback for the UC ERC program and suggested that the ERC program was instrumental in providing its graduates with the right resources to compete in the job market." During year four, the Evaluation Services Center also performed a synthesis of the focus groups' and survey's findings with a comparison to the survey results for our last grant period.

During the academic year 2016-2017, Dr. Jarrell completed a comprehensive review of all syllabi for ERC courses for compliance with University curriculum requirements. In 2019 the Department of Environmental and Public Health Sciences (DEPHS) graduate studies office issued new syllabus guidelines for the department's courses. Dr. Jarrell also worked with Dr. Davis on the learning objectives for all the EIH ABET-approved courses; the EIH program subsequently received a renewal of the ABET for 2019-2025.

During the spring semester of 2020, Dr. Jarrell reviewed the students' evaluations of all ERC-reported activities (e.g., PRP, RCB, RFS, interdisciplinary trips, and other miscellaneous activities) for any trends that would be helpful in planning and/or implementing student learning activities in the future. Four themes were examined in the analysis of qualitative data (written and verbal comments by students): 1. Interactions with other disciplines (e.g., interdisciplinary activities); 2. New Learning Experienced; 3. Satisfaction with the activity and suggestions for improvement; and 4. Value of the activity (e.g., future usefulness). Analysis of the quantitative and qualitative data revealed corresponding high ratings to positive comments for all activities. [NOTE: It is unfortunate that the outbreak of COVID-19 mandated that some in-person activities (e.g., spring student tour to CDC and the Fifth Annual Regional ERC Symposium) had to be canceled.] Dr. Jarrell, due to changes in the curricula for some of the programs, completed an additional comprehensive review of all ERC course syllabi for compliance with University and departmental curriculum guidelines.

## **Interdisciplinary Activities**

### Trips

Drs. Gillespie and Betcher directed this center-wide activity that involved off-campus trips to sites of OSH relevance. The trips away from campus were selected by a student committee representing the core academic programs with input from the ERC EAB. Each year, 3 to 4 trips were completed. Stories on the trips can be found in the ERC Blog: [ERC Blog \(uc.edu\)](https://ercblog.uc.edu).

### Workshop Class

All students in ERC programs participated in the interdisciplinary Occupational Health, Hygiene and Safety Workshop, working in small groups (3 to 4 students) across the disciplines of the ERC and under the direction of Dr. Davis (Environmental and Industrial Hygiene) with faculty mentors of Drs. Gillespie (Occupational Health Nursing), Freeman (Occupational Medicine Residency), and Huston (Occupational Safety and Health Engineering). The topics for the class were drawn from the ERC research foci. The organization of this two-semester class was changed in 2018 so that students started their projects in the spring semester and finished in the fall semester.

### Annual Symposium

The Students' Research Findings Symposium was scheduled each year to coincide with the completion of the workshop projects. In addition to presentations of the workshop class projects, it included presentations by trainees in the Targeted Research Training program.

### Special Seminars

At the beginning of each school year, ERC hosted "ERC Orientation." In this event, all ERC students and faculty met and welcomed new students. The center-wide activities were described, and students had the opportunity to ask questions related to the ERC. Additionally, ERC sponsored eight invited speakers and ten special seminars.

### NIOSH events on campus

Cincinnati ERC hosted the annual NIOSH Manufacturing Council face-to-face meeting on campus on March 13–14, 2019. The morning session on the first day was open to students and faculty on campus. Cincinnati ERC also hosted the NIOSH Center Directors meeting on campus on August 20–21, 2019. The participation was restricted to 100 people. In both events, the sessions on the first day were open to the students and faculty on campus. During the lunch break, ERC trainees presented posters on their current research.

### Collaboration with Illinois, Kentucky, and Michigan ERCs

We continued participating in regular monthly calls with the University of Michigan and the University of Illinois at Chicago (UIC) ERCs. The University of Kentucky ERC joined the group in fall 2018. The monthly calls were aimed at sharing information and opportunities and planning collaborative activities. One of the main outcomes of these calls is the annual Regional ERC Symposium. The collaborating ERCs decide on the theme and the invited speakers together. The logistic details are taken care of by the main organizing ERC, which rotates annually. UC was the main organizer of the 4<sup>th</sup> Annual Regional ERC Symposium held in Cincinnati on March 22, 2019. The topic was "Occupational Safety and Health in Disaster Response." It included a keynote by Dr. Aubrey K. Miller, Senior Medical Advisor to the Director of National Institute of Environmental Health Sciences, and speakers from NIOSH, US Environmental Protection Agency, Agency of Toxic Substances and Disease Registry, and International Chemical Workers Union. It included an interdisciplinary field trip, including a tour of the Cincinnati Fire Museum and NIOSH Disaster Response Vehicle.

## **Developmental Program**

### Diversity Recruitment

Dr. Virkutyte coordinated the planning and implementation of diversity recruitment until Dr. Davis took over this task in January 2020. During the reporting period, we had 99 students, of which 19 were underrepresented minorities. Our student recruitment activity continued to focus on building relationships and active outreach with selected academic institutions. One strategy we have employed is to host campus events. As a part of the annual Pilot Research Program symposium, we invited students to participate in the OSH Career Workshop, which includes tours of our ERC departments and laboratories (see below). We also sent additional follow-up communications to high-performing regional colleges and universities as well as historically black colleges and universities (HBCUs) within the region. We enhanced our brochures for this purpose. The students updated recruiting materials for recruiting trips and presentations to regional colleges and universities. We have identified additional colleges in the area for follow-up relationship building. Thus, our students (MS and PhD) contacted undergraduate programs that have fed into ours in the past: University of Findlay (safety), Eastern Kentucky University (safety/health sciences), NKU (toxicology and environmental health sciences), Xavier (pre-med), and UC (chemistry and biology). Also, our students cold-called other schools (Miami University, College of Mount St. Joseph, Thomas More College) and scheduled meetings with professors and students during classes. During recruitment meetings/events, our students describe what occupational safety and health is, the steps to become a professional in this field, and different aspects of our program: courses and workload, research project options, ERC activities, collaborations with NIOSH and other government agencies, potential career opportunities after graduation (e.g., high placement rates), and available funding (e.g., stipends and tuition).

Also, social media platforms such as Facebook and Twitter have been utilized in recruiting the best students with diverse backgrounds. We distributed several targeted ads via our Facebook page. Ads contained information about the program in general, curriculum, projects, and funding/stipends.

## Workshop

The OSH Careers Workshop (led by Dr. Davis) was offered annually as part of the Pilot Research Project Symposium. The aim of the workshop is to provide information about careers in occupational health and safety. All 12 schools that are part of the PRP are invited to attend a half-day session about graduate education at the UC ERC. Sixty-three students from ten different universities have participated in the workshop since 2016. The average score for all four years on a participant survey was 4.3 on a scale of 1 (not at all useful) to 5 (very useful), with the vast majority of respondents indicating they had a positive impression of the workshop. Tours are conducted in the respiratory protection and exposure chamber, biomechanics lab, aerosol/bioaerosols lab, ergonomics lab, college of engineering, and gait laboratory.

## New Initiatives

This program supported two types of new initiatives:

1. Incentives for faculty supporting the preparation of extramural grant applications
2. Funding to students and faculty to obtain specialized training in the use of innovative research tools

We supported nine initiatives in category 1 and eight initiatives in category 2. So far, these have resulted in five extramural grant applications, two extramurally funded special projects, five peer-reviewed papers, and four conference presentations.

### **A.1.3. Opportunities for Training and Professional Development Provided by the Project**

The PRP symposium and the regional ERC symposium, as well as several webinars, were offered as continuing education events to the professionals in the region at no charge. The "New Initiatives" program supported eight specialized training initiatives for ERC students and faculty.

### **A.1.4. Dissemination of the Results to Communities of Interest**

The ERC website and blog are used to inform all students and faculty of upcoming events and opportunities as well as recap all ERC events for external stakeholders. <http://med.uc.edu/eh/centers/erc>

The ERC added a YouTube playlist to the Department of Environmental and Public Health Science's YouTube channel in 2020. The playlist features webinars and instructional videos. It also includes the UC ERC's video as part of the AIHA docuseries "Healthier Workplaces, A Healthier World": [Workplace Safety Through Real-World Impact | Healthier Workplaces, A Healthier World | UC ERC - YouTube](#)

The ERC has CERKL pages for OHN, OSHE, and EIH, as well as a general ERC page. These pages are used to share student work (theses, dissertations), post jobs, inform the public about ERC events and funding opportunities, and share updates with external stakeholders (more detail in the Outreach component).

The ERC Twitter (and Instagram added in 2021) accounts are used to follow other ERCs and various accounts such as NIOSH, EPA, NIH, to stay informed. They are also used to share information from the UC ERC with other ERCs, students, faculty, and external stakeholders.

The ERC added a Facebook page in 2018 to provide an additional method to advertise upcoming events and use the ads feature to boost posts and enhance recruitment for ERC programs and job openings. A LinkedIn group in Industrial Hygiene was formed in spring 2020.

The PRP Symposium and the Regional ERC Symposium were open to the public. Audiences included OSH practitioners in the region and investigators from NIOSH, US EPA, Wright Patterson Air Force Base.

More details on the dissemination are described in the Outreach report.

## **A.2. PRODUCTS**

### **A.2.1. Publications, conference papers, and presentations**

A total of 134 peer-reviewed papers and 8 book chapters were published based on research funded by the UC-ERC; 17 additional manuscripts are in review. The list of publications is in Appendix 1.

### **A.2.2. Website(s) or other Internet site(s)**

Overall ERC web-site: <https://med.uc.edu/eh/centers/erc>

Upcoming events: <https://med.uc.edu/eh/centers/erc/upcoming-events>

ERC Blog: <https://med.uc.edu/eh/centers/erc/blog>

Facebook: <https://www.facebook.com/University-of-Cincinnati-NIOSH-Education-and-Research-Center-489035578232856>

CERKL: <https://app.cerkl.com/org/profile.php?id=98#.X1kn8GhKjIU>

Twitter: [https://twitter.com/uc\\_erc](https://twitter.com/uc_erc)

LinkedIn: <https://www.linkedin.com/groups/13884134/>

YouTube: <https://www.youtube.com/playlist?list=PLrixl9q4GUJJ2yRae84Wfe3zLENx5B7Ot>

Instagram: [https://www.instagram.com/uofcincy\\_erc/](https://www.instagram.com/uofcincy_erc/)

### **A.3. SUMMARY OF ALUMNI/EMPLOYER SURVEY**

In Years 2 and 4, the UC Evaluation Services Center conducted focus groups carried out with alumni, employers, and community public health professionals (Year 2) and online surveys administered to ERC alumni and Occupational Safety and Health employers in the region (Year 4). The latter survey included a needs assessment. In the conclusions, it is stated: "Overall, based on the responses by alumni, employers and other stakeholders, the ERC program was successful in providing foundational knowledge in a variety of courses; offering valuable hands-on experiences for students; providing graduates with valuable interdisciplinary experiences, and preparing graduates for future success through equipping them with transferable technical skills."

A review of the 2015 surveys revealed the most frequent negative remarks in the 2015 survey were: 1. Job placement support; 2. Mentorship; and 3. Need for a stand-alone comprehensive ventilation course. During the 2016-2021 grant period, these comments were addressed by the addition of faculty in the EIH, OHN, OSHE programs, as well as the restructuring of the OMR program to assure positive experiences for the students regarding mentorship and job placement support. A comprehensive ventilation course was developed and added in the EIH program in the spring of 2021. These actions resulted in higher ratings in these three areas.

## B. INDUSTRIAL HYGIENE (EIH)

PROGRAM DIRECTOR: KERMIT DAVIS, PHD, CPE

DEPUTY DIRECTOR: JUN WANG, PhD, CIH

### B.1. ACCOMPLISHMENTS

#### **B.1.1. Major Goals and Accomplishments Under Each Goal**

**1. Provide a high level of education** to Industrial Hygiene (IH) and Occupational Ergonomics (OE) MS and PhD trainees: We currently have 21 students (13 MS and 8 PhD) in the IH and OE programs, of which 8 MS and 6 PhD are directly supported by the ERC. We had 12 MS and 11 PhD trainees graduate between Jul. 1, 2016 and Aug. 23, 2020.

**2. Solve real-world problems:** First-year trainees are required to take the *Identification of Workplace Hazards* course and visit regional companies in the fall and conduct IH and safety assessments in the *Evaluation of Workplace Exposures* course in the spring. The trainees provide recommendations for controls of the identified hazards, many of which the companies implement. OE trainees are required to take the *Introduction to Measurement Techniques in Ergonomics* course, in which they learn about the commonly used ergonomic assessment tools and then complete an ergonomic assessment at a company.

**3. Develop research and teaching skills for PhD:** A total of 21 PhD trainees have or are being trained in our program with 11 graduating in the last 5 years. Currently, 8 PhD trainees are at one of three different stages: 1) in the process of completing or completed qualifying exams (2), 2) collecting data and writing dissertation (3), and 3) taking classes (3). Many of these trainees have taken the *Research Capacity Building Workshop* offered through the Pilot Research Program. Our faculty have a strong mentoring relationship with the PhD trainees, encouraging them to network professionally, publish and present their work, and overall scientific development. Further, all PhD trainees are required to take at least seven credit hours of dissertation research and two credit hours of teaching practicum that help them hone their teaching skills.

**4. Apply the professional code of ethics in all aspects of practice:** All trainees also take the required class *Ethics in Research*. Most trainees completed human subjects training as well as the appropriate human subject review for their thesis and dissertation studies. A few trainees did not complete human subject training as they did not collect human subjects' data. Dr. Davis is instituting additional ethics training in the Health and Safety Workshop course that all trainees must take.

**5. Develop a culture of continuous improvement:** The IH and OE faculty continue to support the CE program. We encourage trainees to make continuous improvement by offering the ability to take CE courses free (5 trainees have taken courses this past year, with several taking more than one). Students are also required to be involved in professional societies at both local and national levels through taking the *Professional Development* course (once a year for all years in the program). Dr. Grinshpun will offer a course called *Ventilation for Safety and Health* in spring, 2021 in response to previous alumni feedback.

**6. Evaluate and continuously improve the program:** We have instituted a comprehensive evaluation and improvement program as part of our ABET accreditation. Some of the most critical evaluations are the following: 1) student evaluation for individual courses (at the end of the semester) by faculty, 2) course evaluations from students (at the end of the semester) with responses recorded by all faculty, 3) Student feedback on the program (once a year) with faculty feedback, and 4) assessment of alumni and employers (once every 5 years which was completed last year) where faculty look for improvements to the curriculum. We recently received a very positive evaluation from ABET and have been recertified for another 6 years (until 2025).

**7. Recruit high quality and diverse trainees:** We have made significant efforts to recruit high quality and diverse trainees. Over the length of the training grant period, we recruited 6 Black, 6 Asian, and 20 female students. We continue to have very strong placement, with 100% of students getting a job prior to graduation, only exception was 2020 (due to COVID-19), where one student took 1 additional month beyond graduation.

#### **PhD Students:**

A total 21 PhD trainees have or are being trained in our program with 11 graduated and 10 PhD students are currently in training:

Agbonifo\*, Noma (Davis (OE), graduated fall 2018) "Inclined Surfaces – Impact on Postural Stability and Spine Loading." Publications: 2, Presentations: 4.

Aljaroudi, Ali (Bhattacharya (OE), graduated fall 2017) "Utilization of active cooling in hot environments while wearing encapsulated protective ensemble." Publications: 2, Presentations: 3.

Addor\*, Yao (Reponen (IH), in training, TRT Trainee) is working on dissertation; topic is assessing home healthcare workers' exposure to bioaerosols. Presentations: 1, Awards: 6.

Ametepe, Isaac (Davis (IH), in training, started fall 2020).

Benjamin\*, Michael (Virkyute (IH), graduated fall 2019, TRT trainee) "Cleaning Product Chemical Exposures Measured in a Simulated Home Healthcare Work." Publications: 3, Presentations: 3, Awards: 4.

Cox\*, Jennie (Reponen (IH), graduated spring 2018) "Evaluation of indoor aerosol and bioaerosol methods and a HEPA intervention." Publications: 3, Presentations: 3, Awards: 3.

Dahm, Matthew (Grinshpun (IH), graduated spring 2019, NIOSH long-term training) "Evaluating and Predicting Occupational Exposures to Carbon Nanotubes and Nanofibers." Publications: 3, Presentations: 2, Awards: 1.

Elmashae\*, Yousef (Grinshpun (IH), graduated fall 2017) "Evaluating the Aerosol Exposure and Respiratory Protection of Healthcare Workers in Different Environments." Publications: 8, Presentations: 6.

Eturki, Mohamed (Davis (IH), graduated fall 2019) "Effect of Using a Qualitative Exposure Assessment Tool on the Accuracy of Occupational Exposure Assessment for Oil Sector Tasks." Publications: 1.

Gerding\*, Thomas (Wang (IH), in training, started fall 2019). His research focus is lab, field, and community-based assessment of electronic cigarette exposure, Publications: 2, Presentations: 2, Award: 2.

Ishua, Simileoluwa (Grinshpun (IH), graduated spring 2020) "Dermal Exposure and Risk to Aerosolized Pharmaceuticals in Home Healthcare Workers." Publications: 2, Presentations: 1.

Isiugo, Kelechi (Reponen (IH), graduated summer 2018) "Modelling Traffic Related Air Pollutants Indoors and Exploring the Effect of Exposure on Respiratory Health." Publications: 5, Presentations: 4, Awards: 1.

Kander\*, Maria (Christine) (Reponen (IH), in training) is working on qualifier exams. She is working in the area of Impact of PPE and base layers on fireground vapor and particulate exposure risk. Awards: 4.

Nakpan, Worrawit (Grinshpun (IH), graduated spring 2019) "Evaluation of a Novel Synthetic Composition for Inactivation of Aerosolized Spores." Publications: 3, Presentations: 6, Awards: 1.

Nathu, Vishal (Reponen (IH), in training) is researching spatial and temporal distribution of bioaerosols during various activities with subsequent visualization of concentrations indoors. He has completed his qualifier exams. Awards: 9.

Singletary, John (Wang (IH), in training, started fall 2019). His research focus is 3-D printed medical supplies and their usage in preventing pathogen exposure.

Turner\*, Ashley (Reponen (IH), in training, a TRT trainee) is currently working on dissertation investigating short-term respiratory effects of UFPs on asthmatics and the combined effects of UFPs and noise on stress outcomes. Publications: 4, Presentations: 1, Award: 1.

Niemeier-Walsh (nee Uebel)\*, Christine (Reponen (IH), graduated spring 2020, a TRT trainee) "Exposure to Traffic-Related Air Pollution and Biological Aerosols: Effect on the Respiratory Microbiome and a Comparison of Measurement Methods", Publications: 2, Presentations: 5, Awards: 4.

Wu, Bing-Bing (Grinshpun (IH), graduated fall 2018) "Ensuring Respiratory Protection through Respirator Fit Testing and Real-Time Monitoring." Publications: 7, Presentations: 10, Awards: 3.

Zeiler\*, Rachel (Bhattacharya (IH), in training) is currently working on qualifier exams. She is working on the area of bone lead and health-related quality of life. Presentations: 1, Awards: 1.

### **MS Students:**

A total 27 Master's trainees have or are being trained in our program with 14 graduated, 1 left the program, and 12 MS students are currently in training:

Alabdullatif, Abdulrahman (Davis (IH), graduated fall, 2016) "Impact of Lighting on Human Biomechanical Response During Lifting in Confined Spaces." Publications: 1.

Baker\*, Jennifer (Maier (IH), left the program in fall 2018).

Barned\*, Swade (Davis (IH), in training, started in fall 2020).

Barnwell\*, Mackenzie (Davis (IH), graduated spring, 2021) "Evaluation of Occupational Exposure of University of Cincinnati shuttle bus drivers to in-bus traffic-related air pollution concentrations and correlation between traffic patterns."

Benjamin\*, Michael (Maier (IH), graduated fall, 2017) "Investigations of Cleaning Product Sprays." Publication: 1.

Brann\*, Christopher (Maier (IH), graduated summer, 2018) "Examining the Solubility of Lead Nitrate in Synthetic Sweat."

Brock\*, Jacob (Davis (IH), in training, expected to graduate Fall 2021). His research focus is comparing the collection efficiency of respirable crystalline silica samplers in wet environment.

Calvillo\*, Anthony (Reponen (IH), graduated in summer, 2018) "Evaluation of Water-only Decontamination for Firefighters' Turnout Gear." Publications: 1, Presentations: 1.

Cundiff\*, Stephen, (Talaska (IH), graduated in fall 2016) "Screening Evaluation of Risk Assessment Tools that Assist in Exposure Assessment and Prioritization of Hazards in a Chemical Manufacturing Facility".

Ding, Jiajian (Davis (IH), in training, started fall 2020).

Fang, Runcheng (Davis (IH), in training, started fall 2020).

Frank\*, Nathan (Davis (IH), in training, expected to graduate fall 2021). His research focus is on the biomechanical loading on the neck of helicopter pilots.

Gander\*, Nathan (Reponen (IH) graduated summer 2020) "Assessing Potentially Hazardous Metal and Plastic Inhalable Fumes Generated from Additive Manufacturing Processes in a 3D Printing Lab on the University of Cincinnati College Campus." Presentations: 1.

Gould\*, Jory (Davis (IH), in training, started fall 2020), Awards: 1.

Grisso\*, Nicholas (Reponen (IH), graduated spring 2019) "Quantitative Moisture Results as a Predictor of Microbial Growth in Building Material, a Field Study." Presentations: 1, Awards: 3.

Hanson\*, Brendan (Haber (IH), in training, expected to graduate fall 2021). His research focus is on the methods for use of biomarker data in exposure assessment. Publications: 1.

Jesuthasan, Ada (Davis (IH), in training, started fall 2020), Awards: 1.

Niu, Xinyi (Davis (IH), in training, started fall 2020).

Ollier\*, Katherine (Grinshpun (IH), graduated summer 2018) "Inhalation Exposure and Respiratory Protection of Home Healthcare Workers Administering Aerosolized Medications (Simulation Study)." Publications: 1, Presentations: 1, Awards: 2.

Ross\*, Matthew (Davis (OE), graduated summer 2019) "Quantification of the Biomechanical Load When Handling Paint Buckets With and Without Assistive Devices." Publications: 0.

Sampath\*, Shakti Latha (Davis (OE), graduated fall 2018) "Comprehensive Understanding of Injuries in Hospitals Through Nursing Staff Interviews and Hospital Injury Record." Publications: 1, Presentations: 1.

Syck\*, Megan (Reichard (IH), moved to BIOM in spring 2020, graduated spring 2021). Her research focus is still to be determined. Publications: 2, Presentations: 1, Awards: 1.

Tipton\*, Logan (Wang (IH), in training, expected to graduate fall 2021) His research focus is characterization of fumes generated from pulsed TIG welding process. Publications: 1.

Weller\*, Meghan (Davis (IH), in training, started fall 2020).

West\*, Meghan (Reichard (IH), graduated spring 2018). "The Sensitivity to Food Allergies in Individuals with Asthma". Awards: 1.

Whitehead\*, Carson (Davis (IH), graduated fall 2020). "Evaluation of the impact of process design and anthropometric differences on the chemical exposure and ergonomic stress of workers in the petroleum industry." Awards: 1.

Wickstrom\*, Nell (Bhattacharya (OE), graduated summer 2019) "Effect of Chronic Hyperthermia in Firefighters on Cognitive Function and Postural Stability." Awards: 1.

\* **indicates trainee funded by ERC**

### **Accomplishments of the Faculty**

**Dr. Amit Bhattacharya** received two grants: one to study the postural balance and gait effects associated with disorientation among Navy aviators and one to study the impact of reduced thermal load on PFD use among shrimp fisherman. He served as a Member, Special Emphasis Panel for CDC RFA-CE-18-004, Research to Evaluate Medication Management of Opioids and Benzodiazepines to Reduce Older Adult Falls. Dr. Bhattacharya provided an invited Keynote Seminar at the First Annual Research Symposium: "Engineering Better Medicine" at Miami University, Oxford, Ohio. Dr. Bhattacharya was recently named a senior member of the National Academy of Inventors (among 54 from across the country given this honor).

**Dr. Kermit Davis** received the department's Award for Teaching Excellence (2016) and the Bernice Owen Award of Research in Safe Patient Handling from the Association of Safe Patient Handling Professionals in 2018. Dr. Davis is an Associate Editor of two journals: Human Factors and Journal of Agricultural Safety and Health. Dr. Davis was elected a Fellow of the HFES (2018) and Fellow of the AIHA (2019). Dr. Davis was also awarded the Fulbright Scholar award to study at Loughborough University.

**Dr. Sergey Grinshpun** was an invited speaker and panelist in “Workshop on the Integration of FDA and NIOSH Processes Used to Evaluate Respiratory Protective Devices for Health Care Workers” for the National Academies of Sciences (NAS) in August 2016. He was a guest speaker in three European Institutes in the Fall 2016. Dr. Grinshpun served as an invited speaker and panelist at the Workshop on the Use of Elastomeric Respirators in Health Care organized by the NAS in 2017. He also served as a member of the SOH Study Section and an external reviewer of the Research Grants Council of Hong Kong. Dr. Grinshpun served as a visiting scholar and invited lecturer at the Technion in Israel. Dr. Grinshpun gave several invited presentations nationally and internationally in 2018. Dr. Grinshpun was a co-recipient of the Alice Hamilton Award for Occupational Safety and Health from NIOSH in 2019. He also served as a keynote speaker for the International Scientific Committee of the INRS Biological Risks Conference in Nancy, France.

**Dr. Lynne Haber** was a core group panel member and co-author of the IPCS/WHO Working Group on the revisions to EHC 240: Principles and Methods for the Risk Assessment of Chemicals in Food. Based on this work, she was an invited speaker at the 2019 Society for Risk Analysis annual meeting and the 2020 Society of Toxicology annual meeting. Dr. Haber serves on the NSF International Health Advisory Board. She also holds an Interagency Personnel Agreement (IPA) with NIOSH in which she is working on methods for assessing the toxicity of inhalation exposure to data-poor chemicals, as well as for identifying and evaluating the toxicity of respiratory irritants.

**Dr. Michael (Andy) Maier** is now Principal Science Advisor with Cardno Chemrisk. Dr. Maier continues to serve on student committees, serves on the External Advisory Board, and works in close collaboration on consulting and research projects. Activities accomplished while a faculty member in the department included: multiple invited presentations on chemical health risk assessment; co-authored two abstracts that received awards as top ten abstracts in risk assessment at the Society of Toxicology Annual Meeting. He left UC in spring 2018.

**Dr. John Reichard** became a research-track faculty member in August 2015. He was appointed director of the Biomonitoring program on Jan. 1, 2020. He received a highly competitive IPA award with NASA (beginning Jul. 1, 2020). Dr. Reichard supported the development and implementation of a framework to protect pharmaceutical manufacturing workers from allergic sensitization by engineered human pharmaceutical enzymes. He also developed a pharmacokinetic-based framework to prevent adverse pharmacological effects in pharmaceutical manufacturing workers resulting from inhalation of antisense oligonucleotides, a rapidly growing class of potent pharmaceuticals.

**Dr. Tiina Reponen** currently has two ongoing extramural grants related to indoor air quality and microbial exposures in indoor environments. She actively collaborates with other faculty members related to respiratory protection against aerosol hazards, including protection against SARS-Cov-2 virus. During the past project period (2012-20), she published 40 peer-reviewed articles and supervised 2 MS students, 7 PhD students, and 3 post-doctoral fellows. Dr. Reponen was Associate Editor of two journals: *Indoor Air* and *Aerosol Science and Technology*. She received the David Sinclair Award from the American Association for Aerosol Research in recognition of her bioaerosol research in 2019. She was appointed as a member of the NIOSH Board of Scientific Counselors for a 4-year term starting in January 2020 and the chair starting in January 2021.

**Dr. Jun Wang** joined the faculty in January 2020. His areas of expertise include aerosol sciences pertaining to industrial activities such as welding and 3D printing. Dr. Wang has several certifications related to IH, namely CIH, CSP, and PE. Since January, Dr. Wang has been involved in several studies at UC and is currently supervising two PhD students on projects related to COVID-19. He is also on an intergovernmental personnel assignment with NIOSH for efforts related to reopening workplaces.

### **B.1.2. Opportunities for Training and Professional Development Provided by the Project**

ERC trainees are offered opportunities to attend any of our CE courses without registration fees. The IH and OE MS and PhD students are trained in hands-on quantitative techniques, interdisciplinary team projects and research, and state-of-the-art scientific procedures. Our Professional Development requirement necessitates students to become members of local and national societies as well as attend meetings to network and gain professional development. As part of the student experience, all trainees are required to perform student activities that improve the program, such as future student recruitment, lab coordination, student room and locker management, and interdisciplinary trip coordination. Professional development requirements and opportunities include internships, meetings with faculty, and mentoring from our alumni.

### **B.1.3. Dissemination of the Results to Communities of Interest**

The faculty members and students of IH and OE programs continue to disseminate information about our program and research results through our social media program, Cerkl, which has 317 members. The postings average about 2 per week. We have also started a LinkedIn group with some of our alumni and are currently expanding the group. IH trainees (Niemeier-Walsh, Nathu and Zeiler) have been actively involved in the development of the Health and Safety hotline for the workers at the Cincinnati Interfaith Worker Center. After developing the infrastructure and overcoming the legal concerns at the university level, the hotline is now live and receiving calls.

## **B.2. PRODUCTS**

### **B.2.1. Publications, conference papers, and presentations**

EIH students published 60 peer-reviewed papers, see Appendix 1.

### **B.2.2. Website(s) or other Internet site(s)**

<https://med.uc.edu/eh/divisions/ih>

<https://med.uc.edu/eh/divisions/ih/programs/phd-environmental-industrial-hygiene>

<https://med.uc.edu/eh/divisions/ih/programs/ms-environmental-industrial-hygiene>

### **B.2.3. Other Products**

Several of the students were involved in the development of outreach videos:

<https://med.uc.edu/eh/centers/erc/programs/outreach/home-healthcare-workers>

<https://med.uc.edu/eh/centers/erc/programs/outreach/firefighter-health-and-safety>

<https://med.uc.edu/eh/centers/erc/coronavirus-and-workplace-safety>

## **B.3. IMPACT**

An industrial hygiene master's student, Anthony Calvillo (graduated in spring 2018), and his advisor, Dr. Tiina Reponen, collaborated with three fire departments to study the efficiency of decontamination of firefighters' gear after structure fires. Based on the results, using soap and water was recommended instead of water-only decontamination. Since the study was published in March 2019, several local fire departments have adopted the soap and water decontamination protocol.

Dr. Davis, as co-chair of the NIOSH Wholesale, Retail, and Trade sector committee, is working on developing best practice guidelines for the WRT for protecting workers from COVID-19. Dr. Davis also led the development of a white paper for Home Health Care Aides: Occupational Health and Safety Challenges and Opportunities for American Industrial Hygiene Association and Human Factors and Ergonomics Society. Finally, he led the development of a policy paper for HFES on work from home (virtual offices).

Two EIH faculty members participated in the 2019 NIOSH ERCs Ergonomics Webinar Series, managed by the ERC in Berkeley. Dr. Amit Bhattacharya did a webinar in July 2019 on Assessing Heat Stress Associated Changes in Postural Balance Among Firefighters (57 participants). Dr. Kermit Davis did a webinar in November 2019 on A Patient Handling Story: From Patient Migration to Repositioning (110 participants).

Dr. Lynne Haber served on an independent advisory panel convened by the nonprofit National Water Research Institute to review the sampling and monitoring plan and the public health impacts of a project that would use advanced water treatment processes to produce highly treated recycled water and inject it into the groundwater basin. The project was planned for California, an area with a scarce water supply. The panel was able to provide increased confidence for protecting public health and maintaining a scarce resource.

## **B.4. SUMMARY OF ALUMNI AND EMPLOYER SURVEYS**

The **alumni survey** gave our EIH program an "outstanding" rating. Several key aspects were noted: 1) small classes encouraged interactive learning, 2) use of sampling equipment provided a good practical foundation, 3) presentations throughout the program prepared them for public speaking, and 4) courses provided a solid knowledge base. Mentoring was highly rated. The component rated lowest was access to new technology (rated as good). The lack of a ventilation course was also offered as a limitation (a new class in ventilation was offered in spring 2021). Many (85%) will be sitting for the CIH exam within the next 5 years. The **employer survey** indicated that 72% will be hiring IH, and 3% will hire OE in the next 5 years. The majority expected to hire 2 IHs in the next 5 years. The majority (60%) of the employers responded highly favorably towards the IH program, with many indicating that our graduates are very knowledgeable about IH basic principles and have extensive training in IH equipment, with 60% indicating UC IH hires were better trained than other IH programs.

## C. OCCUPATIONAL HEALTH NURSING (OHN)

PROGRAM DIRECTOR: GORDON GILLESPIE, PHD, DNP, RN, FAAN

DEPUTY DIRECTOR: CAROLYN SMITH, PHD, RN

### C.1. ACCOMPLISHMENTS

#### C.1.1. Major Goals

The overarching objectives of the Occupational Health Nursing (OHN) program have been to (1) produce Master of Science in Nursing (MSN) prepared occupational health nurses competent to provide quality, evidence-based occupational health and safety practice in the workplace and (2) prepare OHN specialty nurse scientists (PhDs) able to contribute to the science of occupational health and safety through research and disseminate knowledge through education and publications. The specific objectives of the OHN program have been to: (1) Maintain excellence in OHN academic (MSN) and research training (PhD) through continuous internal and external evaluation of students, faculty, research, and curriculum, and through continued maintenance of strong community OHN relationships; (2) Increase enrollment in master's and doctoral study in the OHN specialty; (3) Increase visibility within the University and ERC through interdisciplinary interaction, and within the College of Nursing (CON) by engaging all faculty members with an occupational health focus or interest to present lectures in OHN courses and mentor master's and doctoral students in research; (4) Continue to develop occupational health research foci; and (5) Mentor junior faculty and students in occupational health and safety research.

#### C.1.2. Accomplishments under These Goals

##### **Overview**

As of June 2021, the OHN program has four faculty members: Drs. Gordon Gillespie (Director), Carolyn Smith (Deputy Director), Beverly Hittle, and Cynthia Betcher. Of the thirteen MSN and ten PhD program trainees, we have graduated ten MSN and four PhD trainees since 2016. One MSN and five PhD trainees continue to matriculate in their respective programs. The MSN program will graduate its last trainee in fall 2021. Moving forward, the OHN program will focus on PhD trainees. Although MSN OHN program enrollment has been suspended due to COVID-19 financial impact, the MSN OHN specialty courses will continue to be offered for PhD, Doctor of Nursing Practice (DNP), and other ERC students.

##### **PhD Students**

##### PhD Trainees Who Graduated During the Project Period

Beverly Hittle, PhD, RN, was admitted to the MSN-PhD program in fall 2016 and graduated in summer 2019. Her mentor/dissertation chair was Dr. Gillespie. The title of her dissertation was "Elusive Sleep: Healthcare Workers, Shift Work, and Implications for Worker Health and Patient Safety." Her dissertation was funded by the Deets Dissertation Award. Her dissertation led to three articles published in *Industrial Health*; *Western Journal of Nursing Research*; and *WORK: A Journal of Prevention, Assessment, and Rehabilitation*. She presented her scholarship as the primary or contributing presenter at four national, one regional, and one local conference while a trainee. In summer 2019, she was Scholar in Residence at the National Council of State Boards of Nursing, located in Chicago. In fall 2019, she was hired as an Assistant Professor (tenure track) at the UC CON.

Dawna Rutherford, PhD, RN, was admitted to the MSN-PhD program in fall 2016, graduated in summer 2020, and was a Provost Scholar from 2016-2019. Her mentor/dissertation chair was Dr. Gillespie. The title of her dissertation was "Educational Intervention to Mitigate the Effects of Bullying in the Student Nurse Population." Her dissertation was funded by the ERC Pilot Research Project Program. She received additional financial support for her studies from the Jonas Foundation. Her dissertation led to three manuscripts: one published in *Nursing Forum* and two undergoing reviews in peer-reviewed journals.

Elizabeth Bien, PhD, RN, was admitted to the MSN-PhD program in fall 2017, graduated in summer 2020, and was an ERC Targeted Research Training (TRT) predoctoral trainee. Her mentor/dissertation chair was Dr. Gillespie. The title of her dissertation was "Occupational Exposure Assessment of Home Healthcare Workers: Development, Content Validity, and Piloting of an Observation Tool." Her dissertation was funded by the ERC TRT Program. Her dissertation led to three articles published in *Home Healthcare Now*, *Journal of Nursing*

*Education and Practice, and Home Healthcare Management & Practice.* Since 2018, she has been a member of the National Occupational Research Agenda (NORA) for Healthcare and Social Assistance Sector (HCSA). She was appointed as a post-doctoral research fellowship with Cincinnati Children's Hospital Medical Center.

Tamara Small, PhD, FNP, RN, was admitted to the MSN-PhD program in fall 2017, graduated in summer 2020, and was an ERC TRT predoctoral trainee. Her mentor/dissertation chair was Dr. Gillespie. The title of her dissertation was "Workplace Violence Prevention Training: A Cross-sectional Study of Home Healthcare Workers." Her dissertation was funded by the ERC TRT Program and the Wekselman Dissertation Award. Her dissertation led to three manuscripts: one published in *Home Healthcare Now*, and a second manuscript is under review in a peer-reviewed journal.

### PhD Trainees Currently in Progress

Georganne Kincer, MSN, RN, was admitted to the BSN-PhD program in fall 2011. During her matriculation, she switched to the MSN program and, after graduating from the MSN OHN program, returned to the PhD program. She is currently a PhD candidate. Her mentor/dissertation chair initially was Dr. Reutman. In May 2020, Dr. Smith assumed the role of dissertation chair; Dr. Reutman remains on her dissertation committee. The title of her dissertation is "Early Criteria for Evaluating the Effect of Heat Stress on Cardiovascular, Neuromuscular, and Cognitive Systems of Firefighters." She is scheduled to graduate in fall 2021.

Kendra Varner, BSN, RN, was admitted to the BSN-PhD program as a part-time student in fall 2014. She started as an ERC OHN trainee in spring 2019. Her mentor/dissertation chair initially was Dr. Susan Reutman. In May 2020, Dr. Gillespie assumed the role of dissertation chair; Dr. Reutman remained on her dissertation committee. The title of her dissertation is "Longitudinal Mixed Methods Study of Newly Graduated Nurse and Teacher Sleep Experiences." Her research was funded in 2019 by the Beta Iota Chapter of Sigma Theta Tau International Honor Society of Nursing. She is scheduled to graduate in the summer of 2021. In addition, she was co-author of a March 2019 manuscript published with other interdisciplinary ERC faculty and students.

Ashley Edgerly, BSN, RN, was admitted to the BSN-PhD program as a full-time student in fall 2019. She started as an ERC OHN trainee in spring 2020. Her mentor/academic advisor is Dr. Gillespie. Her research will focus on environmental exposures in agricultural workers.

Trevor Holtz, BSN, RN, was admitted to the BSN-PhD program as a full-time student in fall 2019. He started as an ERC OHN trainee in fall 2020 and will start as a TRT trainee in July 2021. His mentor/academic advisor is Dr. Smith. His research will focus on self-advocacy to address work stressors in home healthcare workers.

Elizabeth Keller, BSN, RN, was admitted to the BSN-PhD program as a full-time student in fall 2019. She started as an ERC OHN trainee in fall 2020. Her mentor/academic advisor is Dr. Hittle. Her research will focus on SARS-CoV-2 vaccine effectiveness in healthcare workers.

### **MSN Students**

#### MSN Trainees Who Graduated During the Project Period

Renee Lewis, MSN, RN, graduated in spring 2018. Her capstone committee chair was Dr. Gillespie, and her academic advisor was Dr. Reutman. The title of her project was "Recommendations to Redesign the Emergency Department." She presented the project at the 6<sup>th</sup> International Conference on Violence in the Health Sector in October 2018.

Nicole Harris, MSN, RN, graduated in spring 2019. Her capstone committee chair was Dr. Gillespie, and her academic advisor was Dr. Reutman. The title of her project was "Electronic Cigarettes: Exposure to Secondhand Vapors at a Long-term Care Facility." Her capstone project findings were published in *Journal of Nursing Education and Practice*. She presented on hypertension at the Southwestern Ohio Association for Occupational Health Nurses meeting in April 2019. She was the 2019 Secretary for the Southwest Ohio Chapter for the Ohio Association of Occupational Health Nurses.

Sarah Issler, MSN, RN, graduated in spring 2019. Her capstone committee chair was Dr. Gillespie, and her academic advisor was Dr. Reutman. The title of her project was "Addressing the Mental Health Concerns of First Responders." She presented on ergonomic training in physical and occupational therapy at the Southwestern Ohio Association for Occupational Health Nurses meeting in April 2019.

Darris Bohman, MSN, RN, graduated in spring 2019. Her capstone committee chair was Dr. Gillespie, and her

academic advisor was Dr. Reutman. The title of her project was “Prevalence of Compassion Fatigue among First Responders.” She presented on international drug testing at the Southwestern Ohio Association for Occupational Health Nurses meeting in April 2019.

Judy Jobe, MSN, RN, graduated in spring 2021. Her capstone committee chair and academic advisor was Dr. Gillespie. The title of her project was “A National Survey of Secondary Traumatic Stress and Work Productivity of Emergency Nurses Following Trauma Patient Care.” An article reporting her findings was published in the *Journal of Trauma Nursing*. She presented her findings at the Society for Advancement of Violence and Injury Research’s and the Midwest Nursing Research Society’s annual conferences.

Jennifer Naylor, MSN, RN, graduated in spring 2021. Her capstone committee chair and academic advisor was Dr. Gillespie. The title of her project was “Cost Analysis of a Dedicated Nurse vs. Providing Incentive Raises to Current Nurses for COVID-19 Management in a Processing Plant.” An article reporting her findings was accepted for publication in *Workplace Health & Safety*. She was also a co-author for a TRT project published in *WORK: A Journal of Prevention, Assessment, and Rehabilitation*. She presented her capstone project findings at the Midwest Nursing Research Society’s annual conference.

Ruth Norrell, MSN, RN, graduated in spring 2021. Her capstone committee chair and academic advisor was Dr. Hittle. The title of her project was “An Assessment of Sleep Hygiene Needs in Long Term Care Workers.” A manuscript reporting her capstone findings is under review by a peer-reviewed journal.

Sherry Steele Cooper, MSN, RN, graduated in spring 2021. Her capstone committee chair and academic advisor was Dr. Gillespie. The title of her project was “Emergency Department Workers Perceived Support Following Workplace Violence.” She presented her capstone project findings at the Midwest Nursing Research Society’s annual conference. She was also a co-author for a TRT project published in *WORK: A Journal of Prevention, Assessment, and Rehabilitation*.

Taryn Tegarden, MSN, RN, graduated in spring 2021. Her capstone committee chair was Dr. Gillespie, and her academic advisor was Dr. Betcher. The title of her project was “Infectious Disease Safety and Health Protocols Implemented for School During COVID-19 Pandemic: Failure Modes and Effects Analysis.” She was also a co-author for a TRT project published in *WORK: A Journal of Prevention, Assessment, and Rehabilitation*.

Denise Daniels, MSN, RN, graduated in spring 2021. Her capstone committee chair and academic advisor was Dr. Gillespie. The title of her project was “Coping and Wellbeing for Emergency Department Workers Who Experience Workplace Violence.” She presented her project findings at the Society for the Advancement of Violence and Injury Research annual conference. She was also a co-author for a TRT project published in *WORK: A Journal of Prevention, Assessment, and Rehabilitation*.

#### MSN Trainees Currently in Progress

Rachel Farris Hamer, BSN, RN, was admitted in fall 2019 as a first-year full-time student in the OHN MSN Program and an OHN Core ERC trainee. Her capstone project will be: “Clinical Stressor and Resilience Strategies Used by Emergency Nurses.” Her academic and research advisor is Dr. Gillespie.

One MSN trainee admitted in fall 2017 withdrew from the program in spring 2018. A second MSN trainee admitted in fall 2019 withdrew from the program in spring 2020. Trainees reported withdrawing from the program because they were not able to keep up with and complete the course work.

#### **Accomplishments of the Faculty**

Dr. Gillespie, PhD, DNP, RN, FAAN, Professor, served as OHN program deputy director through August 2020, when he became the OHN program director. He also served as the deputy director of the Pilot Research Project program and the CON’s Associate Dean for Research. His primary research focus area was workplace violence. His research during this period was funded by CDC-NIOSH, Ohio Bureau of Worker’s Compensation, and Ohio Department of Medicaid. Since 2016, he has authored or co-authored 62 peer-reviewed articles. In 2016, he was inducted as a Fellow of the American Academy of Nursing. From 2017-2019, he served as the co-chair for the Best Practice Guideline Committee for “Preventing and Managing Bullying and Violence in the Workplace” sponsored by the Registered Nurses Association of Ontario (Canada). From 2018-2020, he was elected as a director to the Emergency Nurses Association, one of the largest specialty nursing organizations in the world, with over 44,000 members. Due to the impact of his research, he was selected to serve as 1 of 28

members to the 2019-2020 National Quality Forum's action team to prevent healthcare workplace violence. Other members were selected from NIOSH, OSHA, CMS, professional healthcare organizations, insurance providers, healthcare systems, and patient advocacy groups. He continued active engagement as a mentor and advisor to OHN MSN and PhD students and faculty. He served as co-faculty for both of the interdisciplinary workshop courses. He also served as a committee member to create and obtain approval for a Doctor of Nursing Practice (DNP) Public Health Nursing program with a specialty track for occupational health nursing. For students, he served as chair for four OHN PhD students (one graduated summer 2019 and three graduated summer 2020). He served as a committee member for two additional OHN PhD students (one for whom he became chair in May 2020 and one from the University of Alabama at Birmingham). In addition, he mentored eight OHN MSN students and two DNP students (1 UC, 1 Vanderbilt University) to disseminate the findings from their capstone projects.

Dr. Smith, PhD, RN, Associate Professor (with tenure), was appointed as the OHN program deputy director in August 2020. Her primary research focus area was violence against women. Her research during this period was funded by CDC-NIOSH and the NIH-Eunice Kennedy Shriver National Institute of Child Health and Human Development. Since 2016, she has authored or co-authored eight peer-reviewed articles. In 2018, she served on the American Nurses Association's Advisory Committee for the #EndNurseAbuse Professional Issues Panel. For students, she served as a committee member for two OHN PhD students who graduated in summer 2020.

Dr. Hittle, PhD, RN, Assistant Professor, is a graduate of our MSN OHN and PhD programs in 2016 and 2019, respectively. Her primary research focus area was sleep hygiene. Her research during this period was funded by CDC-NIOSH through an Intergovernmental Personnel Act contract. Since 2016, she has authored or co-authored seven peer-reviewed articles. Since 2020, she has served as a member of the NIOSH NORA HCSA Sector Council and since 2018 as a planning committee member for the NIOSH Working Hours, Sleep, and Fatigue Forum with the HCSA Sector Workgroup. For students, she served as a committee member for one OHN PhD student.

Dr. Betcher, DNP, RN, COHN-S, Assistant Professor of Clinical Nursing, taught in OHN MSN and undergraduate programs. She is an experienced occupational health nurse who taught OHN practicum and Interdisciplinary Field Trip courses. In addition, she recruited for OHN MSN at the American Association of Occupational Health Nurses conferences. She also assumed the UC ERC Interdisciplinary Field Trip Coordinator role, arranging trips to worksites, which OHN specialty students attend together with other UC ERC trainees and faculty mentors. In 2018, she represented UC at the national OHN Education and Research Center (ERC) directors' meeting. In 2018, she graduated with her Doctor of Nursing Practice degree. Her scholarly project was recently published in *Workplace, Health and Safety* journal. For students, she served as a committee member for three OHN MSN students (1 graduated in spring 2019, 2 graduated in spring 2021).

Dr. Reutman, PhD, RN, Assistant Professor, was the OHN program director through August 2020. Her primary research focus was on increasing physical activity among sedentary workgroups. She developed and taught a CON OHN specialty PhD course and graduate evidence-based nursing courses. During this reporting period, she served on five doctoral committees, including four OHN PhD Candidate advisees and one DNP student with an occupational safety and health focus. In addition, she completed data collection and preliminary analyses for a study externally funded by the Association for Applied Sports Psychology. She received a UC College of Medicine funded Special Coronavirus (COVID-19) Research Pilot Grant Program award entitled "An Improvised Respiratory Protection Evaluation" in collaboration with Drs. Reponen and Grinshpun of the Environmental and Industrial Hygiene program. She co-chaired the annual and mid-year meetings of the national ERC OHN directors. She also served on the PhD Task Force to revise the Nursing PhD curriculum and as co-chair of the Preliminary Examination Committee. Dr. Reutman retired August 2020.

### **C.1.3. Opportunities for Training and Professional Development Provided by the Project**

OHN program faculty, Drs. Gillespie and Reutman, were presenters for the ERC's "Home Healthcare Workers and the Coronavirus: How to Protect Yourself" webinar in April 2020. Program faculty along with trainees provided support during workshops and symposiums held at the University of Cincinnati.

### **C.1.4. Dissemination of the Results to Communities of Interest**

Beverly Hittle, 2019 graduate, received a travel fund award from Washington State University to present and

provide outreach at the “Working Hours and Fatigue Mini-Symposium” in Spokane, WA.

## **C.2. PRODUCTS**

### **C.2.1. Publications, conference papers, and presentations**

OHN students published 29 peer-reviewed publications, see Appendix 1.

### **C.2.2. Other Products**

Dawna Rutherford, a 2020 graduate, developed an educational program to prevent the negative consequences associated with bullying behaviors during nursing care. Elizabeth Bien collaborated with Tamara Small, both 2020 graduates, and program faculty (Dr. Gillespie; Dr. Kermit Davis, Environmental and Industrial Hygiene) to develop the “Home Healthcare Worker Observation Tool.”

Drs. Gillespie and Smith were interviewed by multiple media outlets on the topics of violence. Interviews with Dr. Gillespie were reported in *ENA Connection* (October 2019), *NewKerala.com* (August 2019), *Proto Magazine* (January 2019), *Cincinnati Enquirer* (September 2018), *Managed Care Magazine* (May 2018), *VICE Media* (February 2018), *ACP Hospitalist* (December 2017), *Healthcare Risk Management* (November 2017), *WCPO News* (September 2017), *Nurse.com* (August 2017), *Modern Healthcare* (March 2017), and *American Association of Medical Colleges* (January 2017). Interviews with Dr. Smith were reported in *VICE Media* (February 2018), *WLW-AM radio* (February 2018), and *WKRQ-FM radio* (February 2017).

## **C.3. IMPACT**

Elizabeth Bien, a 2020 graduate, provided a nursing perspective on the national conference calls for the regular meetings of the NORA Healthcare and Social Assistance Sector. In addition, the “Home Healthcare Worker Observation Tool” for which she led the development will be used by future ERC students taking the workshop course series. The findings from the future projects will be used to develop interventions to reduce the risk of injury and exposures to home healthcare workers.

Dr. Gillespie (OHN Program Director) served on the board of directors for the Emergency Nurses Association. During spring/summer 2020, the board met weekly to discuss the impact of COVID-19 on the emergency nursing workforce internationally. In addition, Dr. Gillespie was responsible for communicating with emergency nurse leaders from Michigan, Kentucky, Virginia, Vermont, New Hampshire, and Ohio regarding the impact of COVID-19 to their states. Personal protective equipment, resilience, and burnout were common topics of these regional phone conferences. He also served on the Diversity Task Force for the Midwest Nursing Research Society to create a diverse and inclusive environment for professional members of the association.

## **C.4. SUMMARY OF ALUMNI SURVEY**

Alumni and employer surveys were distributed in spring 2020 to identify program strengths, challenges, and needed improvements.

### **C.4.1. Program Strengths**

Several strengths of the ERC programs were provided by respondents. Responses relevant to the OHN program included: *“The classes were taught very well and with small sizes and an emphasis on interactive learning”* and *“OHN students needed to take courses within the other occ health fields. This allowed me to have a better understanding of the other occ health team members’ approach to solving occ health problems.”*

### **C.4.2. Program Challenges and Needed Improvements**

The program challenges provided by alumni respondents was the lack of job placement support. Job placement support was rated with a mean of 3.4 (out of 5). One respondent said: *“Plus for grad students there’s literally no support from Big UC.”* This challenge will be addressed during the next grant period by incorporating career planning into the students’ individual development plans. In addition, we will leverage the OHN program’s External Advisory Board on potential job opportunities for graduates in academia and industry. Another challenge specific to the OHN program was dissatisfaction by one respondent about clinical placements. This respondent said: *“Finding a quality clinical environment was challenging, mostly due to the limited number of OHN available to be clinical preceptors.”* This challenge will be addressed by having Dr. Betcher responsible for all MSN-level OHN clinical experiences going forward. Her personal relationships with clinical preceptors in industrial settings will be an advantage to the quality of the program. In addition, students

will be informed prior to program entry of the expectations for the clinical rotations, hours needed, and the requirement that most hours will be completed weekdays during normal business hours.

#### **C.4.3. Employer Responses**

In addition, employers reported that key topics for students to learn were management (n=10) and leadership (n=6). Additional content to assure in ERC programs was interpersonal skills, risk assessments, writing skills, and biomonitoring techniques. When considering our graduates' preparation to enter the workforce, 9 of 15 employer respondents reported that our graduates were better prepared for their positions than non-UC graduates. A specific strength of UC alumni was the ability to write technical reports.

## **D.1. ACCOMPLISHMENTS**

### **D.1.1. Major Goals**

The Occupational Medicine Residency (OMR) training program continues to focus on the recruitment of highly qualified residents into the program and preparing residents for careers in clinical, corporate, and academic positions in the field of occupational medicine. The program's objectives are:

- (1) To continue to offer a residency program that offers high-quality academic, clinical, and research training with the flexibility to select clinical and practicum rotations based on the individual resident's background and career goals;
- (2) To focus on the optimal care of occupational illness and injury, including the prevention, clinical evaluation and treatment of each;
- (3) To expand training in management and administrative affairs and the interfaces between clinical practice and regulatory issues;
- (4) To teach the principles of research design and lifelong learning;
- (5) To utilize competency-based evaluations to assure optimally personalized and complete training.

### **D.1.2 Accomplishments under These Goals**

#### ***Overview***

- (1) The OMR program has continued to prepare its graduates for successful placement in a variety of occupational medicine leadership positions throughout the nation, as outlined below for recent graduates. Our graduates receive multiple job offers and usually take a position several months before graduating.

Our graduates generally score above 75% of national test-takers on the Preventive Medicine In-Service examination. More importantly, since 2016, all our graduates (7 of 7) have passed both sections of the American Board of Preventive Medicine (ABPM) occupational medicine specialty board exam (or the equivalent board exam for osteopathic physicians) on their first try and are board-certified.

At the time of the last site visit, in 2013, from the American Council on Graduate Medical Education (ACGME), our program's accrediting body, we received full accreditation for the longest period of time, 10 years. In addition to annual reporting to the ACGME, the program has an additional annual program review by the University of Cincinnati's Office of Graduate Medical Education.

The OMR External Advisory Board (also known as the PEC/RAC using ACGME terminology) develops the OMR annual action plan at the spring meeting along with program faculty. This action plan concentrates on various areas such as resident research opportunities, curriculum improvement, board preparation, and resident clinical rotations. Progress on the previous year's action plan items are considered at these meetings, and the resulting action plan becomes part of the ACGME annual report.

- (2) The recent merger of the employee health clinics of the University of Cincinnati (UC) and UC Health into a single entity in early 2021 has created a full-time position for a medical director (Victoria Wulsin, MD, DrPH) of this combined clinic who is also associate program director the OMR program. Dr. Wulsin also has an appointment in the occupational medicine division of our department. This new clinic has broadened the teaching opportunities for the residents, and it will hopefully become a regional referral source for acute and subacute occupational injuries optimizing the care of occupational illness and injury in the region.
- (3) Dr. Freeman continues to teach the Occupational Health Management course, and the resident portfolios include sections in management training. Most residents take corporate medicine rotations (e.g., Procter and Gamble or Dow). The new combined University/UC Health employee health clinic rotation will offer residents new opportunities in the management of population health studies and interventions.
- (4) All occupational medicine residents engage in scholarly activity, and these papers and presentations are outlined below for each recent graduate. Dr. Freeman was the principal investigator on an Ohio Bureau of

Workers Cn (BWC) grant that included five years of claim data for over 100,000 musculoskeletal injuries. This grant ended in April of 2020, but it is still a rich source of data for current and future resident research, and several papers from this grant have been published or submitted. To foster lifelong learning, residents regularly engage in journal club meetings, and each resident completes a 2-part quality improvement project (using the Plan Do Study Act methodology) relating to their perceived professionalism and history-taking abilities.

- (5) The OMR program, per ACGME guidelines, has a Clinical Competency Committee (CCC) composed of faculty and clinical preceptors that meet twice per year to examine the resident evaluations and draw upon their clinical and research experiences with each of the residents to assign competency-based milestone levels in each of the required 26 areas for each resident. This process included the development of proprietary software by the occupational medicine faculty to summarize by competency the MedHub-based resident evaluations into a Microsoft Access-based report that is utilized by the CCC.

### ***MPH Students / Occupational Medicine Residents / PhD Students***

With the exception of the complementary pathway resident, all our occupational medicine residents graduated with an MPH degree. None of our recent Occupational Medicine residents have elected to pursue a PhD degree following their residency training.

#### *Program Graduates*

Suarez, Rassull, MD, MPH -- Graduated July 2016. He is a Senior Corporate Physician at the Dow Chemical Company in Houston, Texas. His principal mentor was Dr. Freeman. His MPH capstone project was entitled, "Complexity of Occupational Exposures for Home Healthcare Workers: Nurses versus Home Health Aides." He was awarded a 2015 American Occupational Health Conference (AOHC) Resident Scholarship, designed to assist qualified residents in receiving a well-rounded education in occupational medicine. He co-authored three papers in peer-reviewed journals, and he presented at two national meetings.

Taylor, Alan, DO, MPH – Graduated July 2016. He is the Clinic Director at the Reknown Health Clinic in the Reno, NV. His principal mentor was Dr. Newman. His MPH capstone project was entitled "Environmental Justice Indexes and Health Outcomes Across the Neighborhoods of Cincinnati." He presented at a regional meeting.

Almarzouqi, Leena, MD, MPH – Graduated July of 2016. She is a clinic director at a Concentra Clinic in the Chicago, IL area. Her principal mentor was Dr. Newman. Her MPH capstone project was entitled "Use of a smartphone app for health care provider point of care reference for common drinking water contaminants." She presented at a regional meeting.

Huth, Jeff, MD, MPH – Graduated May 2017. He is the medical director for a TriHealth occupational medicine clinic in Cincinnati, Ohio. His mentor was Dr. Freeman. His MPH project was a grant submission entitled "Injury Rates and Medication Safety in Workers Compensation Claims" with which he assisted to a significant degree. He was awarded a 2016 AOHC Resident Scholarship, designed to assist qualified residents in receiving a well-rounded education in occupational medicine. He served as a member of the Stakeholder Advisory Panel for the Pharmacy Quality Alliance during his residency. He presented at one national meeting.

Ly, Nancy (Ngoc Giao), MD, MPH – Graduated July 2018. She is the medical director for a Kaiser Permanente occupational medicine clinic in Walnut Creek, California. Her mentor was Dr. Newman, and her capstone project was entitled "Lead Exposure in Pregnant Workers." She was presented with the second-best resident presentation award at the Western Occupational Health Conference (WOHC) in Maui, HI, in September 2017. She had 3 presentations at national and regional meetings.

Chandrashekar, Bhargav, DO, MPA, MPH – Graduated July 2018 with a Master of Public Administration (MPA) degree from the UC in addition to his MPH degree. He has a corporate medicine position working for GlaxoSmithKline in Pennsylvania. His mentors were Drs. Freeman and Newman. His MPH capstone project was entitled "Lead toxicities from uncommon sources in the pediatric population: A case series from an urban specialty clinic in Cincinnati, OH." His awards included: The HLTH (Innovation in Occupational Health) 2018 travel scholarship, Las Vegas, May 2018 and the AOHC Public Safety Medicine Scholarship, May 2018. His leadership positions included: Member of the House of Delegates, Officer in the Residents and Recent Graduates Section, and Representative to the American Medical Student Association for the American College

of Occupational and Environmental Medicine. He presented at 2 national and 2 regional meetings as a resident.

Lang, David, MD, MPH - Graduated July 2020 with an MPH awarded in April 2020. He has already accepted a position as a medical co-director of a Lake Health occupational medicine clinic in Cleveland, Ohio. His mentor was Dr. Freeman. His MPH capstone was entitled "Workers' Compensation Prescription Medication Patterns and Associated Outcomes." He is co-author of a publication under review that examines the cost and disability effects of opioid medication prescribed for musculoskeletal workers compensation injury claims. He gave one regional conference presentation as a resident.

#### *Non-Graduates or Not Yet Graduated*

Nickle, Tyler, DO – Current Resident. He started his residency on July 1, 2020, and has an expected graduation date of June 30, 2022.

Wali Jahangiri, MD – Current Resident. He started his residency on July 1, 2021, and has an expected graduation date of June 30, 2023.

Taylor Buckley, MD – Current Resident. She started her residency on July 1, 2021, and has an expected graduation date of June 30, 2023.

Alexei Krainev, MD – Current Resident. He started his residency on July 15, 2021, and has an expected graduation date of July 14, 2023.

Richardson, Rhea, DO -- Dr. Richardson did one year of occupational medicine residency training through the complementary pathway finishing July 2017. She did not graduate from the residency or receive an MPH degree. She is boarded in Orthopedic Surgery. She is currently the medical director for a Concentra occupational medicine clinic in Akron, Ohio.

#### *Publications*

Agbonifo N, Hittle B, **Suarez R**, & Davis K. 2017. Occupational exposures of home healthcare workers. Home Healthcare Now. 35(3): 150-159. PMID: 28248782.

Davis K, Freeman A, Ying J, Huth J. 2021, Workers Compensation Costs for Healthcare Caregivers: Home Healthcare, Long-Term Care, and Hospital Nurses and Nursing Aides. American Journal of Industrial Medicine, 64(5), 369-380. PMID: 33616226.

Hittle B, Agbonifo N, **Suarez R**, Ballard T, Davis K. 2016. Complexity of occupational exposures for home healthcare workers: Nurses versus Home health aides. Journal of Nursing Management, 24: 1071–1079.

**Suarez R**, Agbonifo N, Hittle B, Davis K, & Freeman A. 2017. Frequency and risk of occupational health and safety hazards for home healthcare workers. Home Healthcare Management and Practice, 29(4): 207-215.

Freeman A, Davis K, Ying J, Lang D, Huth J, Liu P. 2021. Workers' Compensation Prescription Medication Patterns and Associated Outcomes. American Journal of Industrial Medicine, (In Review).

#### ***Accomplishments of the Faculty***

Andrew Freeman, MD, MS, is studying the association between disability and elevated death rates with prescribed opioid doses in a workers' compensation setting as well the relationships between prescription patterns and workers' compensation claim costs. Both of these efforts will lead to new information that can be used to drive Ohio workers' compensation policies and guidelines for the prevention of worker injuries and to improve care. Dr. Freeman is a member of the state-wide Disability Evaluator's Panel for the Ohio Bureau of Workers Compensation (BWC), and he is a certified examiner for the Ohio Industrial Commission. Dr. Freeman developed a Markov chain Monte Carlo (MCMC) method simulation program to teach medical surveillance principles. The model simulates cost-benefit outcomes resulting from varying monitoring screening test parameters in isocyanate asthma medical surveillance. This allows the residents to fulfill a required training-related ACGME Milestone.

James Lockey, MD, MS, is the principal investigator for the pulmonary surveillance program of RCF (refractory ceramic fiber) manufacturing facilities, an HTIW contract. Dr. Lockey has a presidential appointment to the National Advisory Board on Radiation and Worker Health.

Nicholas Newman, DO, MS, is the site director for the ATSDR & US EPA-funded Pediatric Environmental Health Specialty Unit at Cincinnati Children's Hospital. He is a peer reviewer for journals, including Neurotoxicology & Teratology, Environmental Health Perspectives, and the International Journal of Hygiene and Environmental Health. He is currently serving on the following national and regional committees: Scientific and Technical Advisory Committee Member, World Trade Center Health Program; Chair, Ohio Lead Advisory Committee to the Ohio Department of Health; Member, Ohio Governor's Lead Advisory Council. Dr. Newman provided testimony, based on his experience as a study physician on multiple environmental epidemiological studies, to the National Academy of Sciences (NAS) Committee on Return of Individual-Specific Results Generated in Research Laboratories in 2017. This testimony provided information the NAS used to develop their recommendations on the return of biomonitoring results to study participants. He received the 2020 Michael Shannon Research Award from the Academic Pediatric Association for "Environmental Justice Screen Lead Index and Blood Lead Concentrations in Hamilton County, Ohio."

Victoria Wulsin, MD, DrPH, has been a leader since March 2020 in the University's COVID-19 surveillance and prevention efforts on behalf of its 46,000 students, 12,000 faculty and staff, and 2,400 health care workers. She is Director of Immunization Compliance for the University and co-chairs the UC COVID-19 Vaccine Committee. She is the Medical Director of the combined UC and UC Health employee health clinic, overseeing the merger and commencement of combined operations on 4/1/2021. The merger adds 11,000 UC Health employees to the clinic's responsibilities.

James Donovan, MD, MS, was the medical reviewer for the upcoming 4th edition of the NIOSH Pocket Guide to Chemical Hazards. The website of the current version is:  
<https://www.cdc.gov/niosh/npg/mobilepocketguide.html>

## **D.2. PRODUCTS**

### **D.2.1 Publications, conference papers, and presentations**

#### **Residents**

The residents were co-authors of four published papers and one in review, gave 15 presentations in regional and national conferences, and won 5 awards (see Publication list in Appendix 1 and above details for each resident).

#### **Faculty (selected presentations)**

Dr. Freeman – Invited Speaker: Ohio Safety Conference (Bureau of Workers Compensation) Columbus, Ohio, March 4, 2019. TITLE: Workers Compensation Prescription Medication Patterns and Associated Outcomes.

Dr. Lockey - Presenter: 34<sup>th</sup> Annual Utah Conference on Safety & Industrial Hygiene. A. Ray Olpin University Union, Salt Lake City, UT. October 12, 2017. TITLE: Monitoring Personal Exposure to Nanomaterials.

Dr. Lockey - Presenter: Scanlon Symposium Lecture: The Society of Thoracic Radiology, March 5, 2018, Austin, Texas. TITLE: Emerging and Recurring Occupational Lung Disease in the 21st Century.

Dr. Lockey - Presenter: CEET/Penn SRP Seminar Series, University of Pennsylvania, Perelman School of Medicine. Smilow Center for Translational Research. Philadelphia, PA. May 10, 2018. TITLE: How Results from a 30-Year U.S. Study of Workers Exposed to Vermiculite Drove U.S. Public Health Policy.

Dr. Wulsin – Invited Speaker: Community Health Workers in Kenya (virtual), January 20, 2021. TITLE: Occupational Safety in the COVID-19 Pandemic.

Dr. Newman - Session moderator and Presenter: NIEHS Partnerships in Environmental Public Health annual meeting, 2020. TITLE: Expanding the Environmental Medicine Workforce.

Dr. Newman - Presenter, NIEHS Partnerships in Environmental Public Health annual meeting, 2019. TITLE: Improving collaboration between environmental health scientists and clinicians.

### **D.2.2 Website(s) or other Internet site(s)**

Division of Occupational and Environmental Medicine: <https://med.uc.edu/eh/divisions/occmcd>

Residency Training Program <https://www.med.uc.edu/depart/eh/divisions/occmcd/residency>

## E. OCCUPATIONAL SAFETY AND HEALTH ENGINEERING (OSHE)

PROGRAM DIRECTOR: JAY KIM, PHD, ASP  
DEPUTY DIRECTOR: TOM HUSTON, PhD, CSP, PE

### E.1. ACCOMPLISHMENTS

#### E.1.1. Major Goals

The OSHE program aims at fostering engineers and researchers who will contribute to meeting the regional and national needs in occupational safety and health. The program offers core safety engineering courses, trains students through master's and doctoral research focusing on occupational safety and health and conducts multidisciplinary research in collaboration with other programs of the Cincinnati ERC. After graduation, OSHE trainees will become safety practitioners in public and private organizations who will improve safety in workplaces; engineers who will design safer equipment, personal protective garments, or processes; and researchers who will contribute to research needs relevant to occupational safety and health.

#### E.1.2. Accomplishments under These Goals

##### **Overview**

The OSHE Program currently has nine full-time faculty members: Dr. Jay Kim, Dr. Tom Huston, Dr. Milind Jog, Dr. Henry Spitz, Dr. Rupak Banerjee, Dr. Mark Schulz, Dr. Sarah Watzman from Mechanical Engineering (ME), Dr. Vesselin Shanov from Chemical Engineering (CHE), Dr. Ashley Paz y Puente from Materials Science Engineering (MSE) and two part-time adjunct faculty members, Dr. Phil Stuebbe and Dr. Bryan Beamer, in the College of Engineering and Applied Science (CEAS), and three affiliated faculty members in the College of Medicine, Dr. Amit Bhattacharya, Dr. Kermit Davis and Dr. Jun Wang of the Department of Environmental and Public Health.

The program has been supporting on average five trainees funded by the ERC and three students funded from other sources. During the last project period, three PhD trainees and two MS trainees graduated from the program. The program offers five courses in the area of occupational safety and health every year, which are Occupational Safety and Health, System Safety, Radiation Detection and Measurement, Radiological Engineering and Technology, and Acoustics/Noise Control. On average, these courses are taken by about 140 students every year.

**PhD Students** (\* indicates trainees funded by the ERC grant. Others were funded from other sources.)

##### **PhD Trainees Currently in Progress**

Ng, Vianessa\* (Advised by Dr. Mark Schulz, MSE). Expected to graduate in spring 2021. Dissertation title: "Synthesis of Flame Retardant Nanofabric by the Floating Catalyst Method." Vianessa Ng published two journal papers and four conference papers. She served as the president of UC student chapter of ASSP (American Society of Safety Professionals) for over three years. She also served as Nanoworld Lab Safety Manager, helping the implementation of safety guidelines and improvements of the safety of the labs.

Stotzer, Victoria\* (Co-advised by Dr. Sarah Watzman and Dr. Ashley Paz y Puente, MSE). Expected to graduate in spring 2023. Dissertation title: "Health Effects Associated with Additive Manufacturing of Novel Thermoelectric Materials through Particle-laden Ink Extrusion Printing." She joined OSHE in August 2018 and completed all coursework requirements and passed the PhD qualifying exam. She is currently serving as the president of the UC Chapter of ASSP.

Stucky, Joshua\* (Advised by Dr. Rupak Banerjee, ME). Expected to Graduate in spring 2022. Dissertation title: "Development of Electro-osmotic Microfluidic Sensing Device for Detection of Heat Shock Stress Markers". He joined the OSHE program in 2018 after completing his MS degree at Grove City College. He passed the PhD qualifying exam in 2019 and finished all course requirements.

Stringer, Jimmy (Advised by Dr. Henry Spitz, ME), Expected to graduate in May 2021. Dissertation Title: "Radiation Safety, Evaluating Occupational Exposure Using an Orphan Am<sup>241</sup>Be Source." He is currently working as a medical physicist at the Ann Arbor Veterans Medical Center and submitted one journal paper with Dr. Spitz that was accepted by Radiation Protection journal.

Dobson, Sean\* (Advised by Dr. Ashley Paz y Puente, MSE), joined the program very recently in August 2020. He received his BS and MS degrees in Mechanical Engineering from University of Louisville. His research will be in the area of safety and health effects of metal additive manufacturing processes, while the dissertation title is being determined.

### **PhD Trainees Who Graduated During the Project Period**

Murry, Maisha (Advised by Dr. Henry Spitz, ME), Dissertation Title: "Dissolution and Sequential Extraction of Select Radioactive and Stable Elements in Soil and Lunar Regolith Simulants". She was a former trainee who is working full time as a Health Physicist in the Radiation Safety Program at the Ohio State University. She defended her doctoral dissertation in May 2020 and published one journal paper.

Schneider, Nathan\* (Advised by Dr. Henry Spitz, ME) Dissertation Title: "Comparison of the Measured Biodistribution of  $^{212}\text{Pb}$ -radiolabeled Monoclonal Antibodies (Trastuzumab) in Mice with  $^{232}\text{Th}$  and Progeny in Human Reticuloendothelial Tissue Measured using Alpha Particle Track Autoradiographic Microdosimetry from Thorotrast". He is currently a Medical Physicist with Schneider & Wuest Inc. He defended his doctoral dissertation in December 2019 and published two journal papers during the project period.

Miller, Samuel\* (Advised by Dr. Rupak Banerjee, MSE), Dissertation Title: "Enhanced Capture of Waterborne Pathogens using Magnetic Microbeads under Sequentially Switched Electroosmotic Flow." He defended his PhD degree in 2018 and published two journal papers and one conference paper.

**MS Students** (\* indicates trainees funded by the ERC grant. Others were funded from other sources.)

### **MS Trainees Currently in Progress**

Collins, Jonathan\* (Advised by Dr. Henry Spitz, ME). Thesis Title: "Laboratory method to quantitatively identify naturally occurring radioactive material contained in waste sludge produced during hydraulic fracturing." He joined OSHE in Fall 2017. He is currently working on his MS thesis research using samples provided by NIOSH.

### **MS Trainees Who Graduated during the Project Period**

Owen, Matthew\* (Advised by Dr. Milind Jog). Graduated in May 2019. Thesis Title: "The Effects of Surface Wettability on Droplet-Dry Substrate Impact Outcomes." He published two conference papers during the project period. He currently works for the US Army Corps of Engineers in Wala Wala, WA.

McConnell, Colin\* (Advised by Dr. Vesselin Shanov). Graduated in December 2019. MS thesis: "Development of Hydrogen Sensor Based on CNT Sheet and Fibers". He published one conference paper during the project period. He joined a company as a research engineer.

### **Accomplishments of the Faculty**

Dr. Jay Kim has served as the director of the OSHE program since 2009. He has published four journal papers and two conference papers on topics of noise and vibration controls, graduated 1 PhD and 2 MS students during the project period. He also offered a short course on CSP exam preparation with Dr. Tom Huston. Typically, he teaches a dual-level course, Acoustics and Noise Control, in which students learn and conduct projects on the prevention of occupational hearing loss. He has been serving as the faculty advisor of ASSP UC Chapter.

Dr. Tom Huston has served as the deputy director of the OSHE program since 2013. He has taught two required safety courses in the OSHE program every year. In 2017, he offered a short course on CSP exam preparation with Dr. Jay Kim and participated in the TRT and Outreach programs of the ERC. In 2016 he received the Dean's Award for Faculty Excellence, the highest honor given by the College of Engineering and Applied Science.

Dr. Milind Jog graduated one MS trainee as the primary advisor. He taught two courses every year in the thermal-fluid area and published four journal papers and six conference papers on thermal science and fluid mechanics. Dr. Jog has been the PI of five research projects funded by NIOSH Taft Lab during last project period that includes one ongoing project in collaboration with Dr. Leonid Turkevich and Dr. Pramod Kulkarni.

Dr. Henry Spitz taught two elective safety courses every year. Dr. Spitz is advising an MS trainee and conducted collaborative research with Los Alamos and NIOSH. He published six journal papers and two conference papers and graduated two PhD trainees during the project period.

Dr. Rupak Banerjee graduated one PhD trainee and is currently advising one PhD trainee. He taught three courses every year and published 13 journal papers in the biomedical engineering area. He was elected to a Fellow of the American Heart Association (AHA). He is also the editor of the ASME Journal of Medical Devices.

Dr. Mark Schulz is advising one PhD OSHE trainee. He taught two courses every year and published five journal papers in the area of nanotechnology. He has filed four invention disclosures. He and Dr. Shanaov serve as Co-Directors of NanoWorld lab.

Dr. Sarah Watzman taught five courses in the thermal-fluid area, including developing content for a graduate-level thermodynamics course. She is co-advising one PhD trainee. She has published six peer-reviewed journal papers and filed one invention disclosure during the project period. In 2019, Dr. Watzman received a prestigious DOE Early Career Award.

Dr. Vesselin Shanov graduated one PhD trainee, funded by his research grant, and one MS trainee funded by the ERC grant. He taught two courses every year and published ten journal papers, two book chapters, and one US patent application. The topics of his research include the use of carbon nanotubes and graphene for heating, sensors, filters, and energy storage, and the use of magnesium for medical implant applications. He and Dr. Schulz serve as Co-Directors of NanoWorld lab.

Dr. Ashley Paz y Puente taught three courses related to materials processing and additive manufacturing. She is advising one PhD trainee by herself and co-advising another PhD trainee with Dr. Sarah Watzman. This new collaborative project focuses on determining how additive manufacturing methods affect thermoelectric transport. She has published one peer-reviewed journal paper and presented three invited conference talks related to the processing and fabrication of metallic structures using additive techniques.

Dr. Phil Stuebbe, Adjunct Associate Professor of Mechanical Engineering, taught the System Safety course required of all OSHE students. This course is taken by many ERC trainees, as well as many other graduate and undergraduate students. Dr. Stuebbe also develops safety projects for OSHE students and provides his input to trainees' research utilizing his industry experience as a safety engineer at GE Aviation.

Dr. Bryan Beamer, CSP, Adjunct Associate Professor of Mechanical Engineering, taught a safety course, Occupational Safety Engineering. He is a Senior Research Engineer at NIOSH Taft Lab in the Hearing Loss Prevention Team. He has been the Principal Investigator on a four-year, \$944K NORA Project - 'Developing, Evaluating, and Promoting Noise Control Strategies' since October 2017.

### **E.1.3. Opportunities for Training and Professional Development Provided by the Project**

OSHE program faculty presented keynote talks and seminars in multiple conferences and ERC seminars. Program faculty and students actively participated in interdisciplinary activities of the ERC, including PRP symposiums, PRP projects and Interdisciplinary Workshops. OSHE students are also core members of ASSP (American Society of Safety Professionals) UC Chapter. Drs. Kim and Huston offered four-day short courses on preparing for Associate Safety Professional (ASP) and Certified Safety Professional (CSP) in 2015 and 2017. The short course covers a review of basic math and science, system safety, and safety management. The short course was offered to all ERC trainees for free.

### **E.1.4. Dissemination of the Results to Communities of Interest**

Drs. Shanov and Schulz were organizers of the Nanotechnology Materials and Devices (NMD) international workshop, held May 21–22, 2018, at the University of Cincinnati. Dr. Levi Elston was the Conference Co-Chairman from the AFRL, and Dr. Bang-Hung Tsao was the Conference Co-Chairman from UDRI. The 2020 conference could not be held due to the COVID-19 pandemic. Two OSHE trainees, Vianessa Ng and Victoria Stotzer, obtained travel awards from ASSP to attend the Future Safety Leaders Conference held in Oakbrook, IL, in Nov 2019, sharing best practices of safety management in university labs.

Dr. Mark Schulz gave two presentations to disseminate research on carbon nanotube fabric:

- Department of Environmental Health, College of Medicine University of Cincinnati, Tougher Than the Rest—Engineering with Carbon Nanotube Fabric and Yarn, November 20, 2019.
- Keynote address "Carbon Nanotube Fabric Manufacturing" at the 2nd World Summit on Advances in Science, Engineering and Technology October 3–5, 2019, Indianapolis, USA

### **E.1.5. Response to previous summary statement**

The previous program review mentioned several major strengths of the application: the highly qualified PD and Deputy PD; excellent laboratory facilities; a strong faculty; the extensive evaluation and improvement plan; the introduction of a certificate program; a high degree of academic rigor; the links to the various engineering schools; the impressive trainees; graduates are placed with major employers; the use of the Targeted Research Training program to provide avenues for trainees to learn research to practice (r2p) methods and processes; and the program's successful history of producing high-quality graduates. The weaknesses were labeled as minor. In response to the previous critique, we have made several improvements in the program. For example, we hired Drs. Bryan Beamer and Ed Zechmann as adjunct faculty to strengthen the academic orientations toward public health and occupational safety. Additionally, two new OSHE faculty members, Dr. Paz y Puente and Dr. Sarah Watzman are working on safety issues related to 3-D printing.

## **E.2. PRODUCTS**

### **E.2.1. Publications, conference papers, and presentations**

OSHE trainees and faculty have been active in publication. Combined, they produced 32 peer-reviewed papers (see publication list in Appendix 1) and 9 conference papers during the project period.

**E.2.2. Website(s) or other Internet site(s)** – See Occupational Safety and Health Engineering Home Page: <https://ceas.uc.edu/research/centers-labs/center-for-occupational-safety-and-health-engineering.html>

### **E.2.3. Technologies or Techniques**

The research by Dr. Banerjee and Joshua Stuckey resulted in an improved design of a head cooling system using phase change material for thermoregulation of brain temperature and is expected to benefit firefighters and airmen operating under higher thermal stress. On a similar note, assessment of heat shock proteins under thermal stress conditions using microfluidic devices will allow throughput screening of biomarkers of personnel (firefighters, airmen) operating under adverse thermal stress environments (Banerjee).

### **E.2.4. Inventions, Patent Applications, and/or Licenses**

An invention disclosure agreement (IDA) was filed with the UC by Dr. Banerjee's group with regard to the design of a head cooling system using phase change material for better thermoregulation of brain temperature.

Dr. Mark J. Schulz and Dr. Vesselin Shanov had eight invention disclosures and three patents pending together during the project period. Four of these invention disclosures and two of these pending patents are relevant to or derived from research funded by OSHE.

### **E.2.5. Other Products**

Matthew Owens, an MS trainee who graduated during the project period and served as the president of ASSP for two years, was named among DAAD (Deutscher Akademischer Austauschdienst: German Academic Exchange Service) recipients. He was accepted into the German Academic Exchange Service RISE Professional program for the academic year 2016-17. For three months, he worked on research to design, build, and ultimately test cleaning procedures for micro-annular gear pumps for life science purposes in Germany.

### **E.3. IMPACT**

Research on the application of carbon nanotube (CNT) based fabrics conducted by the program faculty has a high commercial potential to develop better firefighters' protective clothing. General Nano is a startup company founded by two program faculty, Dr. Schulz and Dr. Shanov, based on their research results.

The development of personal protective equipment for firefighters is supported by an Accelerator Project from the 1819 Innovation Center at UC. The nano gloves being developed protect firefighters' hands from hot and cold, aiding firefighters working in hot environments or burning buildings.

Dr. Shanov's students are working on flexible heaters, sensors, and energy storage devices based on CNT and graphene that can be incorporated into the uniforms of first responders (firefighters and Army soldiers). Dr. Shanov and Dr. Schulz recently submitted a large-scale proposal to FEMA (Federal Emergency Management Agency) to improve PPE built from carbon nanotube (CNT) for firefighters and first responders. This FEMA proposal is truly multidisciplinary participated by three different colleges (College of Engineering and Applied Sciences (CEAS), College of Design Art, Architecture and Planning (DAAP), and the College of Medicine (COM)) at UC, NIOSH lab (Pittsburgh) and industry (firefighter Garment Co.). Firefighters also participate as consultants. Dr. Shanov and Dr. Schulz are also developing a CNT-based antenna for Army soldiers that is stitched into the fabric and will eventually replace metal antennas.

#### **Recent Progress in Firefighter Apparel Development.**

The Nanoworld Lab recently manufactured 23 sheets of carbon nanotube (CNT) fabric (each sheet is 6 x 20 inch by 10 microns thick) and provided the fabric to Professor Ashely Kubley in the UC College of Design, Art, Architecture and Planning. Ashley and her group used the CNT fabric to form a composite shirt for firefighters. The shirt has outer layers of wicking fabric with a CNT fabric layer in the center. A novel method is used to composite the three fabric layers. The shirt has been sent to a specialty company for a fabrication step that could not be done at the university. Elastic bands to seal the shirt will be added and the shirt demonstrated and reported in the next OSHE and PRP reports. The shirt will provide heat spreading, electromagnetic shielding, shielding from smoke particles and toxic chemicals, and discharge static electricity. The thin CNT layer is also highly flame resistant. A thesis was presented on modeling the firefighter glove and shirt, and two papers are being prepared based on the thesis work [1]. CNT fabric may have widespread applications. Thus a paper was written giving an overview of the possible commercial impact of the work developing CNT fabric [2]. Because the use of CNT fabric in clothing is new, different journals have been asking us to submit papers and three open access journals have waived publication charges to encourage us to submit papers. The Nanoworld Lab has been working with the NIOSH group at UC (Drs. Bhattacharya, Kim, Grinshpun) to prepare proposals trying to support larger-scale efforts on developing PPE apparel incorporating CNT fabric as a protective and cooling layer.

## F. BIOMONITORING (BIOM)

PROGRAM DIRECTOR: JOHN REICHARD, PHARM.D., PH.D.

DEPUTY DIRECTOR: GLENN TALASKA, Ph.D., CIH

### F.1. ACCOMPLISHMENTS

#### F.1.1 Major Goals

The mission of the Biomonitoring component program (BIOM) is to provide training in toxicology, epidemiology, exposure science, and risk assessment that is needed to develop, implement and evaluate biological monitoring programs in industry, academia or government. This mission is accomplished by attaining three long-term goals: RESEARCH—Seek scientific knowledge on the process by which environmental agents produce adverse human health effects; EDUCATION—Prepare tomorrow’s professionals for leadership roles in research, education, service and patient care; and SERVICE—Diminish adverse health effects through interaction with governmental agencies and community groups.

The overall goals for the BIOM program are shared with the EIH program and provide curriculum, training opportunities, and field experiences for students. The BIOM program adds the following:

1. Prepare students to plan, develop and evaluate exposure assessments utilizing biological monitoring by gaining an understanding of the toxicodynamics and toxicokinetics of exposure and response to a wide variety of toxic agents;
2. Design biological monitoring programs to assess exposure to occupational agents and collaborate with other occupational health professions to increase the safety of US workplaces;
3. Conduct studies to develop and validate new biomarkers of exposure and effect and utilize biological monitoring to evaluate workplaces and workplace controls to protect worker health.

The objectives have not changed since the initial application.

#### F.1.2. Accomplishments Under These Goals

##### **Overview**

Three students are currently registered in the program, and one student graduated. Current trainees in the program include two students seeking PhDs and one seeking an MS.

##### **PhD Students**

Niemeier, Todd (Advisor: Dr. Reichard, (BIOM)), “Characterization of the Dermal Absorption Toxicokinetics of Inorganic Lead Compounds.” Publications: 2 (in preparation), Conference Presentations: 3.

Niang, Mamadou (Advisor: Dr. Reponen, (BIOM), graduated summer 2020), “Assessment of the basis for increased illness in workers exposed to biosolids.” Publications: 3 (in preparation), Conference Presentations: 0.

Efosa Obariase (Advisor: TBD). Efosa is newly enrolled in the BIOM program, and his project is not yet determined.

##### **MS Students**

Dussex, Dustin (Advisor: Dr. Talaska, (BIOM), graduated, summer 2016), “The Utilization of Fluorescent Products to Detect the Inhibition of Acetylcholinesterase by Carbamates and Organophosphate Pesticides: The Groundwork for a New Assay.” Publications: 0, Conference Presentations: 0.

Parker, Ann (Advisor: Dr. Reichard, (BIOM), graduated fall 2019), “Investigation of a Method for Predicting Immediately Dangerous to Life and Health (IDLH) Values Using Inhalation Irritation Data.” Publications: 0, Conference Presentations: 1.

Syck, Megan (Advisor: Dr. Reichard, (BIOM), graduated spring 2021), “Sensitivity to Oral Food Allergies in Subjects with Allergic Rhinitis and Eczema”. Publications: 0, Conference Presentations: 1.

Swade Barned (Advisor: Dr. Reichard, (BIOM), enrolled). Swade is newly enrolled and will select his project during the fall semester, 2021.

##### **Awards:**

Ann Parker: Received an AIHA Scholarship in the amount of \$3,000.00.

## ***Accomplishments of the Faculty***

Dr. John Reichard became a research-track faculty member in August 2015. He was appointed director of the Biomonitoring program on January 1, 2020. He received a highly competitive IPA award with NASA (beginning August 01, 2020). Working closely with Dr. Maier, Dr. Reichard supported the development and implementation of a framework to protect pharmaceutical manufacturing workers from allergic sensitization by engineered human pharmaceutical enzymes. He also developed a pharmacokinetic-based framework to prevent adverse pharmacological effects in pharmaceutical manufacturing workers resulting from inhalation of antisense oligonucleotides, a rapidly growing class of potent pharmaceuticals.

Dr. Glenn Talaska is serving in the role of deputy director for the BIOM program and is now interim director of the Department of Environmental and Public Health Sciences (DEPHS). He remains an active and engaged participant in the BIOM program, which is important because of his broad institutional knowledge of the program. In addition, Dr. Talaska was elected to emeritus status in 2017. He continues as an Active Emeritus and contributes his critical institutional knowledge in support of the program. He continues as director of the Great Lakes OSHA Training Center in the department and serves as vice chair of the ACGIH BEI committee. He is a member of the 9/11 First Responder Scientific and Technical Advisory Committee.

Dr. Michael (Andy) Maier is now Principal Science Advisor with Cardno Chemrisk. Dr. Maier continues to serve on student committees, is a member of the EIH program, serves on the External Advisory Board, and works in close collaboration on consulting and research projects. Activities accomplished while a faculty member in the department included: Editor in Chief of the International Journal of Occupational and Environmental Health; multiple invited presentations on chemical health risk assessment; co-authored two abstracts that received awards as top ten abstracts in risk assessment at the Society of Toxicology Annual Meeting. He left UC in spring 2018

### **F.1.3. Opportunities for Training and Professional Development Provided by the Project**

ERC trainees are offered opportunities to attend any of our CE courses without registration fees. In addition, many of the improvements in curriculum and training materials for CE courses have been used to improve the content of academic courses for ERC trainees. All ERC trainees receive training in hands-on quantitative techniques, interdisciplinary team projects and research, and state-of-the-art scientific procedures. We have a Professional Development course that requires students to join local and national societies as well as attend meetings to network and gain professional development. As part of the student experience, all trainees are required to perform student activities that improve the program. Finally, part of the development professionally includes internships, meetings with faculty, and mentoring from our alumni (e.g., local chapter AIHA).

In 2017 the ERC awarded Dr. Reichard funding support to obtain specialized training for *in vivo to in vitro* Pharmacokinetic Extrapolation from Scitovation (Formerly The Hamner Institutes for Health Sciences). This opportunity was made possible through the ERC's award for Faculty and Student Specialized Training. Also, in 2017, Dr. Reichard completed graduate-level training in Physiologically Based Pharmacokinetic Modeling in R (AP 873) through Kansas State University [online]. This exemplary online course was partially supported by FTE coverage from the ERC.

### **F.1.4. Dissemination of the Results to Communities of Interest**

We are continuously developing outreach mechanisms to increase awareness of courses, course content and research findings. During the current period, we continued to use an ERC CE-specific mailing and contact list. We also posted information on the CERKL resource that is used as one of our primary outreach mechanisms. We are currently evaluating the use of the professional networking site LinkedIn, which has become one of the most popular platforms for professional networking. Of specific interest is the dissemination of new online and free access courses. One example is the chemically-induced asthma course that is available online. This course has been downloaded over 180 times.

## **F.2. PRODUCTS**

### **F.2.1. Publications, conference papers, and presentations**

BIOM students published 5 peer-reviewed papers. Current and recently graduated students have five manuscripts in preparation (Mamadou Niang [3]; Todd Niemeier [2, one under review]). To increase student

research opportunities, we are realigning some ERC funding in an effort to enable more sustained commitment to the training of PhD candidates and greater research opportunities for MS students to contribute to peer-reviewed publications, while also increasing the financial support available for trainees.

### **F.2.2. Website(s) or other Internet site(s)**

<http://med.uc.edu/eh/centers/erc/programs/biom>

### **F.3. IMPACT**

Ann Parker and her adviser collaborated with NIOSH to develop a method for predicting Immediately Dangerous to Life and Health (IDLH) values using 30-minute Acute Exposure Guideline Levels (AEGL2). The project supports NIOSH's effort to protect workers from respiratory irritants.

Todd Niemeier presented his research to the IH community with presentations to the Local Cincinnati AIHA section (2016), NIOSH All-Hands Division Meeting (2018), and a poster presentation at AIHce in 2018.

Mamadou Niang collaborated with researchers at US EPA and a wastewater treatment plant in Hamilton County, Ohio to study how exposure to antibiotics in wastewater affects the antibiotic resistance of bacteria in biosolids.

Drs. Reichard and Maier have implemented three protocols with major pharmaceutical manufacturers for the protection of pharmaceutical manufacturing workers: (1) Protocol for deriving occupational exposure limits (OELs) for inhalation bioavailability of inhibitory nucleic acids; (2) protocol for OEL derivation for allergic sensitizing medical enzymes; (3) Framework for Acceptable Daily Exposure (ADE) derivation of potentially toxic endogenous impurities in pharmaceuticals (relates to cross-contamination in manufacturing).

Under contract, Dr. Reichard has authored over one hundred ADE and OEL assessments of pharmaceutical active ingredients, impurities, and leachates for major pharmaceutical companies. In collaboration with Dr. Lynne Haber (Adjunct Assistant Professor, UC DEPHS), Dr. Reichard contributed to the dose-response evaluations of food allergens which supports FDA risk-based decision-making on allowable contamination limits in food processing. Also, with Dr. Haber and a team of subject matter experts, Dr. Reichard co-authored a detailed assessment of arsenic carcinogenicity for Health Canada and co-authored several assessments for the US Consumer Product Safety Commission.

Community input: Based on continual evaluation and feedback from our trainees and External Advisory Board (EAB), we held faculty retreats in June 2021 to evaluate our programs. No changes affected expenditures. A more recent EAB meeting in August 2021 identified mechanisms for engaging and recruiting candidates, particularly minority candidates.

### **F.4. SUMMARY OF ALUMNI AND EMPLOYER SURVEY**

The most recent survey of employers (delivered summer of 2020) is supportive of the ERC BIOM component program. The survey was conducted and analyzed independent of the UC ERC through a contract with University of Cincinnati Evaluation Services Center. Although no BIOM alumni responded to the survey, the value of biomonitoring skills was supported by employer responses. Employers listed professional and technical skills that would be important for future hires over the next five years. Employers provided a variety of responses centered around interpersonal skills, job-specific skills, and other technical skills. Among the most common responses was knowledge and experience in a topic that included biomonitoring programs.

Employers were asked to rank areas that they expected to hire over the next 5 years. Among responding employers, 14% were planning to hire students with biomonitoring training in the next five years.

## G. PILOT RESEARCH PROJECT (PRP) TRAINING PROGRAM

PROGRAM DIRECTOR: AMIT BHATTACHARYA, PHD, CPE

DEPUTY DIRECTOR: GORDON GILLESPIE, PHD

### G.1. Major Goals

The Pilot Research Project (PRP) training program at the University of Cincinnati was established on July 1, 1999, to provide timely support for enhancing the research capacity of all doctoral students and junior faculty in the many areas of occupational health and safety-related research. The original objectives of the PRP program have not changed.

### G.2. Accomplishments under These Goals

#### *Overview*

During the funding period, 53 proposals out of 89 were accepted for funding totaling \$364,254, with an additional \$9,757 in supplemental funds used from the carryover requests to provide additional support to the awarded projects. The average amount funded per project was \$6,872. The NIH 9-point scale was used when reviewing all proposals, and the average impact score per year was 2.69 in 2016, 2.55 in 2017, 2.5 in 2018, 2.56 in 2019, 2.3 in 2020, and 3.4 in 2021. Reviewers were faculty members from the University of Cincinnati, NIOSH employees, and faculty from the 11 universities in the PRP consortium; Air Force Institute of Technology, Bowling Green State University, Central State University, Eastern Kentucky University, Kentucky State University, Murray State University, Ohio University, Purdue University, University of Kentucky, and Western Kentucky University.

Of the awarded PIs there were 38 PhD students, 4 post-doctoral fellows, and 11 assistant professors. There were 18 PIs new to the field of occupational safety and health. Each year the PRP program was able to offer an additional \$1,000 to proposals that included a strategic priorities focus (focus areas in the Cincinnati region) on firefighters, home healthcare workers, and low wage workers or an interdisciplinary focus, which were projects that included at least 2 disciplines in the research team or study. Additional funding was given to 33 awardees for strategic priorities projects, and 4 awardees received funding for interdisciplinary projects. In 2021 the PRP program also added an additional focus area option; underserved/underrepresented team or topic. This required the applicant to indicate if their proposal was focusing on a topic regarding an underserved/underrepresented population or if the proposal included a PI and/or collaborators from an underserved/underrepresented population. The first proposal in this focus area was funded in 2021. All applicants, funded or not, received scores and comments from their reviewers. Awarded projects were required to respond to reviewer comments before receiving their award.

All projects dealing with human subjects were required to provide approved protocol from their Institutional Review Board addressing human safety, and those with an animal protocol were also required to obtain approval before funds were released.

#### *Accomplishments of the Faculty*

- PRP Director, Dr. Amit Bhattacharya's research accomplishments were recognized by the National Academy of Inventors (NAI) as the Senior Member of NAI.
- PRP Deputy Director, Dr. Gordon Gillespie was inducted as a Fellow of the American Academy of Nursing in 2016 based on his research impact.
- An article written by Dr. Gillespie received Honorable Mention for the 2018 Alice Hamilton Award for Excellence in the Occupational Safety and Health Education and Guidance Category.

### A.3. Opportunities for Training and Professional Development Provided by the Project

Since 2016 the PRP program has provided \$364,254 in funding for 53 pilot projects. Eighteen of those projects had PIs who were new to the field of occupational safety and health research. All PIs are PhD students or junior faculty who are newer to the proposal writing and grant field, so each PI gains expertise writing one of their first proposals as well as working under one of their first grants (see long-term impact below).

In addition to the PRP program providing grant and proposal experience to awardees, each year the program hosts a Research Capacity Building Workshop for University of Cincinnati students and faculty, students and

faculty from the PRP consortium universities, and when enough spaces are open, we extend the invitation to the regional ERCs including University of Michigan and University of Illinois at Chicago.

Since 2016 we have hosted 6 workshops that were attended by 105 participants. Out of 105 participants, 57 were doctoral students, 5 were post-doctoral fellows, 1 occupational medicine resident, 1 master's student, 1 research scientist, and 40 were faculty members ranging from junior to senior level. Overall, participants rated the workshop as 4.2 on a scale of 1 (poor) to 5 (excellent). As the research funding from external sources is getting progressively harder to obtain, the Research Capacity Building Workshop has given our students and junior faculty a competitive edge in capturing research funds in the area of occupational safety and health.

### ***Involvement with Education Research Centers (ERC), Training Program Grants (TPG), PRP Collaborating Institutions, and NIOSH Research Laboratories***

During the funding period, some of our PRP faculty members and PRP awardees have initiated/continued collaborative research projects in and outside our regional TPGs, ERCs, PRP participating institutions, and NIOSH research laboratories. The following selected examples are provided:

Dr. Bhattacharya, his colleagues, and ERC students have continued their collaborations with NIOSH heat stress expert, Dr. Jon Williams, NPPTL Heat Stress labs dealing with the individualized prediction of hyperthermia among firefighters. Last three years, collaborations with Drs. Jagjit Yadav, Kim Cecil (CCHMC MRI clinic), and Williams have been investigating the role of chronic shift work/fire runs in triggering immune dysfunction mediated detrimental impact on their motor functions and influence in their fMRI performance. In addition, Drs. Bhattacharya, Davis, and Rao have recently completed a Navy sponsored collaborative project with investigators from Ohio State University, Wright State University, and Naval Medical Research Unit – Wright Patterson Air Force Base, Dayton, investigating the role of epigenetics influencing motion sickness mediated impact on motor and cognitive functions among navy aviators.

Dr. Mark Schulz, co-director of UC's Nanoworld Laboratory, along with his colleagues, graduate students, and postdocs, have been investigating PRP/TRT sponsored research dealing with a variety of innovative projects such as 1) lightweight nanofabric for protecting firefighters and first responders from toxins and particulates and 2) lead-free, X-ray shielding personal protective equipment (PPE) for healthcare workers. His collaborators encompass a wide range of specialists in firefighting industries such as Fire Chiefs BJ Jetter and Jim Cambell in Cincinnati and Indianapolis, IN, respectively, as well as firefighting equipment industry, Lion Products, Dayton, Ohio. Dr. Vesselin Shanov, and his colleagues, graduate students, and postdocs have been involved in research projects associated with firefighter PPE and medical implant applications supported under multiple PRP awards to his students. Some of their PRP projects related to NORA topics have resulted in patents and invention disclosures, such as a patent application recently filed by Dr. Shanov and recent awardee Vamsi Kondapalli on methods for making 3D-shaped 3D graphene. Often, Drs. Shanov's and Schulz's research involves collaborations with local firefighter stakeholders and UC Entrepreneur in Residence for the firefighter Accelerator Project, Mr. Greg Bell. The primary goal of their research is to reduce core body temperature; even 1<sup>o</sup> C will lessen the chance of heat stress-related medical problems and might be the first commercial nanofabric garment created by the UC Nanoworld Lab

Dr. Bhattacharya is continuing his collaborative study of the effect of heavy metals (Mn) exposure on motor functions among community children, with Dr. Erin Haynes at UK ERC. Dr. Yadav and his postdoc at UC is collaborating with researchers from WKY TPG to investigate microbiome changes as markers of exposure and stress among firefighters.

## **G.4. Dissemination of the Results to Communities of Interest**

### ***Annual Pilot Research Project Symposium***

Each year all funded project awardees were required to present their findings at a symposium held at the University of Cincinnati. During the project period since 2016, over 400 people attended the PRP Symposia.

- The 17<sup>th</sup> annual Pilot Research Project Symposium was held on October 13-14, 2016, at the University of Cincinnati, College of Nursing. At this symposium, there were a total of 23 presenters (platform and poster). The keynote speaker was Dr. Anita Schill from the NIOSH Total Worker Health Program, presenting on *Advancing Well-Being through Total Worker Health*.

- The 18<sup>th</sup> annual Pilot Research Project Symposium was held on October 5-6, 2017, at the University of Cincinnati, Medical Sciences Building. At this symposium, there were a total of 25 presenters (platform and poster). To celebrate the ERC's 40<sup>th</sup> Anniversary, University of Cincinnati President Neville Pinto gave welcoming remarks, and a senior staff member from Ohio Senator Sherrod Brown's office read a proclamation on the importance of occupational safety and health research. The symposium also hosted a special ceremony to award occupational safety and health impact awards. The keynote speaker was Dr. Carri Casteel from the University of Iowa, presenting on *Public Health Approach to Workplace Violence Prevention in Small Businesses*.
- The 19<sup>th</sup> annual Pilot Research Project Symposium was held on October 11-12, 2018, at the University of Cincinnati, College of Pharmacy. At this symposium, there were a total of 22 presenters (platform and poster). The keynote speaker was Captain Lauralynn McKernan from the CDC, presenting on *Listen to the Music: How Rock 'n' Roll Provides Touchstones for the Evolution of Occupational Health*.
- The 20<sup>th</sup> annual Pilot Research Project Symposium was held on October 10-11, 2019, at the University of Cincinnati, Kettering Laboratory. At this symposium, there were a total of 22 presenters (platform and poster). This year an additional 1-hour ethics training was added to the event as well as the use of an event app to increase collaboration and networking. The keynote speaker was Dr. Laura Punnett from the Center for the Promotion of Health in the New England Workplace (a NIOSH Total Worker Health Center), presenting on *Total Worker Health: Integrating Workplace Health Protection with Workforce Well-Being*.
- The 21<sup>st</sup> Annual Pilot Research Project Symposium was held on October 1-2, 2020. Due to COVID-19 concerns, the 2020 symposium was a virtual event using WebEx and the event app Whova. At this event, there were a total of 19 presenters, including the 1-hour ethics session, yoga for office workers special presentation, and the PRP awardees. The keynote speaker was Dr. Claire Caruso from NIOSH, presenting on *Importance of Sleep Health and Workplace Strategies to Promote it*.

Based on the evaluations of the PRP Symposium since 2015, the average ratings received for categories of "Overall rating for the conference" and "Quality of presentations" were 4.55 and 4.5, respectively [1 (low) to 5 (high)]. The PRP symposium also started using the Whova app in 2019 to increase networking and engagement.

#### ***Additional funding for publication and conference presentations***

The PRP program has allocated an additional \$40,550 from carryover funds to offer former awardees the option to apply for funding to help publish manuscripts and present at conferences if the work is related to their PRP project. Multiple past awardees have taken advantage of these funds and presented PRP results at conferences and submitted manuscripts; one was recently published in the Fire Safety Journal on *Assessment of ambient air diesel particulates in fire departments using different exposure metrics: Pilot study*. Another one was published in the Ergonomics International Journal on *Effects of Heat Exposure from Live-Burn Fire Training on Postural Stability of Firefighters*.

## **G.5. PRODUCTS**

### ***Publications, conference papers, and presentations***

Since 2016, PRP awardees have published 33 peer-reviewed articles, 4 book chapters, 9 additional articles in press, and made 35 conference presentations, all based on results from their initial PRP awards. In addition, PRP awardees have received additional grants based on PRP project results since 2016, totaling \$7,502,142.

### ***Website(s) or other Internet site(s)***

- PRP website: <https://med2.uc.edu/eh/centers/erc/programs/prp>
- Blog updates about the RCB workshops and PRP symposia are posted after each event to inform stakeholders: <http://med2.uc.edu/eh/centers/erc/blog>
- Past PRP symposia are posted on the PRP website, including award winners, videos of speakers, and a summary of the event: <http://med2.uc.edu/eh/centers/erc/programs/prp>

### ***Inventions, Patent Applications, and/or Licenses***

Eight invention disclosure and four patents.

### ***Other Products***

- The PRP database is used to track the progress of all current and past PRP awardees.
- The PRP Symposium began using the Whova app in 2019 to allow for easy registration, paperless document sharing (e.g., presentation slides), voting for best poster, and social networking. Within the app, participants can arrange meetings with other attendees, obtain contact information, and post directly to social media outlets such as Twitter. During the symposium, interested parties not attending the symposium in person were able to learn about event highlights.

## **G.6. IMPACT**

### ***Examples of senior researchers from fields outside OSH who are making significant progress in the OSH field- Impact on attracting investigators from fields other than OSH:***

During the last five years, we have supported 18 PRP projects proposed by researchers outside the OSH disciplines. Several of the awardees are postdocs who are being mentored by senior researchers who were originally recipients of PRP funding as far back as 2001. For example, Drs. Yadav, Schulz, Shanov, and Bernstein received their first PRP grants as non-OSH faculty but continued their research agendas in the area of OSH. Since then, these senior researchers have persistently continued their quality OSH research by introducing their non-OSH PhD and postdocs to the disciplines of OSH. Such progressive training of a new generation of researchers from non-OSH fields to solve OSH problems is the hallmark of UC's PRP program.

### ***Examples of career development of junior researchers growing their research with initial PRP support:***

***Personal experience from Cody Morris, Assistant Professor, 2017-18 PRP Awardee:*** “The experience that I have gained as a result of this grant award is immeasurable! This was not only the first external grant that I was a PI on, but the first external grant that I have been involved in any capacity...The grant writing workshop conducted in the Spring by the UC ERC was invaluable to me in helping me to learn more about the grant writing process and how to potentially conduct an impactful study worthy of extramural funding.

This grant also provided me the first experience I have had in working directly with the firefighting population...While this certainly can provide useful information, it provides a certain degree of legitimacy to the project when you can actually employ the intended population rather than attempting to generalize. Also, being able to tell the firefighting departments that we had an extramurally funded grant to the project provided a degree of legitimacy to the project that made them much more comfortable with their participation.”

***Personal experience from Jennifer Perion, PhD Student, 2017-18 PRP Awardee:*** “As a grant recipient, I was able to work as a PI on every aspect of a research project from initial planning through dissemination. I feel that this opportunity has helped prepare me for the dissertation process next year. Additionally, I have a much better understanding of the grants process because of the workshop and grant program.

The opportunity to assume the role of PI for a funded project exposed me to many new responsibilities. Successfully completing the PRP project will show prospective employers that I have the ability to prepare grant proposals, manage a research project, and disseminate my work to the scientific community.”

***Personal experience from Katherine Barlow, PhD Student, 2018-19 PRP Awardee:*** “The pilot project provided an excellent opportunity for me to combine research interests in occupational health, gender, diversity, and high-risk occupations. In addition to providing me with greater exposure to occupational health topics outside the field of industrial/organizational psychology, the pilot project helped me to establish contacts in the field of nursing, which helped me to reach the population I hoped to study...”

***Historically Black University Participation:*** PRP program supports research studies proposed by faculty from two regional historically black universities (HCBUs), i.e., Central State University and Kentucky State University.

### ***Long-term impact of PRP projects***

A 2009-10 PRP awardee and associate professor at the University of Cincinnati recently identified cancer-causing chemicals to which firefighters may be exposed. The research, coupled with help from the City of Cincinnati, was used in an awareness campaign instructing firefighters to take precautions that could prevent exposure to potentially dangerous chemicals. The awareness campaign also helped pass Ohio Senate Bill 27, signed into law in 2018, that compensates firefighters diagnosed with certain types of cancers.

The purpose of one project was to develop a system that increases first responder situational awareness and reduces the risk of environmental accidents by reducing the time it takes for first responders to get to injured individuals. Unmanned Aerial Vehicles (UAVs), Simultaneous Localization and Mapping (SLAM) algorithms, and computer vision-based object identification and victim state estimation were used to develop an interactive map for first responders. The impact of this work will assist first responders and firefighters during disaster events. The technology was developed to reduce risk and injuries to first responders during rescue missions. This will also effectively improve the search for victims in areas affected by the disaster.

Another project focused on the work-related injuries of nurses caused by doing unhealthy, unsafe, and repetitive movements with heavy objects while at work. The researchers presented a novel approach to collecting movement data with a lower-limb IMU-based sensor frame. IMUs are inertial measurement units, which allow the determination of joint acceleration. The project laid the groundwork for future studies related to the field of occupational health nursing and created a prototype for a tool to be used in real-time by nurses to help reduce workplace injury.

### ***Pilot projects have resulted in Research-to-Practice (r2p) applications***

All PRP proposals are required to provide potential r2p applications of their research findings in their final report. Therefore, we have a list of r2p applications from the last funding period. In the following, examples of a couple of r2p applications are presented.

- A PRP carried out by a PhD student of robotics in the college of engineering developed a computer vision-based application of human posture recognition using an artificial intelligence algorithm. This algorithm is designed to detect unsafe worker postures and then provide corrective feedback, thereby minimizing ergonomic risk factors in the workplace.
- A PRP carried out by an engineering student from the UC's Nanoworld Laboratories dealt with dual-functionality heatable carbon nanotube (CNT) air filters and a unique self-sterilizing face mask for healthcare workers. The CNT air-filters used in this mask exhibit ultrafast thermal response, low operation voltage, and long lifetimes. Furthermore, CNT is a hundred times lighter than copper, which is often used in filters. This r2p application has immediate application to help develop a self-sterilizing face mask for the current COVID-19 pandemic.

### ***Summary of PRP accomplishments during the funding period since 2016***

- PRP program allocated \$364,254 to support 53 pilot research projects
- These projects served as a catalyst for bringing in \$7,502,142 (ROI 19:1) in additional grant funding from sources independent of the PRP program to support the OH, KY, IN region.
- Publications: 33 peer-reviewed articles, 4 book chapters, 9 additional articles in press, and 35 conference presentations
- 18 investigators new to the occupational safety and health field.

## H. TARGETED RESEARCH TRAINING PROGRAM (TRT)

TRT DIRECTOR: TIINA REPONEN, PHD  
DEPUTY DIRECTOR: AMIT BHATTACHARYA, PHD, CPE

### H.1. ACCOMPLISHMENTS

#### H.1.1. Major Goals

The objective was to offer interdisciplinary research training with a focus on home healthcare. PhD students and post-doctoral fellows were recruited as TRT trainees and will conduct their thesis research in this project. Suitable parts were used as spin-off student projects in the interdisciplinary Occupational Safety & Health (OSH) Workshop class (EIH-8019 and EIH-8020) as well as MS and PhD theses projects. The results were disseminated to practitioners in the region in collaboration with the Outreach program. Mentors are expected to use the results as pilot data to develop extramural grants.

The central objective during the current five-year cycle was to develop and validate a comprehensive and systematic framework for assessment and control of cumulative health and safety risks among home healthcare workers (HHCWs).

#### H.1.2. Accomplishments under These Goals

##### **Overview**

During the reporting period, there were 7 PhD trainees and 3 post-doctoral fellows in the TRT program. Additionally, the thesis research of one PhD student and one MS student was on occupational safety and health of home healthcare workers.

##### **PhD Trainees**

Addor, Yao [Mentor: Dr. Reponen (EIH), in training] passed the PhD qualifying exam in May 2020, and studies indoor and outdoor biological particles.

Awards: 6 (Barkley, Bell, and Bingham Award, 2018; AIHF Ralph J. Vernon Scholarship, 2019; AIHF Gary and Bonnie Olmstead Scholarship 2020 and 2021); PRP grant, 2020.

Number of peer-reviewed papers: 0; conference presentations: 6

Benjamin, Michael [Mentor: Dr. Virkutyte (EIH), graduated in fall 2019] The title of the dissertation is "Cleaning Product Chemical Exposures Measured in a Simulated Home Healthcare Work".

Awards: 4 (AIHF Industrial Hygiene Outstanding Student Award, 2018; AIHF Gary and Bonnie Olmstead Scholarship, 2018; Best student paper from Society for Chemical Hazard Communication, 2018, Best Paper Award at AIHce from Exposure and Control Banding Committee, 2018)

Number of peer-reviewed papers: 1 published; conference presentations: 3

Bien, Elizabeth, MSN, RN [Mentor: Dr. Gillespie (OHN), graduated in summer 2020]. She graduated in August 2020. Title of the dissertation is "Observing Healthcare Workers in the Home Environment."

Awards: 0

Number of peer-reviewed papers: 4 published; conference presentations: 1

Other: Member of National Occupational Research Agenda (NORA) for Healthcare and Social Assistance Sector (HCSA).

Elmashae Yousef [Mentor: Dr. Grinshpun (EIH) Graduated in fall 2017]. The title of his dissertation is "Evaluating the Aerosol Exposure and Respiratory Protection of Healthcare Workers in Different Environments."

Awards: 0

Number of peer-reviewed papers: 8 published; conference presentations: 6

Niemeier-Walsh (nee Uebel), Christine [Mentor: Dr. Reponen (EIH), graduated in spring 2020]. Title of dissertation is "Exposure to Traffic-Related Air Pollution and Biological Aerosols: Effect on the Respiratory Microbiome and a Comparison of Measurement Methods."

Awards: 4 (AIHF Scholarship, 2018; Gary and Bonnie Olmstead Scholarship, 2018; Barkley, Bell & Bingham Award, 2018. Safety Activist-Scholar of the Year by the Cincinnati Interfaith Workers Center, 2018); PRP grant, 2018.

Number of peer-reviewed papers: 3 published; conference presentations: 5

Nathu, Vishal, MPH [Mentor: Dr. Reponen (EIH), in training] passed the PhD qualifying exam in May and started as TRT trainees in September 2020. His research will focus on the use of a direct-reading fluorescence instrument on bioaerosol assessment.

Awards: 9 (AIHA/F Scholarship(s) 2018-2021; ASSP Scholarship(s) 2019-2021; NSC Scholarship 2019; 3M PSD Scholarship 2020).

Number of peer-reviewed papers: 0 published, 3 in preparation; conference presentations: 1

Small, Tamara, MSN, RN [Mentor: Dr. Gillespie (OHN) and Dr. Davis (EIH), graduated in summer 2020]. Title of the dissertation is "Violence in Home Healthcare (dissertation)."

Awards: 1 (Wekselman Dissertation Award)

Number of peer-reviewed papers: 2 published; conference presentations: 1

Turner, Ashley [Mentor: Dr. Reponen (EIH), in training] passed the PhD qualifying exam in May 2020 and did her thesis on the effect of ultrafine exposures in respiratory health (graduated in August 2021)

Award: 1 (Ohio Valley Local Section Scholarship); PRP grant, 2019.

Number of peer-reviewed papers: 1 published, 3 submitted; Conference presentations: 3

### **Post-doctoral Fellows**

Cox, Jennie [Mentor: Dr. Reponen (EIH), completed in January 2021]. The topic of the research is "Microbiome exposure and respiratory health."

Awards: 0

Number of peer-reviewed papers: 3; conference presentations: 2

Frank, Evan [Mentors: Drs. Maier and Grinshpun, completed in spring 2019]. The topic of his research was "Estimating safety limits for exposure to active drugs during home healthcare work."

Awards: 0

Number of peer-reviewed papers: 5; conference presentations: 5

Virkutyte, Jurate [Mentor: Dr. Reponen (EIH), completed in fall 2018 and then moved to a faculty position]. The topic of her research was "Characterizing bioaerosol exposures during home healthcare activities."

Awards: 0; PRP grant, 2017.

Number of peer-reviewed papers: 3; conference presentations: 7

### **Other students**

Ollier, Katherine (Mentor: Dr. Grinshpun (EIH), graduated in summer 2018). The title of her MS thesis is "Inhalation Exposure and Respiratory Protection of Home Healthcare Workers Administering Aerosolized Medications (Simulation Study)".

Award: 1 (Best Paper Award at AIHce Philadelphia, PA, 2018)

Number of peer-reviewed papers: 1; conference presentations: 1.

Ishua, Simileoluwa [Mentor: Dr. Grinshpun (EIH), graduated in spring 2020]. The title of his dissertation is "Dermal Exposure and Risk to Aerosolized Pharmaceuticals in Home Healthcare Workers".

Awards: 0

Number of peer-reviewed papers: 4; conference presentations: 3

### **Accomplishments of the Faculty**

Dr. Tiina Reponen currently has two ongoing extramural grants related to indoor air quality and microbial exposures in indoor environments. She actively collaborates with other faculty members related to respiratory protection against aerosol hazards, including protection against the SARS-CoV-2 virus. During the past project period, she published over 40 peer-reviewed articles and supervised four TRT PhD students and two TRT post-doctoral fellows. Dr. Reponen was an Associate Editor of two journals: *Indoor Air* and *Aerosol Science and Technology*. She received the David Sinclair Award from the American Association for Aerosol Research in recognition of her bioaerosol research in 2019. She was appointed as a member of the NIOSH Board of Scientific Counselors starting on January 1, 2020, and a chair starting on January 2021.

Dr. Amit Bhattacharya received two grants: one to study the postural balance and gait effects associated with disorientation among Navy aviators and one to study the impact of reduced thermal load on PFD use among shrimp fisherman. Dr. Bhattacharya provided an invited Keynote Seminar at the First Annual Research Symposium: "Engineering Better Medicine" at Miami University, Oxford Ohio. Dr. Bhattacharya was recently named a senior member of the National Academy of Inventors (among 54 from across the country given this honor).

Dr. Kermit Davis has received two grants and three contracts during this period. He published 12 peer-reviewed papers (with additional 10 in review), and mentored two TRT PhD students. He received the department's Award for Teaching Excellence (2016) and the Bernice Owen Award of Research in Safe Patient Handling from the Association of Safe Patient Handling Professionals in 2018. Dr. Davis is an Associate Editor of two journals: Human Factors and Journal of Agricultural Safety and Health. Dr. Davis was elected a Fellow of the HFES (2018) and Fellow of the AIHA (2019).

Dr. Gordon Gillespie received three extramural grants. Since 2016, he has authored or co-authored 41 peer-reviewed articles. In 2016, he was inducted as a Fellow of the American Academy of Nursing. Due to the impact of his research, he was selected to serve as one of 28 members to the 2019-2020 National Quality Forum's action team to prevent healthcare workplace violence. He supervised two TRT PhD students.

Dr. Sergey Grinshpun received three extramural grants/contracts and published over 40 peer-reviewed papers. During the past 6 months, he has been active in investigating respiratory protection against the SARS-CoV-2 virus. He supervised one TRT post-doctoral fellow, one TRT PhD student, and two additional students who conducted their thesis research related to home healthcare workers.

Dr. Thomas Huston received the Dean's Award for Faculty Excellence, the highest honor given by the College of Engineering and Applied Science.

Dr. Jay Kim published four journal papers and two conference papers and graduated one OSHE PhD and two OSHE MS students during the project period.

Dr. Nicholas Newman is the site director for the Pediatric Environmental Health Specialty Unit grant. He published five peer-reviewed papers and supervised three OMR residents. He currently serves as a mentor for a TRT PhD trainee's PRP project.

Dr. John Reichard received a highly competitive IPA award with NASA (beginning July, 2020). Additionally, he was the PI or co-PI in five other grants/contracts. He published ten peer-reviewed papers and mentored one PhD and two MS students in the EIH and BIOM programs.

### **H.1.3. Opportunities for Training and Professional Development Provided by the Project**

#### **Overview**

The TRT program afforded significant training opportunities for students and post-doctoral fellows as discussed above. The TRT program relied on the diversity recruitment approaches for the ERC as a whole and drew candidates from the pool of students admitted to the program. The training and professional development focused on the following aspects:

- Course work: Strong set of skills in research design, development and epidemiological methods, biostatistics, study and survey design, measurement of outcomes, determining impact and ethical and regulatory principles of research.
- Skills in grant writing: Each trainee attending the Research Capacity Workshop.
- Skills in oral communication: Each trainee presenting in PRP symposium and Students Research Findings symposium annually.
- Skills in written communication: Each trainee striving for one conference abstract and/or one publication per year

### **H.1.4. Dissemination of the Results to Communities of Interest**

We organized two webinars targeting home healthcare workers and agencies as the audience:

1. Home Healthcare Workers and the Coronavirus: How to Protect Yourself
2. UC ERC Town Hall: Personal Protective Equipment Donations for Home Healthcare Workers,
3. Stress and Burnout in Home Healthcare: Causes, Impact, and Prevention, and
4. Workplace Violence in Home Healthcare.

These are available online free of charge at the ERC website: <https://med.uc.edu/eh/centers/erc>

Additionally, Dr. Grinshpun gave a departmental seminar, "Respiratory Protection and Transmission Routes for SARS-CoV-2" on June 10, 2020 and an ERC Continuing Education webinar, "Respiratory Protection in the

COVID-19 Pandemic: Research Findings from the Center for Health-Related Aerosol Studies” on May 11, 2021.

## **H.2. PRODUCTS**

### **H.2.1. Publications, conference papers, and presentations**

The TRT research objectives focus on the characterization of hazards and exposures to home healthcare workers. During this reporting period, 28 peer-reviewed manuscripts were published, and 5 additional manuscripts were submitted on the results from TRT studies. The TRT trainees received 26 awards and presented their results via 36 presentations at local, national, and international conferences.

### **H.2.2. Website(s) or other Internet site(s)** – include URL(s)

TRT website: <https://med.uc.edu/eh/centers/erc/programs/trt>

## **H.3. IMPACT**

### **H.3.1. Examples of research results published by TRT trainees**

In 2016, Hittle et al. reported in their UC ERC-funded Targeted Research Training project that musculoskeletal injuries were still a leading burden to home healthcare aides. Other risks and exposures were administering medication outside their scope of practice and second-hand smoke.

Several other students have been working with home healthcare workers to catalog their risks and exposures. Recent projects have focused on identifying strategies that would increase the safety and health of home healthcare workers (e.g., Bien et al. 2020). Exposures and risks identified in other research include exposure to body fluids, sharps, bloodborne pathogens, and SARS-CoV-2; contact with chemical agents and fumes; dangerous conditions outside the home; and physically aggressive persons and pets (Bien et al., 2020).

Elmashae et al. (2017) compared one model of an N95 filtering facepiece respirator (FFR) and one model of a surgical mask (SM) while they were worn by home healthcare workers during various activities performed in a patient's home. They concluded that the FFR offers a much higher protection level as compared to an SM. The performance of N95 FFR and SM was found to be dependent on activities and/or body movements (Elmashae et al., 2017). The data obtained in this research effort will help respirator manufacturers to design better respiratory protective devices for healthcare workers. The findings can also be used by regulatory agencies to create a respiratory guideline for protecting healthcare professionals in their workplaces.

In a laboratory-based study, Elmashae et al. (2019) showed that a commonly used test aerosol, NaCl, can serve as a reliable surrogate for assessing aerosol exposures for the selected aerosolized medications (Elmashae et al., 2019). In two follow-up studies, NaCl aerosol was used as a test aerosol to assess home healthcare workers' inhalation and dermal exposures to pressure-nebulized medications (Ollier et al., 2019, Ishau et al., 2020).

The results on the inhalation exposure showed that the proximity to the aerosol source affected the aerosol concentration, but only within close proximity, within 24 inches. For an unprotected home healthcare worker, ventilation was the most effective way to reduce inhalation exposure to nebulizer-produced medical aerosols. An increase in the air exchange rate from 0 to 5 h<sup>-1</sup> significantly reduced the exposure. Wearing N95 respirators was found to be the most efficient way to reduce aerosol exposure resulting in protection factors varying from 62 to 101 (corresponds to over 98% reduction) (Ollier et al., 2019). Regarding the dermal exposure, there was a 2.78% reduction in dermal deposition for every centimeter the home healthcare worker moved away from the patient. Increasing the room's air exchange rate by one air change per hour increased dermal deposition by about 2.93%, possibly due to a decrease in near-field particle settling (Ishau et al. 2020). These results suggest some practical steps for exposure reduction. Exposure reduction based on engineering and nebulizer product design is the preferred method based on the hierarchy of controls. Increasing the ventilation can reduce exposures, but exposure reduction is highly dependent on the direction of the air movement relative to the patient and worker. Additionally, administrative controls are likely to be effective in reducing exposures. Home healthcare agencies and hospitals can provide training to their staff on how to protect themselves from dermal over-exposure when administering medications. The training should include instructions on choosing an appropriate operational distance (where the risk of over-exposure is lowest and hands-on care is not impacted) and maintaining adequate positioning techniques based on the direction of the air supply to the room or treatment area. The provision of personal protective equipment (PPE) could also help mitigate exposures. Wearing gloves was estimated to reduce the deposited dermal dose by about 20%.

Together this combination of actions provides a potential exposure reduction program relevant to HHCW scenarios.

Frank et al. (2019) developed risk-based exposure limits for workers in the form of occupational exposure limit (OEL) values for exposure to nebulized forms of the three most common drugs administered by this method: albuterol, ipratropium, and budesonide. The derived OEL for albuterol was 2 µg/day, for ipratropium was 30 µg/day, and for budesonide was 11 µg/day. These OELs were derived based on human effect data and adjusted for pharmacokinetic variability and areas of uncertainty relevant to the underlying data (human and non-human) available for each drug. The resulting OEL values provide input to the occupational risk assessment process to allow for comparisons to HHCW exposure that will guide risk management and exposure control decisions.

Benjamin et al. (2020) studied airborne chemical concentrations of sprayed cleaning chemicals (acetic acid or ammonia) during typical cleaning tasks in a simulated residential work environment. While measured exposures were not above OELs for acetic acid or ammonia, they were in a range that may require risk management decisions. It was observed that the use of ventilation reduced exposures for most but not all tasks, meaning that alternative control measures may need consideration in these environments. Posture differences (mopping vs. kneeling to clean floors) also reduced exposures, possibly due to increased distance between subjects and the cleaned surfaces.

Niemeier-Walsh et al. (2020) compared the bacterial and fungal communities in the environment and the human respiratory tract. Induced sputum and saliva samples and environmental dust wipes were collected from a cohort of study participants. We found that home dust had a very low bacterial load and a very high fungal load compared to the lower respiratory tract. Therefore, when considering the exposure pathways, home dust appears to be a more significant reservoir for fungi than for bacteria. The association between environmental and respiratory microorganisms was most clearly seen between mycobiomes in dust and saliva.

Cox et al. (2020) measured visible mold and moisture damage to find a quantitative variable that would help determine specific exposure-response relationships regarding dampness and mold and poor respiratory health outcomes. The highest categories analyzed for both variables, moisture damage ( $\geq 0.29 \text{ m}^2$ ) and mold damage ( $\geq 0.19 \text{ m}^2$ ), had significant associations with negative health outcomes.

### **H.3.2. Examples of the past TRT trainee's current positions**

- Dr. Evan Frank TRT postdoc) is now working at NIOSH, Cincinnati, as Senior Fellow.
- Dr. Michael Benjamin (TRT PhD student) is currently working as Assistant Professor in Fire and Safety Engineering Technology at the University of North Carolina at Charlotte.
- Dr. Yousef Elmashae TRT PhD student) is currently working at NIOSH Pittsburgh as Industrial Hygienist.
- Dr. Elizabeth Bien (TRT PhD student) is currently working as a Research Fellow in the Employee Safety Learning Laboratory in the Cincinnati Children's Hospital Medical Center.

### **H.4. SUMMARY OF ALUMNI SURVEY**

An ERC-wide survey of alumni in the last five years was conducted in spring 2020. Due to the small number of TRT graduates, they were not surveyed separately. However, in the overall ratings of 12 different ERC program components, research mentoring was rated the highest (4.4 on a scale from 1-5).

## I.1. ACCOMPLISHMENTS

### I.1.1. Major Goals

The goals of the Outreach program are:

1. To disseminate information via Cerkl
2. To increase collaborations and consultations with local and regional industry partners to disseminate information
3. To develop and implement a safety and health hotline for low-wage workers
4. To develop online courses in safety and health topics among the ERCs and TPGs.

### I.1.2. Accomplishments under These Goals

**Goal #1:** Cerkl is a customizable social media network that allows engagement with the stakeholders in the region as well as the alumni of our programs. The group continues to add more members and update e-mail addresses for existing members for all groups, although COVID-19 has slowed this effort over the last six months (March 2020 to September 2020). Cerkl has a structure where all members belong to the ERC group (parent group) as well as a program-specific group (e.g., EIH, OHN, OMR, or OSHE) (sibling group). If a message is sent to the ERC group, it goes to all programs. Current memberships for the Cerkl groups are 362 members for the EIH, 68 members in OHN, 22 members in OMR, and 399 members in OSHE. The read rate for messages is 37% for EIH, 17% for OHN, 17% for OMR, 7% for OSHE, and 36% for ERC, as compared to the national average for the system of 22%. Each of the programs aims to send at least one message per week on average, which has been maintained for most of the programs. Each program has at least one trainee assigned to oversee the expansion and keep the members current as people change jobs (e.g., change e-mails). Each program is required to post abstracts of their recent graduates for theses and dissertations. Programs such as EIH and OHN have posted about recent job openings as well as requests to assist our programs (e.g., need for companies for walkthrough courses, speakers for current topics, and interdisciplinary trips).

**Goal #2:** Each program puts a trainee in charge of recording the many interactions and outreach activities of the faculty. These outreach activities include: 1) presentations and seminars to non-health & safety peers, 2) consultations with industry, government, labor, and public health groups, and 3) continuing education activities. Table Outreach-1 provides a summary of the outreach activities for each category. We also track interactions with our external advisory boards and alumni, such as providing feedback to the program, lecturing in courses, and serving on thesis/dissertation committees. Further, the outreach team has started two initiatives in addition to Cerkl that aim to increase collaborations with the local industry. First, webinars that focus on health and safety in home healthcare were designed to build better links to agencies and workers, going beyond asking for their help for research. These efforts have yielded a focus on gathering Personal Protective Equipment (PPE) for workers who are struggling due to COVID-19. Second, we have continued our efforts and collaborations with the Cincinnati Interfaith Workers Center (CIWC), where we have provided guidance about health and safety for low-wage earners who work in construction and restaurants. These two focus areas have been the traditional workers attending meetings in the CIWC. Brennan Grayson, CIWC director, has become an active member of the ERC external advisory board (EAB).

**Goal #3:** A group of ERC student trainees and faculty have implemented a hotline for the workers at CIWC. The idea was initiated by Christine Niemeier-Walsh (EIH PhD trainee). Bing-Bing Wu, Vishal Nathu, and Rachel Zeiler (IH PhD non-ERC supported trainees) have all assisted with setting up and opening the hotline, as well as coordinating the volunteers. The hotline is a collaboration between the ERC students and faculty, CIWC, and the local chapter of AIHA. The concept is that a worker can call in and leave a message about a question on health and safety concerns for their work, and a volunteer will develop an answer and call them back to explain it. We have developed a bank of about 30 volunteers with various expertise and backgrounds. After several months of no

**Table Outreach-1: Summary of Faculty, EAB Members, and Alumni Outreach Activity.**

Activity	July 2016 - June 2017	July 2017 - June 2018	July 2018 - June 2019	July 2019 - June 2020	July 2020 - October 2020
Presentations and Seminars to Non-Peers	21	19	26	8	5
Consultations with Industry, Government, Labor, and Public Health	19	17	19	20	21
Continuing Education Activities	13	12	8	10	1
External Advisory Board Interactions	2	1	3	4	3
Alumni Interactions	9	10	24	18	9

calls, a Health and Safety Workshop team conducted a study using focus groups to ask whether workers had any knowledge of the hotline and what barriers existed for using the hotline. Several barriers were identified, including 1) need for better ways to publicize the hotline, which could include public announcements on the local Spanish radio station and a team member in person at CIWC meetings and 2) better guarantee that hotline is safe in the new situation of immigrants (e.g., they are worried about being turned in to ICE). The Outreach team was about to implement some initiatives to address these issues when the COVID-19 pandemic started and shut down all non-essential university activities. When the university opens up, the team will reengage these initiatives.

**Goal #4:** The development of the collaborative online Continuing Education course was found to be more difficult to implement than was expected due to several years with no ERCs or TPGs submitting to the call. In the first year, the Mountain & Plains and Johns Hopkins ERCs developed the Occupational Health Nursing Online Review Course. In the second year, the Rocky Mountain and North Carolina ERCs submitted a proposal for a course called Health Effects of Environmental Agents, but about a month later, faculty changed, the group rescinded the proposal, and no course was developed. During the 3rd and 4th years, no submissions were received. At this point, the outreach team decided to refocus this money on outreach. The team decided to develop a webinar series for home healthcare workers (based on the success of the Industrial Hygiene and Ergonomics webinar series that was developed by the Center for Occupational and Environmental Health – Northern California ERC). Starting in May 2020, we have had monthly webinars including the following titles: 1) Home Healthcare Workers and the Coronavirus: How to Protect Yourself, 2) UC ERC Town Hall: Personal Protective Equipment Donations for Home Healthcare Workers, 3) Stress and Burnout in Home Healthcare: Causes, Impact, and Prevention, and 4) Workplace Violence in Home Healthcare (webinar links: <https://med.uc.edu/eh/centers/erc/coronavirus-and-workplace-safety>). This link also contains other sources related to COVID-19. We have also developed an initiative to raise funds to buy PPE for home healthcare agencies from the first set of webinars, as these agencies are at a significant disadvantage compared to hospitals and long-term care facilities.

### **I.1.3. Opportunities for Training and Professional Development Provided by the Project**

The webinars are offered in collaboration with the CE program and are eligible for CE credits.

### **I.1.4. Dissemination of the Results to Communities of Interest**

Cerkl continues to be a major informational mechanism that allows recent research to be translated directly to the stakeholders in the region and nationally. Every trainee who completes a thesis or dissertation provides a short summary (abstract) that is disseminated on Cerkl. This allows cutting-edge research to be provided directly to the practitioners in our network. We have close to 900 members across the four programs within the ERC that have continued to receive messages since the initiative was implemented in our ERC. In general, messages about job openings, thesis/dissertation abstracts, and program announcements are sent by e-mail at a rate of about one to four per month. Also, we have added other social media such as Twitter (Twitter @uc\_erc), Facebook (<https://www.facebook.com/University-of-Cincinnati-NIOSH-Education-and-Research-Center-489035578232856>), and ERC blog (<https://med.uc.edu/eh/centers/erc/blog>). Recently, we started a YouTube channel (<https://www.youtube.com/playlist?list=PLrixI9q4GUJJ2yRae84Wfe3zLENx5B7Ot>) and a LinkedIn group (<https://www.linkedin.com/groups/13884134/>). Our goal is to expand the reach of these latter two social media tools. Table Outreach-2 provides a summary of the members/hits/views of the outreach social media domains.

Trainees and faculty have developed videos to address health and safety concerns for firefighters and home healthcare workers. These short videos provide recommendations and best practices to mitigate many of the

potential risk factors in these two professions. Each video is 3 to 5 minutes long, covering a summary of the problem, an interview with workers (testimonials), and a description of interventions or procedures that could reduce the exposures. These videos include topics of inhalation safety for firefighters, heat stress for firefighters, noise exposure for firefighters, pets and pests for home healthcare nurses, and egress and ingress safety for home healthcare. The Ohio Association of Professional Firefighters posted our YouTube video on their Facebook page,

**Table Outreach-2: Summary of Social Media Activities.**

<b>Social Media</b>	<b>Members, Hits, and Views (Jan, 2018 to Aug, 2020)</b>
Cerkl	886 members
Facebook	54 likes, 61 followers
Twitter	157 followers
ERC Blog	5973 page views
YouTube channel	6901 views
LinkedIn	14 members

and it now has over 151,000 views. Recently, a group of trainees developed health and safety training for construction workers, specifically for ergonomics and respirators. This training module was distributed to low-wage workers at the CIWC. In addition to webinars for firefighters and home healthcare workers, we offer webinars on other topics of regional interest. For example, recent requests from the UC College-Conservatory of Music and Cincinnati Symphony led to an assessment of the release of particles while playing wind instruments and singing. The results were shared with an ERC-sponsored webinar that attracted over 900 participants.

### **I.1.5. Response to previous summary statement**

While all of the previous critiques were deemed as minor, we made several improvements based on the reviewers' responses from the previous summary statement. These include: 1) we expanded our social media beyond Cerkl to Twitter, Facebook, and more recently, a LinkedIn group (as recommended by an EAB member) and a YouTube channel to release our recorded webinars, 2) we have continued to work with CIWC on multiple projects over the last five years including a Safety and Health Hotline, 3) we discontinued the CE ERC collaboration initiative and allocated that funding to other outreach activities, and 4) we expanded outreach activities to include monthly webinars on home healthcare and other topics (e.g., Characterization of Aerosols from Musical Performances). Overall, we continue to adapt the outreach program to disseminate knowledge and expertise within the ERC to the stakeholders in the region.

## **I.2. PRODUCTS**

### **I.2.1. Publications, conference papers, and presentations**

A total of 85 publications and 54 conference abstracts were published based on research by ERC trainees.

### **I.2.2. Website(s) or other Internet site(s)** – include URL(s)

Outreach website: <https://med.uc.edu/eh/divisions/ih/program-outreach>  
 ERC Facebook: [https://www.facebook.com/pg/OAPFF/videos/?ref=page\\_internal](https://www.facebook.com/pg/OAPFF/videos/?ref=page_internal)  
 Cerkl: <https://app.cerkl.com/org/profile.php?id=98#.X1kn8GhKjIU>  
 Twitter: [https://twitter.com/uc\\_erc](https://twitter.com/uc_erc)  
 LinkedIn: <https://www.linkedin.com/groups/13884134/>

## **I.2. IMPACT**

In a short period of time, our webinar series has had over 75 attendees. These webinars will be focused on providing the personnel of the home healthcare agencies with health and safety information that they can implement and impact their workers directly.

There are more than 20 representatives of the offices of state and federal senators and representatives who are members of the Cerkl groups and receive our updates from our programs. In addition, researchers and leaders of NIOSH are also members of Cerkl. We continue to identify people within the region to include in the updates we send out through Cerkl. These contacts include individuals at NIOSH, Ohio Bureau of Workers' Compensation (OBWC), industrial companies, and government representatives. We continue to add individuals who Drs.

Reponen and Davis meet in Washington, DC as part of the Hill visits to talk about the great things the ERC is doing (occurs every February using non-federal travel funds).

As part of the outreach budget, a small amount is budgeted for incentives for the Occupational Safety and Health Workshop course, where those funds are used on projects of regional interest. The results are disseminated to various groups in the industry, such as home healthcare and low-wage earners (e.g., CIWC). Over the past five years, the interdisciplinary teams have worked on projects such as 1) a survey of home healthcare nurses and nursing aides, 2) a study of work-related injuries in workers at the local public school system, 3) an investigation into modes of publicizing the safety and health hotline for low-wage earners, 4) a survey of electronic cigarettes for Maple Knoll Long-term Care Facility (a partner who asked for assistance), 5) identification of health and safety training needs for low-wage construction workers, and 6) a study of exposures to cleaning chemicals for home healthcare workers. These results are being distributed directly to the constituents. For example, results from the study on e-cigarettes were given to Maple Knoll Village (an assisted living and home healthcare agency) administrators, who changed their policies to reduce exposures; the results of the study of work-related injuries in public schools resulted in new training modules for employees; training modules for low-wage construction workers were developed and disseminated based on the results of the study; and home healthcare study results continue to be presented as webinars which are distributed to home healthcare agencies.

The research that ERC faculty members have conducted on firefighters' health and safety in collaboration with other faculty members in the Department of Environmental and Public Health Sciences contributed to the passage of Ohio Senate Bill 27. The bill, known as the "Michael Louis Palumbo Jr. Act," is named in honor of a fire department captain from Beachwood and Willowick, who was diagnosed in 2015 with brain cancer. According to the new law, firefighters with specific cancers linked to firefighting can now receive workers' compensation benefits and paid medical treatment.

## J. CONTINUING EDUCATION (CE)

PROGRAM DIRECTOR: JESSICA BLOOMER  
DEPUTY DIRECTOR: GLENN TALASKA, PHD, CIH

### J1. Major Goals

The major purpose of the Continuing Education (CE) component of the ERC at the University of Cincinnati is to develop and present a multidisciplinary program of training courses in the fields of occupational medicine, industrial hygiene, occupational safety, and occupational nursing. Training courses are offered to enhance the education and expand the knowledge and skills of practicing professionals supporting occupational and public health. Meeting the needs of regional stakeholders through continuing education accomplishes several long-term outcomes: 1) access to multidisciplinary education via CE courses for graduate students, graduates and other professionals, including those in the fields of occupational ergonomics, occupational health nursing, industrial hygiene and biomonitoring, occupational medicine, and occupational safety and health engineering; 2) delivery of continuing education, consultation, and offering of venues to address environmental and occupational safety and health needs through regional partnerships; 3) ensuring that stakeholders' long-term needs for CE offerings are met through needs assessment, evaluation of impacts, and ongoing refinements of strategic plans.

### J.2. Accomplishments under These Goals

The primary products of the CE Program are professional education courses and events. These include the development of materials and offering in-person courses. We have added courses on specialty topics (e.g., hazards of silica). We also have made significant progress in enhancing existing courses (ergonomics, bloodborne pathogens, respiratory protection, hazard awareness, and advanced risk assessment topics such as dosimetry).

For the reporting period of 2016-2021, the CE program has been successfully training occupational safety and health practitioners. During the reporting period, the CE program offered 480 courses with a total of 7,185 attendees specializing in diverse areas of environmental and industrial hygiene, safety and ergonomics, medicine, and nursing (see Table CE-1 with attendee and course numbers).

Of the 480 course offerings, 33 were special events such as workshops, conferences, and symposia. Special events are typically annual or one-time-only based on pressing topics and are often ERC center-wide activities, not just CE. These course offerings received positive feedback; in a recent CE Needs Assessment Survey (see section A7 below), 98% of respondents reported that they were satisfied with the types of CE courses offered. The results of our course evaluations indicate that our CE program offers breadth and quality in courses. Trainees have rated the overall program positively with a 97% customer service approval rating. For special events, attendees have given an overall rating of 4.5 out of 5.0 during the 2016-2021 period. Additionally, trainees find our courses to be relevant (4.2 out of 5.0) and useful (4.5 out of 5). Table CE-1 summarizes the total of all CE offerings during the current project period. During 2016 – 2021, 7,185 participants attended 480 courses.

**Table CE-1. Summary of CE course offerings in 2016-2021**

Core Program	Number of Courses	Number of Participants
Environmental and Industrial Hygiene	16	2,072
Occupational Medicine	10	134
Occupational Health Nursing	52	609
Occupational Safety and Health Engineering	390	3,399
Other	12	971
<b>Totals</b>	<b>480</b>	<b>7,185</b>

### *Specialty Training*

The CE program refined and continued to offer specialty courses in the reporting period as well. These courses include a comprehensive review course for associate and certified safety professionals, a course on risk

assessment and management in collaboration with the US Air Force School of Aerospace Medicine, and Dr. Roy McKay's courses in respiratory protection and spirometry. Drs. Lynne Haber and Andy Maier developed courses in risk assessment and chemical safety. Dr. Glenn Talaska began pairing 1-hour ethics training courses with bigger ERC events in 2018 to increase attendance and offer ABIH ethics credit.

To develop online presence, a risk assessment course was offered in June 2016 that included 16 in-person participants, with four remote participants joining live via audio technology. In collaboration with the American Cleaning Institute, the Society of Toxicology, and the Society for Risk Analysis, Dr. Haver completed the last two sessions of a five-part webinar training session on asthma risk assessment. A 20-module course was designed for online self-study completion on basic food safety risk assessment. This course includes slide and video content with quizzes to verify knowledge acquisition.

The UC Safety TEAM initiative was designed to encourage mentorship between ERC trainees and industry professionals. To enhance training and improve impact assessment, the Safety TEAM developed; A plan for a hotline for ongoing mentoring with a local non-profit worker rights center, AIHA, and ERC students. A 1.5-day on-site training session on setting benchmarks for chemical safety for the staff at a food company. A site visit at a metal products company to discuss workplace hazards and ongoing training and collaboration with ERC students.

The CE program also developed new courses such as silica hazards training in March 2018 that reflected stakeholder interest in the topic. The program continued to offer options for live webinars and remote viewing options as well as recorded courses for later viewing, such as the asthma risk assessment modules, which have been downloaded 241 times.

To connect with local organizations and reach underserved worker populations, the CE program developed a student-led OSHA training with the Cincinnati Interfaith Worker's Center and small businesses.

In 2018 the UC ERC CE program worked with the other ERC CE programs to collaborate and create monthly webinars, hosted by UC Berkeley, in ergonomics for 2019, 2020, and 2021 and added monthly webinars in industrial hygiene in 2020 and 2021. Several UC ERC representatives volunteered to present on industrial hygiene and ergonomics. In 2019, Dr. Amit Bhattacharya presented on "NIOSH ERCs Ergonomics Webinar Series: Assessing Heat Stress Associated Changes in Postural Balance among Firefighters" and Dr. Kermit Davis presented on "NIOSH ERCs Ergonomics Webinar Series: A Patient Handling Story: From Patient Migration to Repositioning" both for the ergonomics series. In 2020, Dr. John Reichard presented for the industrial hygiene series on "Biomonitoring and Risk Assessment: Essential Concepts & Emerging Technology." In 2021, Dr. Sergey Grinshpun presented for the industrial hygiene series on "Respiratory Protection in the COVID-19 Pandemic: Research Findings from the Center for Health-Related Aerosol Studies" and ERC trainee, Thomas Gerding presented for the ergonomics series on "An Investigation of Home Ergonomics Issues Experienced by University Faculty and Students Due to COVID-19." Another ERC trainee, Rachel Zeiler is scheduled to present in November 2021 for the ergonomics series on "Effects of Chronic Shift Work and Heat Stress on Postural Stability in Firefighters: A Pilot Study."

In collaboration with the Targeted Research Training Program, Drs. Davis, Tiina Reponen, Susan Reutman, and Gordon Gillespie gave a webinar on "Home Healthcare Workers and the Coronavirus: How to Protect Yourself" in April 2020. Drs. Davis and Reponen also collaborated with Dr. Clare Barratt from Bowling Green State University on a webinar "Stress and Burnout in Home Healthcare: Causes, Impact, and Prevention" in July 2020. Both webinars had continuing education credit available for nurses.

Dr. Jun Wang worked with the CE program to offer a webinar "Characterization of Aerosols from Musical Performance and Risk Mitigation Related to COVID-19 Pandemic" in July 2020. The webinar was popular across the nation and had over 500 live attendees, and the recorded version currently has over 10,000 views on YouTube. When attendees were asked if the webinar changed workplace behaviors, many commented they will change layouts in their practice rooms, purchase/request HEPA filters, distance students farther than 6ft, and take the results to their administration to help inform decisions.

### ***Symposia and Workshops***

In collaboration with the ERC PRP program, the CE program was able to offer continuing education points for each annual PRP symposium, which are two half-day events that ranged from keynote topics including total

worker health, small business workplace violence prevention, wellbeing in the workplace, how Rock 'n' Roll provides touchstones for the evolution of occupational health, and the importance of sleep health. The last symposium also included a 1-hour ABIH ethics training session led by Dr. Talaska. In collaboration with regional ERCs in Lexington, Ann Arbor, and Chicago, the UC ERC hosted a regional symposium in 2019 on disaster response topics in occupational safety and health, which included faculty and students as well as industry professionals interested in CE credit. The regional symposium also included an ABIH 1-hour ethics training course, a tour of the NIOSH emergency response vehicle, and poster sessions in addition to the speakers.

The most recent PRP symposium was held virtually in October 2020. The keynote speaker was Dr. Claire Caruso from NIOSH, speaking on the importance of sleep health in the workplace. The virtual event also included presentations from all pilot project awardees and a virtual poster session. It also included more wellness breaks to encourage attendees to step away from their computer and in place of the usual reception, Dr. Ray Nandyal, founder of Yoga Leela, did a presentation and demonstration on yoga poses that are helpful for office workers.

In December 2019, Dr. Haber presented "Moving Forward: Towards a Harmonized Approach" at the Society for Risk Analysis Symposium on BMD Modeling. On April 21, 2020, as part of the Society of Toxicology (SOT) virtual meeting, Dr. Haber presented a talk on "New Decision Tree for Dose-Response Analysis and Choice of the Benchmark Response." The webinar, titled "Globally Harmonized Guidance for Dose-Response Analysis and Derivation of Health-Based Guidance Values for Chemicals in Food," attracted more than 300 attendees. In April 2021, Dr. Haber was a speaker for a Society of Toxicology/FDA colloquium on nanoparticles which had up to 220 attendees.

The Risk Science Center (RSC) of the Department of Environmental and Public Health Sciences partnered with the Consortium for Environmental Risk Management (CERM), including a scientist who is on the faculty at Johns Hopkins University Center for Alternatives to Animal Testing (CAAT), and with Cardno ChemRisk, to deliver a course to scientists at the Consumer Product Safety Commission (CPSC) on read-across methods in chemical risk assessment. Read-across methods use the information on chemical structural similarities to identify analogues and predict the toxicity of data-poor chemicals. These methods are growing in importance as increased attention is placed on reduced animal testing and assessing larger numbers of chemicals. The course was held virtually in September 2020 and included interactive presentations and hands-on exercises. There were 11 participants in the class.

### ***Additional planned courses for 2021***

The Annual PRP symposium will be a hybrid event on October 21-22, 2021. To celebrate the 50<sup>th</sup> anniversary of NIOSH, the UC ERC is inviting alumni who now work at NIOSH to serve on a keynote panel and discuss the future of occupational safety and health. The event will also include a one-hour industrial hygiene ethics session, presentations by PRP awardees, and virtual and in person poster sessions.

The CE director is working with several ERC faculty serving as content experts and two instructional designers to develop an online 6-module OSH ethics series focusing on ethical issues in OSH research, industrial hygiene, biomonitoring, occupational health nursing, occupational medicine, and occupational safety and health engineering. Work has begun on the first module, occupational health nursing, and all 6 modules are expected to be available online in late 2021 or early 2022. Each module is asynchronous and will take about 1 hour to complete with a CE certificate awarded after completing the assessments and post-event evaluation.

### ***Accomplishments of the Faculty***

**2016-17:** Drs. Jay Kim and Tom Huston from the OSHE academic core of the ERC led the comprehensive review course for associate and certified safety professionals. Dr. Maier from the EIH component developed the occupational risk assessment and management course with the US Air Force School of Aerospace Medicine.

**2017-18:** Dr. Maier and his team presented a poster on training technologies at a University-wide training symposium. Dr. Maier supported the NIOSH Occupational Exposure Banding (OEB) team and assisted in developing an online toxicology course and served as an instructor for in-person courses on OEBs held at professional society meetings.

2018-19: Dr. Talaska began developing 1-hour ethics training courses to be taught in conjunction with other ERC events like the annual Pilot Research Project Symposium to offer Ethics hours for industrial hygienists already attending the events.

2019-20: Dr. Bhattacharya presented an ergonomics webinar in July 2019 on “NIOSH ERCs Ergonomics Webinar Series: Assessing Heat Stress Associated Changes in Postural Balance among Firefighters” and Dr. Davis presented in November 2019 on “NIOSH ERCs Ergonomics Webinar Series: A Patient Handling Story: From Patient Migration to Repositioning.”

Dr. Haber taught a 2-day course in collaboration with the Society of Toxicology Canada on risk assessment. The course included modules on risk-informed decision-making, hazard characterization, dose-response assessment, exposure assessment, risk characterization, and methods for data-poor chemicals. Most of the focus was on the hazard characterization and dose-response portions, beginning with basic concepts, and proceeding up to state-of-the-science methods. The course was highly interactive, including individual and team exercises.

Dr. Haber also taught a course in August 2019, which was a 2-hour overview of risk assessment as part of a 5-day course sponsored by the American College of Toxicology, and titled “Advanced Comprehensive Toxicology.” The course was designed in part to be useful for those seeking certification in toxicology (DABT). Dr. Haber’s lecture addressed all aspects of the risk assessment paradigm, including general concepts, specific applications, and cutting edge methods.

Dr. Talaska taught two ABIH ethics courses at UC ERC events in March 2019 and October 2019.

2020-21: Dr. Jun Wang’s webinar from July 2020 on “Characterization of Aerosols from Musical Performance and Risk Mitigation Related to COVID-19 Pandemic” has over 10,000 views on YouTube.

Dr. Talaska taught an ABIH ethics course virtually as part of the virtual 2020 PRP Symposium in October.

Dr. Haber's allergy research was featured on [Cincinnati Public Radio](#) in April 2021.

Dr. Grinshpun presented an industrial hygiene webinar in May 2021 on “Respiratory Protection in the COVID-19 Pandemic: Research Findings from the Center for Health-Related Aerosol Studies.”

### **J.3. Opportunities for Training and Professional Development Provided by the Project**

ERC trainees are always offered the opportunity to attend any CE courses without paying registration fees. Special CE events are also ERC center-wide events, which trainees are encouraged, or sometimes required, to attend. Attending events with industry professionals helps increase networking and gives the students a chance to get feedback on their current work from experts in the field. ERC trainees are also able to be presenters in the ERC ergonomics and industrial hygiene series, which provides experience in presenting their research to a larger audience – ERC trainees Thomas Gerding presented in May 2021 and Rachel Zeiler will present in November 2021. CE courses provide training to professionals in occupational safety and health fields through in-person and online education. Courses can provide refreshers on certain topics, requirements for certifications, and education about emerging issues in OSH.

### **J.4. Dissemination of the Results to Communities of Interest**

ERC CE-specific mailing and contact list, CERKL, website, Facebook, Instagram and Twitter are all used to communicate upcoming CE events. The ERC CE team also meets with an external advisory board to collaborate on important topics in the region and help communicate courses to external stakeholders and their employees.

### **J.5. Website(s) or other Internet site(s)**

CE website: <http://med.uc.edu/eh/centers/erc/programs/ce>. The ERC CE website includes information about the program as well as upcoming events and past events that are still available for viewing.

Dr. McKay site: <http://www.drmmckay.com/>. Dr. McKay is an expert at the University of Cincinnati in respiratory protection and offers a variety of CE courses listed on his website.

Great Lakes OSHA Education Center site: <https://www.greatlakesosha.org/course-catalog>. The OSHA Education Center course catalog also includes all ERC CE events as both OSHA and ERC CE use the same registration system.

### **J.6. Other Products**

Webinars in collaboration with ERC CE directors are available on the UC ERC website, including upcoming webinars as well as a link to view the archived webinars. The UC ERC YouTube channel has past recorded webinars available: <https://www.youtube.com/playlist?list=PLrixI9q4GUJJ2yRae84Wfe3zLENx5B7Ot>.

The ERC CE program participated with Outreach and AIHA in 2021 to create a video as part of the docuseries “Healthier Workplaces, A Healthier World.” The video emphasizes the real-world impact of the UC ERC as well as the importance of continuing education in terms of keeping professionals informed of current research in OSH. The UC ERC’s video can be found on the YouTube playlist or on any of the social media pages.

The ERC website includes a learning module teaching the process of submitting NIH and ERC-funded publications to PubMed Central so that they comply with the NIH public access policy.

### **J.7. Impact**

Our courses are directly relevant to public health issues and are driven by stakeholder demand and needs assessments. A needs assessment conducted by Continuing Education directors at ERCs in Colorado, California, and New Jersey indicated many high-interest topics from those surveyed (1,501 completed surveys), including Total Worker Health, Disaster Preparedness and Response, and Risk Assessment. In the survey, 17% of the 2,064 respondents were from midwestern states, including Ohio, so the data reflects a portion of the needs in our CE program’s region. Topic ideas from this needs assessment were shared with the CE EAB to ensure we are meeting the regional needs.

By using the needs assessment results on important topics to professionals, the CE program was able to increase the impact on the community by offering relevant courses and training topics. For example, The UC ERC hosted a regional symposium in March 2019, which focused on disaster response and preparedness and was open to students, faculty, and industry professionals for continuing education credit. The UC ERC also held the 20th Annual Pilot Research Project Symposium in October 2019. The keynote speaker was Dr. Laura Punnett, Co-Director of the NIOSH Total Worker Health Center in New England. Both events also had a 1-hour ethics training session for ABIH training points taught by Dr. Talaska.

In the most recent CE webinar 100 attendees indicated their workplace behaviors would change because of the information in the webinar. Many commented they felt more confident using the research results to inform administrators making safety decisions in their organizations.

Some other examples of impact include; the chemically induced asthma courses which were downloaded 241 times, 7,185 attendees participating in CE courses since 2016, and over 10,000 views of recorded webinars on the ERC YouTube playlist.

### **J.8. Summary of Alumni Survey**

The ERC sent out impact surveys for alumni and employers in the region to complete in 2020. The alumni survey asked for responses on the following CE topics; emerging areas in which occupational safety and health professionals should be trained, CE courses alumni have taken or plan to take, and feelings regarding taking CE courses in online format. Overall, alumni indicated they would take courses in an online format (67%), while 25% said they probably would, and 8% said they probably would not. They also suggested several emerging areas for CE courses, including training with new IH equipment, sleep fatigue research, total worker health, and electronic devices to assess ergonomic risks. Several of these suggested topics have been addressed in the CE program since 2016.

**UC-ERC Publications 2016 to 2021**

Abdulrahman A, Davis KG, Kotowski SE. 2020. Impact of lifting under poor lighting and confined spaces and spine loads. *Ergonomics International Journal*. 4(5), 000258. (EIH)

Adusei PK, Gbordzoe S, Hsieh Y-Y, Johnson K, Fang Y, Mishra S, Phan N, Alvarez N, Shanov V. 2019. A scalable nano-engineering method to synthesize 3D-Graphene-Carbon nanotube hybrid fibers for supercapacitor applications. *Electrochimica Acta*, 312:411-423. (OSHE)

Adusei PK, Gbordzoe S, Kanakaraj S, Hsieh Y-Y, Alvarez N, Fang Y, Johnson K, McConnell C, Shanov V. 2020. Fabrication and study of supercapacitor electrodes based on oxygen plasma functionalized carbon nanotube fibers, *Energy Chemistry*, 40:120-131. (OSHE)

Agbonifo N, Hittle B, Suarez R, & Davis K. 2017. Occupational exposures of home healthcare workers. *Home Healthcare Now*. 35(3): 150-159. PMID: 28248782. (OHN, EIH)

Alexander, B. Flame-retardant contamination of firefighter personal protective clothing - A potential health risk for firefighters. *Journal of Occupational and Environmental Hygiene*. 2016. 13(9): D148-155. (PRP)

Aljaroudi AM, Kadis DS, Bhattacharya A, Strauch A, Quinn TD, Williams JW. 2020. Effect of continuous cooling on inhibition and attention while wearing firefighter's PPE in a hot environment. *Journal of Occupational and Environmental Hygiene*. 17(5) 243-252.  
<https://doi.org/10.1080/15459624.2020.1726933>. (EIH)

Aljaroudi AM, Bhattacharya A, Yorio P, Strauch AL, Quinn TW, Williams WJ. 2021. Probability of hyperthermia in a hot environment while wearing a liquid cooling garment underneath firefighters' protective clothing. *Journal of Occupational and Environmental Hygiene*, DOI: 10.1080/15459624.2021.1898622 (EIH)

Al-Rjoub M, Kazmierczak MJ, Bhattacharya A, Rakkimuthu S, Ramadurai S, Stuckey JP, Banerjee RK. 2021. Better Thermoregulation of Brain Temperature using Phase Change Material-Mediated Head Cooling System. *International Journal of Heat and Mass Transfer* 173. 121204//doi.org/10.1016/j.ijheatmasstransfer.2021.121204. (OSHE)

Anusiewicz CV, Ivankova NV, Swiger PA, Gillespie GL, Li P, Patrician PA. 2020. How does workplace bullying influence nurses' abilities to provide patient care? A nurse perspective. *Journal of Clinical Nursing*. 29(21-22):4148-4160. doi:10.1111/jocn.15443 PMID: 32757394. (OHN)

Awosika Oluwole O, Matthew S, Staggs EJ, Boyne P, Song X, Rizik BA, Sucharew HJ, Zhang C, Mungcal G, Moudgal R, Bhattacharya A, Dunning K, Woo D, Kissela BM. 2020. Backward Locomotor Treadmill Training Combined with Transcutaneous Spinal Direct Current Stimulation in Stroke: A Randomized Pilot Feasibility and Safety Study. *Brain Communications* (In press). (EIH)

Banerjee RK, Kalathil RT, Zachariah SA, Paul AK, Bhattacharya A, Horn GP, Smith DL. 2019. Comparison Between Experimental and Heart Rate-Derived Core Body Temperatures Using a Three-Dimensional Whole Body Model. *Journal of Thermal Science and Engineering Applications*. 11(2):024502—6. (OSHE, TRT)

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Benjamin M, Davis KG, Maier MA, Virkutyte J. 2021. Ventilation and posture effects on inhalation exposures to volatile cleaning ingredients in a simulated home healthcare work environment. *Indoor Air*, 31(1), 128-140. PMID: 32648981. DOI: <https://doi.org/10.1111/ina.12715> (TRT, EIH)

Betcher CA, Standish MD, Gillespie GL. 2020. Need and capacity of a toolkit for occupational health nurses to promote a new or enhanced drug-free workplace program. *Workplace Health & Safety*. 68(6): 263-271. doi:10.1177/2165079920911550 (OHN)

Berry PA, Gillespie GL, Fisher BS, Gormley D, & Haynes JT. 2016. Psychological distress and workplace bullying among registered nurses. *OJIN: The Online Journal of Issues in Nursing*, 21(3). doi:10.3912/OJIN.Vol21No03PPT41 (PRP, OHN)

Berry PA, Gillespie GL, Fisher BS, & Gormley DK. 2016. Recognizing, confronting, and eliminating workplace bullying. *Workplace Health & Safety*, 64(7): 337-341. (PRP, OHN)

Bien EA, Gillespie GL, Betcher CA, Thrasher TL, & Mingerink DR. 2016. Respiratory protection toolkit: Providing guidance without changing requirements: Can we make an impact? *Workplace Health & Safety* 64 (12): 596-602. (OHN, PRP)

Bien E, Davis KG, Gillespie G. (2020). Home Healthcare Workers Occupational Exposures, *Home Healthcare Now*, 38(5), 247-253. doi:10.1097/NHH.0000000000000891 PMID: 32889992 (TRT, OHN)

Bien EA, Davis K, Reutman S, Gillespie GL. 2021. Occupational exposures in the homecare environment: Piloting an observation tool. *Home Health Care Management & Practice*, 33(3), 162-170. <https://doi.org/10.1177/1084822320986917>. (OHN, TRT)

Bien EA, Davis KG, Small TF, Reutman S, Gillespie GL. 2021. Design and development of the home healthcare worker observation tool. *Journal of Nursing Education and Practice*. 11(9):29-38. <https://doi.org/10.5430/jnep.v11n9p29> (OHN, TRT)

Calvillo A, Haynes E, Burkle J, Schroeder K, Calvillo A, Reese J, Reponen T. 2019. Pilot study on the efficiency of water-only decontamination for firefighters' turnout gear. *Journal of occupational and environmental hygiene*. 6(3):199-205. PMID: 30485152 (EIH)

Chauhan C, Xu C, Chen D, Kubley A, Brandewie B, Hou G, Li W, Ng V, Rabiee M, Cahay M, Kim W.K, Chaudhary S, Moinuddin K, Paine M, Kleismit R, Mast D, Devarakonda S, Son S.Y, Shanov V.N, Schulz M.J. 2019. Introduction to Carbon Nanotube Hybrid Textiles. *J Textile Sci & Fashion Tech*. 1(5). JTSFT.MS.ID.000525. (OSHE).

Chitranshi M, Chauhan D, Kubley A, Pujari A, Xu C, Chen D, Chaudhary S, Hou G, Bell G, Brandewie B, Kaneria R, Hudepohl R, Schulz MJ. 2019. Pioneering carbon nanotube textile engineering & fashion technology, *Journal of Textile Engineering & Fashion Technology (JTEFT)*, 5, issue 2. (OSHE).

Chitranshi, M, Pujari, A, Ng, V, Chen, D, Chauhan, D, Hudepohl, R, Saleminik, M, Kim, SY, Kubley, A, Shanov, V, Schulz, M. Carbon Nanotube Sheet-Synthesis and Applications. *Nanomaterials*. October 2020. 10(10): 2023. (PRP, OSHE).

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Chitranshi, M, Chen, D, Schulz, M. Heat treatment of carbon nanotube hybrid material for textile applications. *Journal of Textile Engineering Fashion Technology*. 2021. 7(4): 121-125. (PRP, OSHE).

Cox J, Cho S-H, Isiugo K, Ross J, Chillrud S, Zhu Z, Jandarov R, Grinshpun SA, Reponen T. 2019. Combining sensor-based measurement and modeling of PM<sub>2.5</sub> and black carbon in assessing exposure to traffic-related aerosols. *Aerosol Science and Technology* 53:817-829. (PRP, TRT, EIH)

Cox J, Isiugo K, Ryan P, Grinshpun SA, Yermakov M, Desmond C, Jandarov R, Vesper S, Ross J, Chillrud S, Dannemiller K, Reponen T. 2018. Effectiveness of a portable air cleaner in removing aerosol particles in homes close to highways. *Indoor Air*. 28(6):818-827. PMID: 30133950, PMCID: PMC6188808 (EIH)

Cox J, Indugula R, Vesper S, Zhu Z, Jandarov R, Reponen T. 2017. Comparison of indoor air sampling and dust collection methods for fungal exposure assessment using quantitative PCR. *Environmental Science Process Impacts*, 19(10):1312-1319. PMID: 28858343 (EIH)

Cox J, Stone T, Ryan P, Burkle J, Jandarov R, Mendell MJ, Adams E, Niemeier-Walsh C, and Reponen T. 2021. Associations of observed home dampness and mold with the fungal and bacterial dust microbiomes. *Environmental Science Processes & Impacts* 23:491-500. (TRT, EIH)

Cox J, Ryan R, Burkle J, Jandarov R, Mendell MJ, Hershey GK, LeMasters G, Reponen T. 2021. Quantitative and semi-quantitative estimates of mold exposure in infancy and childhood respiratory health. *Environmental Epidemiology*. 4(4): e101. doi: 10.1097/EE9.00000000000010; PMCID: PMC7423528 (TRT)

Cox J, Stone T, Ryan P, Burkle J, Jandarov R, Mendell MJ, Adams E, Niemeier-Walsh C, and Reponen T. 2021 Associations of observed home dampness and mold with the fungal and bacterial dust microbiomes. *Environmental Science Processes & Impacts* 23:491-500. (TRT, EIH)

Coombs K, Vesper S, Green BJ, Yermakov M, Reponen T. 2017. Fungal microbiomes associated with green and non-green building materials. *International Biodeterioration and Biodegradation*, 125:251-257. (EIH, PRP)

Coombs K, Taft D, Ward DV, Green BJ, Chew GL, Shamsaei B, Meller J, Indugula R, Reponen T. 2018. Variability of indoor fungal microbiome of green and non-green low-income homes in Cincinnati, Ohio. *The Science of the Total Environment*. 610-611:212-218. PMID: 28803198 (EIH)

Dahm MM, Schubauer-Berigan MK., Evans DE, Birch ME, Bertke S, Beard JD, Erdely A, Fernback JE, Mercer RR, Grinshpun SA. 2018. Exposure Assessment for a Cross-Sectional Epidemiologic Study of US Carbon Nanotube and Nanofiber Workers. *International Journal of Hygiene and Environmental Health*, 221:429-440. (EIH)

Dahm MM, Evans DE, Bertke S, Grinshpun SA. 2019. Evaluation of Total and Inhalable Samplers for the Collection of Carbon Nanotube and Carbon Nanofiber Aerosols. *Aerosol Science and Technology*, 53(8):958-970. (EIH)

Davis KG, Kotowski SE, Daniel D, Gerding T, Naylor J, Syck M. 2020. The Home Office: Ergonomic Lessons From the “New Normal”. *Ergonomics in design*, 28(4), 4-10.

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<https://doi.org/10.1177/1064804620937907> (EIH, Outreach)

Davis KG, Freeman A, Ying J, Huth JR. 2021. Workers Compensation Costs for Healthcare Caregivers: Home Healthcare, Long-Term Care, and Hospital Nurses and Nursing Aides. *American Journal of Industrial Medicine*. 64(5), 369-380. (EIH, OMR)

Devarakonda S, Bulusu P, Al-rjoub M, Bhattacharya A, Banerjee R. 2017. Influence of external head cooling on the head, core body, and blood temperatures using 3D whole body model. *International Journal of Numerical Methods for Heat and Fluid Flow*, 139(3):031102--10. (TRT, OSHE)

Elmashae Y, Grinshpun SA, Reponen T, Yermakov M, Riddle R. 2017. Performance of two respiratory protective devices used by home-attending health-care workers (A Pilot Study). *Journal of Occupational & Environmental Hygiene*, 14(9):D145-D149. (TRT, EIH)

Elmashae Y, Koehler R, Yermakov M, Reponen T Grinshpun, S.A. 2018. Surgical Smoke Simulation Study: Physical Characterization and Respiratory Protection. *Aerosol Science and Technology*, 52(1):38-45. (EIH)

Elmashae Y, Yermakov M, Frank E, Benjamin M, Maier A, Newman N, Reponen T, and Grinshpun SA. 2019. Exposure of home-attending healthcare workers to aerosolized medications (Simulation Study). *Journal of Aerosol Science*, 133:49-55. (TRT, EIH)

Estill CF, Rice CH, T Morata, Bhattacharya A. 2017. Noise and neurotoxic chemical exposure relationship to workplace traumatic injuries: A review. *Journal of Safety Research*, 60:35-42 (EIH)

Fang Y, Hsieh Y-Y, Khosravifar M, Johnson K, Adusei P K, Kanakaraaj S, Preisler S, Zhang G, Shanov V, 2021. Lithiophilic Current Collector Based on Nitrogen Doped Carbon Nanotubes and Three-Dimensional Graphene for Long-Life Lithium Metal Batteries”, *Journal of Materials Science and Engineering B*, 267, pp.115067. (OSHE)

Frank EA, Carreira V, Birch ME, and Yadav JS. 2016. Carbon nanotube and asbestos exposures induce overlapping but distinct profiles of lung pathology in non-Swiss Albino CF-1 mice. *Toxicologic Pathology*, 44(2): 211-225. (PRP)

Frank E, Haber LT, Genter MB, and Maier A. 2018. Defining molecular initiating events of airway sensory irritation in support of predictive testing approaches. *Applied In vitro Toxicology*, 4(4), online publication <https://doi.org/10.1089/aivt.2018.0007> (TRT, EIH)

Frank E, Ishau S, Maier A, Reutman S, & Reichard JF. 2019. An occupational exposure limit (OEL) approach to protect home healthcare workers exposed to common nebulized drugs. *Regulatory Toxicology and Pharmacology*, 106:251-261. (OHN, EIH, TRT)

Fries M, Williams PRD, Ovesen J, Maier A. 2018. Airborne exposures associated with the typical use of an aerosol brake cleaner during vehicle repair work. *J Occup Environ Hyg*. 15(7):531-540. doi: 10.1080/15459624.2018.1467017. PubMed PMID: 29672233. (BIOM)

Gbordzoe S, Malik R, Alvarez N, Wolf R, Shanov V. 2016. Flexible low-voltage carbon nanotube heaters and their applications. *Adv. Carbon Nanostructures*, Rijeka: InTech; p. Ch. 0. doi:10.5772/64054. (OSHE)

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Gbordzoe S, Yarmolenko S, Kanakaraj S, Haase M, Alvarez N, Borgemenke R, Adusei PK, Shanov V. 2017. Effects of laser cutting on the structural and mechanical properties of carbon nanotube assemblages. *Materials Science and Engineering*, 223:143-152. (PRP, OSHE)

Gbordzoe S, Adusei PK, Chauhan D, Alvarez N, Haase M, Mansari K, Kanakaraj S, Hsieh Y-Y, Shanov V. 2019. A simple two-step process for producing strong and aligned carbon nanotube-polymer composites, *C Journal of Carbon Research*, 5(35):1-10. (OSHE).

Gerding T, Syck M, Daniel D, Naylor J, Kotowski SE, Gillespie GL, Freeman AM, Huston TR, Davis KG. 2021. An assessment of ergonomic issues in the home offices of university employees sent home due to the COVID-19 pandemic. *Work*. 68(4), 981-992. (EIH)

Ghosh D, Bernstein JA. 2020. Health effects of Trimellitic Anhydride occupational exposure: Insights from animal models and immunosurveillance programs. *Clinical Reviews in Allergy & Immunology*. <https://doi.org/10.1007/s12016-020-08801-w>. (PRP)

Gillespie GL, Leming-Lee T, Crutcher T, & Mattei J. 2016. Chart it to stop it: A quality improvement study to increase the reporting of workplace aggression. *Journal of Nursing Care Quality*, 31(3): 254-261. (PRP, OHN)

Gao S, Kim JY, Yermakov M, Elmashae Y, He X, Reponen T, Grinshpun SA. 2015. Penetration of Combustion Aerosol Particles through Filters of NIOSH-Certified Filtering Facepiece Respirators (FFRs). *Journal of Occupational and Environmental Hygiene*, 12(10):678-685. (EIH)

Gao S, Kim JY, Yermakov M, Elmashae Y, He X, Reponen T, Zhuang Z., Rengasamy S, Grinshpun SA. 2016. Performance of N95 FFRs against Combustion and NaCl Aerosols in Dry and Moderately Humid Air: Manikin-based Study. *Annals of Occupational Hygiene*, 60(6):748-760. (EIH)

Grinshpun SA, Weber AW, Yermakov M, Indugula R, Elmashae Y, Reponen T, Rose, L. 2017. Evaluation of Personal Inhalable Aerosol Samplers with Different Filters for Use during Anthrax Responses. *Journal of Occupational and Environmental Hygiene*, 14(8):585-595. (EIH)

Grinshpun SA, Yermakov M. 2021 Impact of face covering on aerosol transport patterns during coughing and sneezing. *Journal of Aerosol Science* 158:105847. (EIH)

Guangfeng H, Ruitao S, Wang A, Ng V, Li W, Song Y, Zhang L, Sundaram M, Shanov V, Mast D, Lashmore D, Schulz M, Liu Y. 2016. The effect of a convection vortex on soot formation in the floating catalyst method for carbon nanotube synthesis. *Carbon*, 102, 513–519. (OSHE)

Haines SR, Adams RI, Boor BE, Bruton TA, Downey J, Ferro AR, Gall E, Green BJ, Hegarty B, Horner E, Jacobs DE, Lemieux P, Misztal PK, Morrison G, Perzanowski M, Reponen T, Rush RE, Virgo T, Alkhayri C, Bope A, Cochran S, Cox J, Donohue A, May, AA, Nastasi N, Nishioka M, Renninger N, Tian Y, Uebel-Niemeier C, Wilkinson D, Wu, T, Zambrana J, Dannemiller KC. 2019. Ten questions concerning the implications of carpet on indoor chemistry and microbiology. *Build Environ*. 170:1-16. PubMed PMID: 32055099. (TRT, EIH)

Hanson B, Cooper SS, Tegarden T, Tipton L, Freeman AM, Davis KG, Gillespie G, Huston T. 2021. The Impact of Emergency Responders Musculoskeletal Injuries in the State of Ohio. *Work*. 68(4), 1001-1008. (EIH, OMR, OHN, OSHE)

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- Harris N, Gillespie GL, Davis KG. 2021. Electronic cigarettes: Exposure to secondhand vapors at a long-term healthcare company. *Journal of Nursing Education and Practice*. 11(2):1-6. doi:10.5430/jnep.v11n2p1 (OHN)
- Hittle B, Agbonifo N, Suarez R, Ballard T, Davis K. 2016. Complexity of occupational exposures for home healthcare workers: Nurses versus Home health aides. *Journal of Nursing Management.*, 24: 1071–1079. (EIH, OMR, OHN, Outreach)
- Hittle B, Gillespie G. 2018 Identifying shift worker chronotype: Implications for health. *Industrial Health*.56(6):512-523. doi:10.2486/indhealth.2018-0018 PMID: 29973467 (OHN)
- Hittle B, Caruso C, Jones H, Bhattacharya A, Lambert J, Gillespie G. 2020. Nurse Health: The Influence of Chronotype and Shift Timing. *Western Journal of Nursing Research*. 019394592091680. 10.1177/0193945920916802. (OHN, EIH)
- Hittle B, Gillespie GL, Jones HJ, Bhattacharya A. 2021. Time lost: Factors influencing advanced practice provider's prioritization of sleep. *WORK: A Journal of Prevention, Assessment, and Rehabilitation*. 68(3):653-665. <https://doi.org/10.3233/WOR-203400> (OHN)
- Hsieh Y-Y, Zhang Y, Zhang L, Fan Y, Kanakaraj S, Je-Hyeong Bahk, Shanov V. 2019. High thermoelectric power-factor composites based on flexible three-dimensional graphene and polyaniline. *Nanoscale*, 11:6552-6560. (OSHE)
- Hsieh Y-Y, Zhang L, Daum J, Mishra S, Fang Y, Kanakaraj S, Zhang G, Gbordzoe S, Shanov V. 2019. Bio-inspired, nitrogen doped CNT-Graphene hybrid with amphiphilic properties as a porous current collector for lithium-ion batteries. *Carbon*, 145:677-689. (OSHE)
- Hwang, J, Cai, C, Nishimura, T, Hu, X, Kuroda, A. Asbestos Detection with Fluorescence Microscopy Images and Deep Learning. *Sensors*. 2021. 21(13): 4582. DOI: <https://doi.org/10.3390/s21134582>. (PRP)
- Hwang, J, Chen, W, Davis, E, Stoner, J, Robledo, C, Goodman, J, Garwe, A, Xu, C, Peck, J. Urinary total arsenic and arsenic methylation capacity in pregnancy and gestational diabetes mellitus: A case-control study. *Chemosphere*. 2021. 271(129828): DOI: 10.1016/j.chemosphere.2021.129828. PMID: 33736216. (PRP)
- Hwang, J, Friesen, M, Choo-Wosoba, H, Sarazin, P, Dopart, P, Russ, D, Deziel, N, Lavoue, J, Albert, P, Zhu, B. Simultaneous modeling of detection rate and exposure concentration using semi-continuous models to identify exposure determinants when left-censored data may be a true zero. *Journal of Exposure Science and Environmental Epidemiology*. 2021. DOI: <https://doi.org/10.1038/s41370-021-00331-7>. PMID: 34006962. (PRP)
- Hwang, J, Shao, Y, MacLehose, R, Lin, L, Alexander, B, Mandel, J, Ramachandran, G. A Bayesian Approach for Determining the Relationship between Various Elongate Mineral Particles (EMPs) Definitions. *Annals of Work Exposure and Health* . 2020. 64(9): 993-1006. DOI: 10.1093/annweh/wxaa074. PMID: 33196824. (PRP)
- Hwang J, Taylor R, Cann CM, Golla V, Gilbert W. 2019. Assessment of ambient air diesel particulates in fire departments using different exposure metrics: Pilot study. *Fire Safety Journal*, 106:155-162. Online publication. (PRP)

## APPENDIX 1 - Publications

Hwang, J, Xu, C, Agnew, R, Clifton, S, Malone, T. Health Risk of Structural Firefighters from Exposure to Polycyclic Aromatic Hydrocarbons: A Systematic Review and Meta-Analysis. *International Journal of Environmental Research and Public Health*. 2021. 18(8): 4209. DOI: <https://doi.org/10.3390/ijerph18084209>. PMID: PMC8071552. (PRP)

Ishau S, Reichard JF, Maier A, Niang M, Yermakov M, Grinshpun SA. 2020. Estimated dermal exposure to nebulized pharmaceuticals for a simulated home healthcare worker scenario. *J Occup Environ Hyg*, 17(4):193-205. doi:10.1080/15459624.2020.1724297 PubMed PMID: 32134702. (EIH, BIOM, TRT)

Isiugo K, Jandarov R, Cox J, Chillrud S, Grinshpun SA, Hyttinen M, Yermakov M, Wang J, Ross J, Reponen T. 2019. Predicting indoor concentrations of black carbon in residential environments. *Atmos Environ*, 201:223-230. PMID: 31598090. (EIH)

Isiugo K, Jandarov R, Cox J, Ryan P, Newman N, Grinshpun SA, Indugula R, Vesper S, Reponen T. 2019. Indoor particulate matter and lung function in children, *Science of the Total Environment*, 663:408-417. PMID: 30716631 (EIH, TRT)

James C, Bernstein DI, Cox J, Ryan P, Wolfe C, Jandarov R, Newman N, Indugula R, Reponen T. 2020. HEPA filtration improves asthma control in children exposed to traffic-related airborne particles. *Indoor Air*, 30(2):235-243. (TRT)

Jobe JA, Gillespie GL, Schwytzer DJ. (accepted for publication, 2021). A national survey of secondary traumatic stress and work productivity of emergency nurses following trauma patient care. *Journal of Trauma Nursing*. (OHN)

Kalathi RT, D'Souza GA, Bhattacharya A, Banerjee RK. 2016. Uncertainty analysis of the core body temperature under thermal and physical stress using a 3D whole body model. *J. Heat Transfer*, 139(3): 031102-031102-10. (OSHE, TRT, EIH)

Kanakaraj S, Alvarez N, Gbordzoe S, Lucas M, Maruyama B, Noga R, Hsieh Y-Y, Shanov V. 2018. Improved dry spinning process at elevated temperatures for making uniform and high strength CNT fibers. *Mater. Res. Express*, 5: 065036, 1-11. (OSHE)

Kanakaraj S, Hsieh Y-Y, Adusei PK, Homan B, Fang Y, Zhang G, Mishra S, Gbordzoe S, Shanov V. 2019. Nitrogen-doped CNT on CNT hybrid fiber as a current collector for high-performance Li-ion capacitor. *Carbon*, 149:407-418. (OSHE)

Kim JY, Gao S, Yermakov M, Elmashae Y, He X, Reponen T, Grinshpun SA. 2016. Performance of Electret Filters for Use in a Heating, Ventilation and Air Conditioning System and an Automotive Cabin against Combustion and NaCl Aerosols. *Aerosol and Air Quality Research*, 16(6): 1523-1531. (EIH)

Latha SS, Wilson K, Davis KG, Kotowski SE. 2019. Reality of safe patient handling policies and programs in hospitals across the United States. *International Journal of Safe Patient Handling*, 9(2), 69-76. (EIH)

Leppänen M, Wu B, Corey J, Yermakov M, Liu Y, Grinshpun SA. 2018. Performance of a Novel Real-Time Respirator Seal Integrity Monitor on Firefighters: Simulated Workplace Pilot Study. *Journal of Occupational and Environmental Hygiene*, 15(8):607-615. (EIH)

## APPENDIX 1 - Publications

Leso V, Niang M, Iavicoli I, Schulte P. 2018. Biological monitoring of workers exposed to engineered nanomaterials. *Toxicology Letters*, 298:112-124. (BIOM)

Liu Y, Corey J, Yermakov M, Wu B, Grinshpun S. 2018. Preliminary Development of a Real-Time Respirator Seal Integrity Monitor with Low-Cost Particle Sensor. *IEEE Transactions on Industry Applications*, 54(4):3928-3933. (EIH)

Lockhart T, Gillespie GL, & Grant V. 2017. An integrative review of text message reminders for medical surveillance examinations. *Workplace Health and Safety*, 65(8): 372-378. PMID: 27913810. (OHN, PRP)

Malik AK, McConnell RC, Alvarez NT, Haase M, Gbordzoe G, and Shanov V. 2016. Rapid, in situ plasma functionalization of carbon nanotubes for improved CNT/epoxy composites. *RSC Advances*, 6(110):108840-108850. (OSHE)

McConnell C, Kanakaraj S, Dugree J, Malik R, Zhang G, Haase M, Hsieh Y-Y, Fang Y, Mast D, Shanov V. 2020. Hydrogen sensor based on flexible carbon nanotube-palladium composite sheet integrated with fabric. *ACS Omega*, 5(1):487-497. (OSHE)

Miller SA, Heineman WR, Banerjee RK, Increased capture of magnetic microbeads due to switching of electroosmotic flow. 2016. *Proceedings of Summer Biomechanics, Bioengineering, and Biotransport Conference*, SB3C2016-1262. (OSHE)

Miller SA, Heineman WR, Weiss AA, Banerjee RK. 2018. Analysis of magnetic microbead capture with and without bacteria in a microfluidic device under different flow scenarios. *Journal of Medical Devices*, 12(4):041005--6. (OSHE)

Miller SA, Weiss AA, Heineman WR, Banerjee RK. 2019. Electroosmotic flow driven microfluidic device for bacteria isolation using magnetic microbeads. *Sci Rep. (A Nature journal)*, 9(1):14228. (OSHE)

Morris C, Arnett SW, Jackson AJ, Winchester LJ. 2019. Comparing physical fitness in career vs. voluntary firefighters. *Medicine and Science in Sports and Exercise*. 51(5S), online publication DOI: 10.1249/01.mss.0000561311.12101.f8. (PRP)

Murry M, Spitz H, Connick W.B. 2016. Sequential extraction of uranium metal contamination. *J Radioanal Nucl Chem* 307, 2075–2078. doi:10.1007/s10967-015-4521-7.(OSHE)

Nakpan W, Grinshpun S.A, Yermakov M, Indugula R, Reponen T, Wang S, Schoenitz M, Dreizin, EL. 2018. Inactivation of Aerosolized Surrogates of Bacillus Anthracis Spores by Combustion Products of Aluminum- and Magnesium-based Reactive Materials: Effect of Exposure Time. *Aerosol Science and Technology*, 52(5):579-587. (EIH)

Nakpan W, Yermakov M, Indugula R, Jandarov R, Reponen T, Grinshpun SA. 2019. Inactivation of Aerosolized Bacillus Anthracis Surrogate Spores in Close Proximity to the Flame: Simulation Study. *Journal of Aerosol Science*, 128:72-78. (EIH)

Nakpan W, Yermakov M, Indugula R, Reponen T, Grinshpun SA. 2019. Inactivation of Bacterial and Fungal Spores by UV irradiation and Gaseous Iodine Treatment Applied to Air Handling Filters. *Science of the Total Environment*, 671:59-65. (EIH)

## APPENDIX 1 - Publications

Naylor J, Gillespie GL, Betcher C, Orr CE. (accepted for publication, 2021). Cost analysis of a dedicated nurse vs. providing incentive raises to current nurses for COVID-19 management in a processing plant. *Workplace Health & Safety*. (OHN)

Nelson ML, Cox C, Altman L, Khoury J, Bhattacharya A, Wasserman H. 2019. Bone Shock absorption in pediatric patients with osteogenesis imperfecta – A pilot study to assess the potential of this technique to detect differences in bone fragility. *Journal of Clinical Densitometry: Assessment of Skeletal Health*. PMID: 31740100 DOI: 10.1016/j.jocd.2019.09.004. (EIH)

Nie L, Liu Y, Mostafaei F, Sowers D, Hsieh M, Zheng W. 2017. Customized compact neutron activation analysis system to quantify manganese (MN) in bone in vivo. *Physiological Measurement*, 38, 452-465. (PRP)

Nie L, Liu Y, Rolle-McFarland D, Mostafaei F, Zheng W, Wells E. 2017. In vivo measurement of bone manganese and association with manual dexterity: A pilot study. *Environmental Research*, 160, 35-38. (PRP)

Niemeier-Walsh C, Ryan PH, Meller J, Ollberding NJ, Adhikari A, Indugula R, Reponen T. 2021 The Mycobiomes and Bacteriomes of Sputum, Saliva, and Home Dust. *Indoor Air* 31(2): 357-368. (EIH, TRT)

Niemeier-Walsh C, Ryan PH, Meller J, Ollberding NJ, Adhikari A, Indugula R, Reponen (2021) Exposure to Traffic-Related Air Pollution and Bacterial Diversity in the Lower Respiratory Tract of Children. *Plos One* 16(6): e0244341. <https://doi.org/10.1371/journal.pone.0244341> (TRT, EIH)

Ollier K, Leppänen M, Wu B, Yermakov M, Reponen T, and Grinshpun SA. 2019. Inhalation exposure and respiratory protection of home healthcare workers administering aerosol medications (Simulation Study). *Aerosol and Air Quality Research*, 19(5):937-944. (EIH, TRT)

Park Y, Fritz C, Jex SM. 2016. Daily cyber incivility and distress: The moderating roles of resources at work and home. *Journal of Management*. doi:10.1177/0149206315576796 (PRP)

Pecquet, A. Exposure to perfluorooctanoic acid (PFOA) decreases neutrophil migration response to injury in zebrafish embryos. *BMC Research Notes*. August 31, 2020. 13(1): 1-6. DOI: 10.1186/s13104-020-05255-3. PMID: 32867820. (PRP)

Reutman SR, Lewis R. 2019. A Move-A-Thon event: A workplace demonstration of a proposed alternative strategy to incentivize workers to engage in physical activity. *Workplace Health & Safety* 14 [e-pub ahead of print]. doi: 10.1177/2165079918823211.(OHN)

Reutman SR, Reponen T, Yermakov M, A Grinshpun S. (2021) Homemade facemasks: particle filtration, breathability, fit, and other performance characteristics. *J Occup Environ Hyg*. 18(7):334-344. PMID: 34080950. (EIH)

Ritter, K, Matthews, RA. A concise, content valid, gender invariant measure of workplace incivility. *Journal of Occupational Health Psychology*. July 2016. 21(3): DOI: <http://dx.doi.org/10.1037/ocp0000017> (PRP)

Robins K, Zachariah S, Paul A, Bhattacharya A, Horn G, Smith D, Banerjee R. 2018. Comparison between experimental and heart rate-derived core body temperatures using a 3d whole body

## APPENDIX 1 - Publications

model. TSEA-18-1036 (Technical Brief), Journal of Thermal Science and Engineering Applications, 11(2):024502. (TRT, OSHE, EIH)

Rutherford D, Gillespie G, Smith C. 2019. Interventions against bullying of prelicensure students and nursing professionals: An integrative review. Nursing Forum, 54(1): 84-90. (PRP, OHN)

Rutherford DE, Smith CR, Bresler S, Gillespie GL. 2020. Emotions and feelings evoked in nursing students exposed to bullying behaviors in clinical settings. Journal of Nursing Education and Practice. 10(11):54-64. doi:10.5430/jnep.v10n11p54 (PRP, OHN)

Sandwall P, Bastow B, Spitz H, Elsonb H, Lamba M, Connick W, Fenichel H. 2018. Radio-Fluorogenic Gel Dosimetry with Coumarin. Bioengineering. DOI: 10: 3390/Bioengineering5030053. (OSHE)

Schulte P, Leso V, Niang M, Iavicoli I. 2019. Current state of knowledge on the health effects of engineered nanomaterials in workers. Scandinavian Journal of Work Environment and Health. 45(3):217-238. (BIOM)

Schulte P, Leso V, Niang M, Iavicoli I. 2018. Biological monitoring of workers exposed to engineered nanomaterials. Toxicol Lett. 1;298:112-124. doi:10.1016/j.toxlet.2018.06.003. PubMed PMID: 29920308; PubMed Central PMCID: PMC6239923. (BIOM)

Schulz, Mark J., Kim, Sung Yong, Kubley, Ashely, Mast, David, Shanov, Vesselin. 2021. Nanotube Sheet and Yarn Manufacturing and Commercialization. WSEAS Transactions on Business and Economics, E-ISSN: 2224-2899, p. 1149-1163, Volume 18. DOI: 10.37394/23207. 18.108. (PRP, OSHE)

Schneider N, Glover S, Dong D, Spitz H. 2016. Microdosimetry of alpha-emitting decay products in tissue using conventional film autoradiography. J. Radioanal. Nucl. Chem. 307, 2029 – 2033. (OSHE)

Schneider N, Xie T, Glover S, Tolmachev S, Dong Z, Spitz H. 2018. Determination of <sup>232</sup>Th and progeny in human reticuloendothelial tissue using alpha particle track autoradiographic microdosimetry from Thorotrast. J. of Radioanal Nucl. Chem, 318:235-239. (OSHE)

Singh U, Mani A, James K, Rao M and Bhattacharya A. 2019. Effects of heat exposure from live-Burn fire training on postural stability of firefighters. Ergonomics Int J. 3 (4), online publication; <https://doi.org/10.23880/eoij-16000213>. (TRT, EIH)

Small T, Gillespie G, Kean E, Hutton S. 2020. Workplace violence interventions used by home healthcare workers: An integrative review. Home Healthcare Now, 38(4), 193-201. doi:10.1097/NHH.0000000000000874 PMID: 32618777 (OHN, TRT)

Smith CR, Gillespie GL, Brown KC, & Grubb PL. 2016. Seeing students squirm: Nursing students' experiences of bullying behaviors during clinical rotations. Journal of Nursing Education, 55(9): 505-513. (PRP, OHN)

Smith CR, Gillespie GL. 2016. Do adolescent employees perceive the risks of workplace violence? A mixed method study. Journal of Nursing Education and Practice, 6(7):116-124. (PRP, OHN)

## APPENDIX 1 - Publications

Sprung JM, & Britton AR. 2016. The dyadic context of safety: An examination of safety motivation, behavior, and life satisfaction among farm couples. *Safety Science*, 85:1-8. (PRP)

Sprung J, Jex S. 2017. All in the family: Work-family enrichment and crossover among farm couples. *Journal of Occupational Health Psychology*, 22(2): 218-224. PMID: 27101342. (PRP)

Stringer J, Spitz H. Measurement and analysis of the neutron energy spectrum and associated occupational exposure from a shielded 241Am-Be source. *Rad. Prot. Dosi.* (In press) (OSHE)

Suarez R, Agbonifo N, Hittle B, Davis K, & Freeman A. 2017. Frequency and risk of occupational health and safety hazards for home healthcare workers. *Home Healthcare Management and Practice*, 29(4): 207-215. (OHN, OMR, EIH, TRT)

Turner A, Brokamp C, Wilfe C, Reponen T, Ryan P. 2021. Personal Exposure to Average Weekly Ultrafine Particles, Lung Function, and Respiratory Symptoms in Asthmatic and Non-Asthmatic Adolescents. *Environmental International* 156; 106740  
<https://doi.org/10.1016/j.envint.2021.106740> (TRT, EIH)

Veta J, Singh K, Bhattacharya A. 2021. Study Correlating Lead (Pb) Level Exposure and Bone Shock Absorption Capacity Based on Damping Associated with Higher Modes of Vibration. *ASME Journal of Engineering and Science in Medical Diagnostics and Therapy*.  
doi: <https://doi.org/10.1115/1.4050862>. (EIH)

Viegas C, Caetano LA, Cox J, Korkalainen M, Haines SR, Dannemiller KC, Viegas S, Reponen T. 2020. The effects of waste sorting in environmental microbiome, THP-1 cell viability and inflammatory responses. *Environ Res.* 185:109450. doi: 10.1016/j.envres.2020.109450. PMID: 32244107. (TRT)

Wright-Brown S, Sekula K, Gillespie GL, & Zoucha R. 2016. The experiences of registered nurses who are injured by interpersonal violence while on duty in an emergency department. *Journal of Forensic Nursing*, 12(4): 189-197. (PRP, OHN)

Wu BB, Varner K, Dahm MM, Reutman S, Davis KG. 2019. Work-related Injuries within a Large Urban Public School System in the Mid-Western United States, *Work*, 62: 373–382. (Outreach, OHN, EIH)

Wu B, Leppänen M, Yermakov M, Grinshpun S. 2017. Evaluation of a New Instrument for Aerosol Quantitative Fit Testing. *Journal of International Society for Respiratory Protection*, 34(2):111-127. (EIH)

Wu B, Corey J, Yermakov M, Liu Y, Grinshpun SA. 2018. Laboratory Evaluation of a Novel Real-Time Respirator Seal Integrity Monitor. *Annals of Work Exposures and Health*, 62(6):742-753. (EIH)

Wu B, Leppänen M, Yermakov M, Grinshpun S. 2018. Utility of an Optical Particle Counting Instrument for Quantitative Respirator Fit Testing with N95 Filtering Facepieces. *Journal of International Society for Respiratory Protection*, 35(1):14-25. (EIH)

Wu B, Leppänen M, Yermakov M, Grinshpun S. 2018. Response to Letter to the Editor. *Journal of International Society for Respiratory Protection*, 35(2):115-119. (EIH)

**Publications under Review**

Acquavita SP, Zhang J, Boone X, Swoboda C, Yolton K. 2020. A Hidden Occupational Health Hazard: ETS among Child Welfare Workers. Submitted to Children & Youth Services Review. (PRP)

Adusei P K, Johnson K, Kanakaraj K, Zhang G, Fang Y, Hsieh Y-Y, Khosravifar M, Gbordzoe S, Nichols M, Shanov V, 2021. Asymmetric Fiber Supercapacitors Based on a FeC<sub>2</sub>O<sub>4</sub>/FeOOH-CNT Hybrid Material, Submitted in C Journal of Carbon Research, In Review (OSHE)

Benjamin M, Arnold S, Rao MB, Davis K, Maier, A, Virkutyte J. Airborne concentrations of two cleaning chemicals generated from residential cleaning tasks. Submitted to Indoor Air (In Revision) (TRT, EIH)

Chitranshi, M, Chen, D, Adusei, PK, Schulz, M, Shanov, V, Cahay, M. Chlorosulfonic acid stretched carbon nanotube for flexible and low-voltage heating application. Submitted to Nanomaterials. (PRP, OSHE).

Chitranshi, M, Kubley, A, Hou, X, Schulz, M. Manufacturing and Characterization of Customizable Flexible Carbon Nanotube Fabrics for Smart Wearable Applications. Submitted to Textiles Journal. (PRP, OSHE).

Dufour JS, Reiter A, Cox C, Weston EB, Markey M , Turner A , Le P, Aurand AM, Simmons S, Altman L, Mageswaran P, Davis K, Huber D, Bhattacharya A, Marras WS. 2020. Motion sickness decreases low back function and changes gene expression of military aircrew. Submitted to Clinical Biomechanics. (EIH)

Eturki M, Davis KG, Snawder J, Elmashae Y, Vincent M, Arnold SF, Maier MA. Micro-environmental factors impact breathing zone exposures: a simulated petrochemical manufacturing facility task. Submitted to Journal of Occupational and Environmental Hygiene. (EIH, TRT)

Keller EG, Boch S, Hittle BM. Unsafe and unsettling: An integrative review on correctional nursing work environments and stressors. Submitted to Journal of Forensic Nursing. (OHN)

Kim S Y, Megha C, Anuptha P, Ng V, Kubley A, Hudepohl Rd, Shanov V, Anantharaman, D, Chen D, Chauhan Devika, Schulz M. 2021. Reactor Design for Manufacturing Carbon Hybrid Materials. IAAM Advanced Materials Letters (AML) Journal. In Review. (PRP, OSHE)

Kim S Y, Megha C, Anuptha P, Ng V, Kubley A, Hudepohl Rd, Shanov V, Anantharaman, D, Chen D, Chauhan Devika, Schulz M. 2021. Synthesis Tuning for Manufacturing Carbon Hybrid Materials. IAAM Advanced Materials Letters (AML) Journal. In Review. (PRP, OSHE)

Kondapalli V K R, He X, Khosravifar M, Khodabakhsh S, Collins B, Yarmolenko S, Puente A, Shanov V, 2021 CVD Synthesis of 3D Shaped 3D Graphene (3D2G) using 3D Printed Nickel-PLGA Catalyst Precursor, ACS Omega, In Review (OSHE).

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Morris C, Arnett SW, Winchester LJ. Comparing physical fitness in career vs. volunteer firefighters. Submitted to Journal of Strength and Conditioning Research. (PRP)

Ng V., Chauhan D., Noga R, Chitranshi M, Pujari A., Bhattacharya A., Grinshpun S, Fialkova S, Yarmolenko S, Selcen K-B, Campbell J., Jetter B J, Shanov V., Kubley A, Schulz, M 2021. Chapter 10. CNT Hybrid Fabric – Manufacturing and Applications Including Structural and Wearables. In book: Toughened Composites – Micro Macro Systems. editors Sri Bandy & R Gujjala. CRC Press, In Review. (PRP, OSHE)

Turner, A. L., Markey, M., Le, P., Reiter, A., Cox, C., Simmons, S., Rao, M.B., Altman, L., Davis, K., Huber, D., Dufour, J.S., Marras, W., Bhattacharya, A. (2021). Disorientation effects, circulating small RNA, and genetic susceptibility on static postural stability. Submitted to Clinical Biomechanics. (EIH, TRT)

Turner, A. L., Brokamp, C., Wolfe, C., Reponen, T., & Ryan, P. H. (2021). Impact of personal, 30-minute exposure to ultrafine particles on lung function and respiratory symptoms in asthmatic and non-asthmatic adolescents. Submitted to American Journal of Respiratory and Critical Care Medicine. (TRT, EIH)

Kim, Sung Yong, Chitranshi, Megha, Pujari, Anuptha, Ng, Vianessa, Kubley, Ashley, Hudepohl, Ronald, Shanov, Vesselin, Anantharaman, Devanathan, Chen, Daniel, Chauhan, Devika, Schulz, Mark. *Reactor Design for Manufacturing Carbon Hybrid Materials*. Submitted to IAAM Advanced Materials Letters (AML) Journal.(PRP, OSHE)

Kim, Sung Yong, Chitranshi, Megha, Pujari, Anuptha, Ng, Vianessa, Kubley, Ashley, Hudepohl, Ronald, Shanov, Vesselin, Anantharaman, Devanathan, Chen, Daniel, Chauhan, Devika, Schulz, Mark. *Synthesis Tuning for Manufacturing Carbon Hybrid Materials*. Submitted to IAAM Advanced Materials Letters (AML) Journal. (PRP, OSHE)

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### Books/Chapters

Dunning, K, Mani A, Bhattacharya A. 2017. Improving Balance Control: Current State and Practices (Chapter 14). In Fall Prevention and Protection: Principles, Guidelines, and Practices, ed. H. Hsiao, 223–239, Boca Raton: CRC Press. (EIH)

Gbordzoe, S, Rachit Malik, Noe Alvarez, Robert Wolf, Vesselin Shanov . "Flexible low voltage carbon nanotube heaters and their applications". Advances in carbon nanotubes. Adrian M.T. Silva and Sonia A.C. Carabineiro. InTech. 2016. (PRP)

Kwasi, P, Hsieh, Y, Kanakaraj, S, Fang, Y, Johnson, K, Alvarez, T, Shanov, V. "Supercapacitors". Science Technology Advance Applications. August 01, 2018. (PRP)

Schulz MJ, Shanov V, Yin J, Cahay M, editors. Nanotube Superfiber Materials, Science, Manufacturing, Commercialization, Elsevier, March, 2019. (OSHE)

Turner, A. L., & Ryan, P. H. (2021). Epidemiology of UFPs and respiratory disease in adults and children. In D. Brugge, & C. H. Fuller (Eds.), Ambient combustion ultrafine particles and health (1st ed., pp. 335-335-360). New York: Nova Science Publishers, Inc. (TRT, EIH)

Varner K. Transition theories, research, and occupational health. In J. Hansen (Ed.). Nurse residency program builder: Tools for a successful new graduate program (2nd ed.). 2018; 51-58. HCPro, Inc. <http://hcmarketplace.com/nurse-residency-program-builder> (OHN)

Ng, V., Chauhan, D., Noga, R., Chitranshi, M., Pujari, A., Bhattacharya, A., Grinshpun, S., Fialkova, S., Yarmolenko, S., Selcen Kilinc-Balci, F., Campbell, J., Jetter, B.J., Shanov, V.N., Kubley, A., Schulz, M.J. Chapter 10. CNT Hybrid Fabric – Manufacturing and Applications Including Structural and Wearables. In book: Toughened Composites – Micro Macro Systems. editors Sri Bandy & R Gujjala. CRC Press, submitted 8/2021. (PRP, OSHE)

Schulz, Mark J., Kim, Sung Yong, Kubley, Ashely, Mast, David, Shanov, Vesselin. 2021. Nanotube Sheet and Yarn Manufacturing and Commercialization. WSEAS Transactions on Business and Economics, E-ISSN: 2224-2899, p. 1149-1163, Volume 18. DOI: 10.37394/23207.2021.18.108. (PRP, OSHE)