JOHNS HOPKINS EDUCATION AND RESEARCH CENTER FOR OCCUPATIONAL SAFETY AND HEALTH

Final Research Performance Progress Report

July 1, 2018-June 30, 2023

ERC SUMMARY

The mission of the Johns Hopkins Education and Research Center for Occupational Safety and Health is to provide an integrated, interdisciplinary approach to training researchers and practitioners in the field of occupational safety and health with the ultimate goal of protecting the safety and health of all workers. Master's and doctoral training is provided in Occupational and Environmental Hygiene (MS, PhD, DrPH, ScD), Occupational and Environmental Health Nursing (MPH, PhD, DrPH, ScD), Occupational and Environmental Medicine (MPH and residency rotations), Occupational Epidemiology and Biomarkers (PhD, DrPH, ScD), and Occupational Injury Epidemiology and Prevention (PhD, DrPH). Each academic program upholds the strong research tradition of our school and strives to address the priority areas set by NIOSH in the sector-based National Occupational Research Agenda. Additionally, our Pilot Project Research Training Program supports students and junior faculty at research institutions within our region, while our Outreach and Continuing Education components bring the strengths of the core ERC programs to practicing occupational safety and health professionals throughout our region and beyond.

RELEVANCE

Approximately 120 million U.S. workers' health, quality of life, and productivity are affected directly or indirectly by the expertise of occupational safety and health professionals. Situated in the largest, most highly ranked school of public health in the world, the Johns Hopkins ERC builds the national capacity to provide care, set policy, design and manage safety and health programs, and conduct research that furthers the National Occupational Research Agenda and discovers new knowledge to advance the body of knowledge in this field. Since its establishment in 1977, the center has evolved in response to changing demands in the field, as well as to scientific and technological advances that impact occupational safety and health practice, research, and education, while retaining steadfastly its commitment to an integrated, interdisciplinary approach to training researchers and practitioners—and as the only ERC in U.S. Department of Health and Human Services region III, we are dedicated to meeting regional as well as national and international needs, and our center's Outreach and Continuing Education efforts serve hundreds of organizations each year, including private-sector businesses, nonprofit and academic organizations, local, state, and federal government agencies, and the military.

KEY PERSONNEL

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PROGRESS REPORT—EVALUATION AND PLANNING

Our five academic programs thrive in terms of the number of students impacted and the number of graduates.

The ERC **Occupational and Environmental Hygiene Program**, directed by Dr. Kirsten Koehler, hosts a part-time master's degree option that has proven to be successful and has increased access to professional graduate-level education for practitioners who must maintain their current employment. The program has graduated 26 master's students during this grant period (since 2018), including both full-time and part-time trainees, for an average of approximately five graduates per year, and there are currently 19 students enrolled in the master's program. Doctoral training is strong, with four PhD students having graduated since 2018, all of whom were supported by NIOSH, with one more scheduled to finish by March 2023. Currently, 9 PhD students are enrolled in the program, as well as two DrPH students who are not supported by NIOSH. Occupational and Environmental Hygiene faculty and students were authors of more than 195 peer-reviewed publications during this period, and our graduates have found employment in industrial hygiene and allied disciplines, in consulting companies, federal agencies such as the EPA, and chemical companies. The program is set to undergo successful re-accreditation by the Accreditation Board for Engineering and Technology in 2024, with a site visit scheduled for early November 2023.

The **Occupational and Environmental Residency**, led by Dr. Brian Schwartz, is an important and well-integrated component of the Johns Hopkins ERC. The Residency has successfully navigated the past three years during the Covid-19 pandemic, within the constraints imposed by the university, School, residency partners, and practicum rotation sites. Classes transitioned from a mix of purely in-class and purely online, to fully online during the early pandemic, to greater flexibility now with a variety of methods of course offerings including hybrid and asynchronous. The number of applications, interviews, accepted residents, and matriculating residents has been vigorous and sustained during this reporting period, with an average of 14 applications per year. Since July 2018, the Residency has graduated 8 residents, including 7 MPH students. There are currently 4 residents enrolled, with 3 of them also being MPH students. Louis Fazen, MD, PhD, tenure track assistant professor, board-certified in internal medicine and occupational and environmental medicine, joined the faculty in September 2022, while Dr. Aisha Rivera Margarin, the program deputy residency director, works closely with Dr. Brian Schwartz. ERC residents achieve at a very high level, and many have been nominated and elected to the school's Delta Omega Public Health Honor Society. Residency faculty and students authored 51 publications during this period, and one resident was the first recipient of the American College of Occupational and Environmental Medicine Corporate Rotation Scholarship, which led to a corporate rotation for residents at General Motors in 2021. Nine of our graduates sat for the American Board of Preventive Medicine certifying examination in occupational medicine, and all nine received a passing grade. Each year our residents apply for and receive American Occupational Health Conference scholarships, in 2022, three out of our four residents applied and received scholarships to attend that conference. Many graduates remain in the Mid-Atlantic because of the many varied employment opportunities in this region. Our graduates hold leadership positions in all sectors of occupational safety and health, including industry, clinical, consulting, academia, state and federal governments, and the military.

The **Occupational Epidemiology and Biomarkers Program** has been successful in training and graduating doctoral candidates, 9 of whom have graduated since 2018, 6 of whom were supported by NIOSH. Currently,4 doctoral students are enrolled in the program. Faculty members have extensive interdisciplinary research support and a productive publication record that frequently includes student co-authors. In addition to publications, our trainees and faculty have presented their work at numerous conferences as platform or poster presentations. Program faculty authored 216 publications during this reporting period, and 99 of these had student coauthors. Program graduates have been successful in establishing high-profile careers in environmental and occupational health, including in academia and within federal and non-governmental agencies and private sector enterprises.

The **Occupational Injury Epidemiology and Prevention Program** has continued the tradition of outstanding training of doctoral students for careers in occupational injury prevention and control. During this reporting period, one of the ERC-supported predoctoral trainees have graduated and is contributing to the occupational safety and health field as a health scientist at the Centers for Disease Control and Prevention. Program trainees have excelled in research (both their own and collaborative projects) and teaching. All trainees are provided with several opportunities to work with ERC faculty on research projects and publications, and

program faculty and students authored 66 publications during this reporting period. Program faculty make significant contributions to field of occupational injury epidemiology, are leaders in the field who are regularly sought after to participate in national advisory panels and to present at national and international meetings, and they also receive prestigious accolades to celebrate their contributions to the field.

The influence of courses developed for the ERC has spread throughout the school, and a large proportion of students taking ERC courses are from programs other than the ERC. A total of 26 didactic and laboratory courses are taught by ERC faculty, making up a significant proportion of the courses in the Department of Environmental Health and Engineering. Of further significance is the fact that more than half of the courses taught by ERC faculty have been formally recognized for “Teaching Excellence,” an accolade that is reserved for the top 10% of courses per term schoolwide, which typically number more than 100.

Our ERC graduates are employed in the occupational safety and health and allied fields and have obtained important professional positions with a regional and national reach. A majority have successfully obtained the appropriate professional certifications for their field, and their placement in key sectors of our society and their training makes them prepared to address traditional and emerging threats to workforce health. ERC graduate research productivity has been outstanding, and the research outputs are in emerging areas of significance to occupational health. These accomplishments show that the ERC meets all of the short- and intermediate-term outcomes of our strategic mission, while we have not carried out an analysis to study long-term impacts.

CONTINUING EDUCATION

The Johns Hopkins ERC prepares occupational safety and health professionals for practice and research roles that reflect not only the competencies required for their areas of the field, but also the changing climate in technical practices, regulations, compliance, healthcare delivery, and corporate culture. Our Continuing Education Program addresses these objectives by offering short courses, seminars, workshops, and conferences on a multitude of broad and innovative topics to practicing professionals such as physicians, nurses, industrial hygienists, safety engineers, and hazardous materials managers. During this five-year grant period, the success of our Continuing Education Program is evidenced by 3,678 occupational safety and health professionals trained (27,966 person-hours) at 1,187 companies through 85 courses. In addition, the program serves as a resource to private, state, local and federal government personnel working in region III and nationally, and the program has averaged 17 courses and over 700 trainees per year during this reporting period, and counting. While our trainee numbers have been lower than the previous grant period, primarily due to the COVID-19 pandemic, they have remained well in excess of the 600 trainees required by NIOSH.

OUTREACH

Situated in the largest, most highly ranked school of public health in the world, our ERC faculty conducted numerous, diverse outreach activities during this grant period, serving organizations within our region and beyond—including private-sector businesses (e.g., pharmaceutical, poultry, healthcare, food), nonprofit and academic organizations, government agencies (local, state, federal), and the military—through educational offerings and trainings, consultations, event sponsorship, and various other activities. Our faculty serve on external advisory boards, develop or enrich curricula and programs, and teach occupational safety and health courses at other universities and training project grantees, as well as for local, state, federal, and foreign governments, and partner with labor unions, nonprofit organizations, private sector businesses, and nongovernmental organizations. Our faculty have strong ties to many professional societies, and they serve on various committees and panels in their areas of expertise. The following are some highlights, with a more complete description outlined in the Outreach section of this application.

National and International Leadership Positions: ERC faculty have been at the forefront of leadership in national and international forums in occupational safety and heatlh. ERC Director Dr. Ramachandran is leading an effort in conjunction with NIOSH personnel to update the NIOSH exposure assessment strategy of 1977. He chaired the 2018 International Scientific Committee of the International Occupational Hygiene Association International Scientific Conference and was a member of the National Academies of Sciences, Engineering, and Medicine committee for reviewing the U.S. Department of Defense’s proposed occupational exposure levels for lead. Dr. Ramachandran is on the editorial boards of *Environmental Research: Health, Annals of Work Exposures and Health* and the *Journal of Occupational and Environmental Hygiene*. Dr. Brian Schwartz was appointed to serve as a 2021-2023 member of the U.S. Environmental Protection Agency’s Clean Air

Scientific Advisory Committee, Lead Review Panel, and he was also appointed as a 2021-22 member of the National Academies of Sciences, Engineering, and Medicine's ad-hoc committee to review the impacts of gold mining in Virginia. Residency Deputy Director Dr. Aisha Rivera Margarin assumed the role of chair for the Occupational and Environmental Medicine Residency Director's group, which is composed of residency directors across the United States. Occupational and Environmental Hygiene faculty member Dr. Quirós-Alcalá is an associate editor for several journals in her field, including the *Journal of Exposure Science and Environmental Epidemiology* and the *International Journal of Hygiene and Environmental Health*, while Dr. Patrick Breysse has been the director of the National Center for Environmental Health and Agency for Toxic Substances and Disease Registry since 2014. Dr. Keshia Pollack Porter served on the NIOSH Traumatic Injury Prevention NORA Council. Dr. Bruce Lippy participated on a NASEM Committee on the use of elastomeric respirators and is also working with the NIOSH Nanotechnology Center, NIOSH Office of Construction Safety and Health, and EU Nanotechnology Researchers, on the ANSI/ASSE A10 committee on construction safety and health, as well as the ISO TC 229 WG3 working group on nanotechnology health and safety.

COVID-19 Impact: The work and findings of ERC faculty had a significant impact on our response to the COVID-19 pandemic. Our ERC Biomarkers Director Dr. Chris Heaney's lab has developed a multiplex oral fluid SARS-CoV-2 antibody assay that is being used to determine SARS-CoV-2 IgG seroprevalence within cohorts at many universities including Johns Hopkins, Uniformed Services University, U.S. Naval Academy, Georgia Institute of Technology, and Emory University. A number of our faculty (Drs. Rule, Koehler, Ramachandran, Rivera, and Quirós-Alcalá) were interviewed by or their work cited by numerous media outlets—including CNBC, Vogue, The Scientist, Scientific American, Politifact, FactCheck, Elite Daily, The Verge, USA Today, Washington Post, Cosmopolitan, WMAR, and Mic—on aspects of aerosol exposures, mask usage, potential abuse and misuse of chemicals in the healthcare setting, and ventilation related to the COVID-19 pandemic. Dr. Rule participated on advisory panels for the World Health Organization's Technical Advisory Group on Personal Protective Equipment for COVID-19 and the NIEHS Disaster Research Response (DR2) working group, SARS-CoV-2/COVID-19. Dr. Quiros-Alcala provided written guidance on ventilation to the Word Health Organization. Dr. Ramachandran worked with Amtrak to evaluate the effectiveness of the ventilation and air filtration systems in a range of representative Amtrak Passenger Cars, and he is advising NY Metro Transit Authority on upgrading of their air handling systems. Ms. Mary Doyle provided guidance to small businesses to "Re-Open Maryland Safely" and contributed to guidance on "Occupational Health and COVID for Small Employers." The ERC sponsored the 2020 Mid-Atlantic Regional Conference in Occupational and Environmental Medicine, with the keynote delivered by NIOSH Director Dr. John Howard.

Regional Impact: Dr. Virginia Weaver testified for presumptive legislation for firefighter health coverage in Maryland workers' compensation, while Dr. Chris Heaney provided written testimony to the Baltimore City Council and Mayor's Office to summarize what is known about the environmental and occupational health effects of crude oil extraction, transport, and storage, and his testimony informed the Baltimore City Council's passage of a permanent ban on the siting of any new crude oil terminals within Baltimore City. Dr. Cassandra Crifasi has new and ongoing partnerships with Maryland law enforcement agencies, including the Baltimore Police Department, the State's Attorney Office of Baltimore City, and the Governor's Office of Crime Control and Prevention. Dr. Rule and Dr. Heaney have worked with the Curtis Bay community for several years to address air pollution and environmental justice concerns resulting from a highly industrialized waterfront area in south Baltimore. Dr. Rule was appointed to the Maryland Commission on Climate Change's Mitigation Working Group, Dr. Quiros-Alcala serves on the Maryland Governor's Commission on Environmental Justice and Sustainable Communities, and Ms. Mary Doyle collaborates with other centers within our institution, including the Johns Hopkins POE Total Worker Health Center in Mental Health, and she is on the planning committee for an October 2022 summit on mental health. Ms. Doyle also served on multiple conference planning committees for occupational and environmental health nursing, medicine, industrial hygiene, safety, hazardous materials, and other professional associations. She collaborated with the International Safety Center, Federal Occupational Health Nurses, and the National Council for Occupational Safety and Health to offer webinars, and conferences, served on the external advisory boards at the Public Employees Safety Association of Maryland, the Mountains and Plains ERC, and the New York University's occupational health nursing program, and she was appointed to the NIOSH Board of Scientific Counselors for a three-year term.

PILOT PROJECTS

We also believe that we have had an impact on the research training capacity of other institutions. The ERC's Pilot Projects Research Training Program has recently completed its twenty-second year of funding, during which a total of 104 pilot projects have been supported. In the current reporting period, 42 pilot project applications were received and 22 projects (approximately 52%) were funded. Junior faculty and predoctoral students from seven different institutions received awards during the project period, in addition to faculty and students from Johns Hopkins. In the last five-year funding cycle (2017-2022), PPRT-funded investigators published 28 peer-reviewed manuscripts and have at least 12 in preparation and made 41 presentations. Of the 22 applications submitted for additional research funding, 13 were successful, including one EPA award for $1,300,000, one CDC award for $2,165,000, and one NIH Intramural Research Training Award PDF for $70,000. In addition, PhD students and postdoctoral fellows received career development awards totaling $64,700, for a combined total of $3,907,000 out of $7,122,000 attempted. This is a 22:1 return on investment of the $175,000 awarded in pilot grants.

ALUMNI SURVEYS

Graduates of the ERC academic programs are periodically asked to evaluate the value and perceived proficiency of their education experience. The survey was most recently conducted in 2022 and contained detailed questions regarding their experiences in ERC academic programs. An electronic survey instrument (Survey Monkey) was used to measure the educational impact among students who graduated from the ERC programs between 2000 and 2016 (see the Evaluation and Planning Appendix for details). Overall, 34% (89 of 259) of our graduates contacted completed the survey, with results showing that 90% of our graduates are currently employed and of those, 85% are currently working in an occupational safety and health-related field or else continuing their education. The survey found that 94% of the alumni said they would recommend the program to others with similar career goals. This is evidence of the rigor of our training program, as is their record of successful employment of our highly qualified and motivated trainees, whose career trajectories have led to professional leadership positions across the country. We have a critical, sustainable mass of faculty and trainees, as demonstrated by the large network of internal and external faculty participating in our program. Our trainees continue to be successful in finding employment inside and outside of the region, which is evidence that our program meets regional needs and has a national impact, and our trainees report being satisfied with our programs' educational experience and resultant job opportunities.

DIVERSITY RECRUITMENT

ERC faculty are involved in schoolwide efforts to support minority recruitment and retention, which has inherent benefits to ERC recruiting. The Dean's Office has worked closely with ERC faculty in the past to attract underrepresented minority students and faculty to the ERC. In the last five years, the ERC was successful in applying to the Provost's Office for support for the recruitment of underrepresented minority faculty through the Targeted Opportunity Program, and two ERC faculty—Drs. Ana Rule and Lesliam Quiros Alcala—were recruited through this mechanism. Most recently, the Equity Fellowship was used to recruit a PhD student and will completely support this student for the first two years of doctoral work, with the ERC supporting the rest. Dr. Rule leads our ERC diversity recruiting efforts and meets with our faculty on a regular basis to develop plans for the recruitment of minority students into all ERC programs. These efforts have borne fruit, and we have a steady stream of underrepresented minority student applications and admissions. Our Occupational and Environmental Hygiene Program saw 8 of the 46 master's students and 4 of the 10 PhD students admitted being URM students, a significant improvement over the previous reporting period, and our Occupational and Environmental Medicine Residency also has an excellent record in the recruitment of trainees from underrepresented racial and ethnic groups, including 5 of the 10 residents admitted over this reporting period. Over the 45-year history of this residency, four of seven residency directors or codirectors have been women, including Drs. Melissa McDiarmid, Virginia Weaver, Francesca Litow, and Aisha Rivera Margarin. During this period, our Occupational Epidemiology and Biomarkers Program matriculated 1 underrepresented minority student out of the 4 who were admitted, while our Occupational Injury Epidemiology and Prevention Program matriculated 7 underrepresented minorities out of 22 admitted. Dr. Keshia Pollack Porter continues to work with the director of our school's Student Diversity Office on the Diversity Summer Internship Program that supports students from populations underrepresented in public health training, including minority groups and under-resourced institutions.

PROGRESS REPORT—OCCUPATIONAL AND ENVIRONMENTAL HYGIENE PROGRAM

FACULTY ACCOMPLISHMENTS

All program goals for the 2018-2023 period have thus far been met. Major activities included offering strong coursework, providing internship opportunities for fulltime students, and ensuring that successful projects were undertaken by part-time students. Our faculty are actively involved in continuing education and outreach, such as cosponsoring the local American Industrial Hygiene Association's professional development and continuing education conferences, and our students present their research at forums such as the national American Industrial Hygiene Conference and Exposition. Our program also participates in a wide range of interdisciplinary centers and institutes that afford opportunities to enrich student training and student research and provide practice opportunities. Our collaborating centers and institutes at Johns Hopkins include:

- Johns Hopkins Psychosocial, Organizational, and Environmental (POE) Total Worker Health Center
- Johns Hopkins Community Health: Addressing Regional Maryland Environmental Determinants of Disease (CHARMED) Center
- Baltimore BREATHE (Bridging Research, Lung Health & the Environment) Center
- Institute for Global Tobacco Control
- Center for a Livable Future
- Bloomberg American Health Initiative

Our faculty have extensive interdisciplinary research support and a productive publication record with 195 contributions to the peer-reviewed literature. Of those, 15 include students as first author, and 6 additional publications have students as coauthors. Please refer to our full publication list for details. Our faculty also conducted numerous, diverse outreach activities during this reporting period, and they held positions of leadership within national and international professional groups and editorial boards. Some examples include:

- Dr. Kirsten Koehler is a member of NIOSH's Safety and Occupational Health Study Sectio, and she is an occupational health section editor for *Current Environmental Health Reports*.
- Dr. Gurumurthy Ramachandran is on the editorial boards of *Environmental Research: Health, Annals of Work Exposures and Health* and the *Journal of Occupational and Environmental Hygiene*.
- Dr. Ana Rule is a board member of the Maryland Pesticide Education Network, as well as the stakeholder working group for the Maryland Department of the Environment's Methane Emissions Minimization Plan, and the Maryland Commission on Climate Change's Mitigation Working Group.
- Dr. Rule served on the editorial board for *PLOS One*, a peer-reviewed open access scientific journal published by the Public Library of Science, and she is coeditor of a special issue of the *International Journal of Environmental Research and Public Health* on remote sensing technologies.
- Dr. Rule participates on advisory panels for the World Health Organization's Technical Advisory Group on Personal Protective Equipment for COVID-19 and the National Institute of Environmental Health Sciences' Disaster Research Response (DR2) working group, SARS-CoV-2/COVID-19 Environmental Health Research Needs Panel.
- Dr. Lesliam Quirós-Alcalá serves on the Scientific Advisory Board of the Children's Environmental Health Network, as well as on the Maryland Governor's Commission on Environmental Justice and Sustainable Communities.
- Dr. Quirós-Alcalá is an associate editor for several journals in her field, including the *Journal of Exposure Science and Environmental Epidemiology* and the *International Journal of Hygiene and Environmental Health*, and she is on the executive board for the International Society of Exposure Science, for which she also serves on the conference technical organizing committee and has served as the nominations committee chair since 2020.

- Dr. Quirós-Alcalá distributed Worker Back Reports to salons and salon participants in her hair salon pilot study, including educational materials on how to reduce their exposures to VOCs and phthalates in an occupational setting as well as mitigation techniques specific for salon owners.

The work and findings of this ERC program also reach the larger community when our people and their work are featured in the news. During this reporting period, Drs. Rule, Koehler, and Quirós-Alcalá were interviewed by numerous media outlets—including CNBC, Vogue, The Scientist, Politifact, FactCheck, Elite Daily, The Verge, USA Today, WMAR, and Mic—on aerosol exposure, mask usage, potential abuse and misuse of chemicals in the healthcare setting, and ventilation related to the COVID-19 pandemic. Drs. Koehler and Rule also wrote an article on *Applying the Hierarchy of Controls for COVID-19*, published on the ERC website: https://www.jhsph.edu/research/centers-and-institutes/johns-hopkins-education-and-research-center-for-occupational-safety-and-health/can-a-mask-protect-me-putting-homemade-masks-in-the-hierarchy-of-controls.

TRAINEE ACCOMPLISHMENTS

Students are the number one priority of this program, and our faculty members maintain a close professional relationship with our master's and doctoral trainees, as well as with our graduates. This relationship is strengthened through our small lecture and lab sizes, numerous seminars, and one-on-one faculty advising. To ensure that students meet our educational objectives, the program provides a variety of educational activities, including both in-class and online courses, as well as seminars, and we encourage our students to attend the annual American Industrial Hygiene Association Conference. Since 2018, 26 master's students and four doctoral students have graduated from the program. All current students are on-track to graduate on time (18 months for fulltime MS students; 2-5 years for part-time MS students and doctoral students). Some highlights include: Ashley Newton's (PhD, 2019) paper was selected as the winner of the Michigan Industrial Hygiene Society's Jim D'Arcy *Journal of Occupational and Environmental Hygiene* Original Article Award for 2021; Christopher Zuidema's (PhD, 2018) paper published in the *Journal of Occupational and Environmental Hygiene* was selected as the winner of the American Industrial Hygiene Association's Aerosol Technology Committee's David L. Swift Award for best paper for 2020; and Melissa Edmondson created a personal protective equipment (PPE) burn rate calculator that was used by the Centers for Disease Control during the COVID-19 pandemic. A summary of all student projects and their current positions are listed below in Table OEH-1.

Table OEH-1. OEH Master's and Doctoral Program Graduates, their Advisors, Essay or Dissertation Topics, and Current Positions

2018
Colin Brander, MSPH, CIH, CSP (Koehler) **Final Essay:** OSHA's Revised Silica Standard: Corporate Adaptation and Preventative Controls **Positions:** Sr. Principal Health & Safety Analyst, Northrop Grumman, Ada, MI
Andrew Brown, MSPH, CIH, CSP (Koehler) **Final Essay:** Respirable Crystalline Silica (RCS) Exposure Assessment of Asphalt Plants and Quarries in the Mid-Atlantic Region of the US **Positions:** Corporate Industrial Hygiene and Occupational Health Specialist, Arkema, Pottstown, PA
Ryan Burgess, MSPH, CSP (Rule) **Final Essay:** Take-home Lead Exposure; a State of the Science Literature Review **Positions:** Environmental Health & Safety Specialist, Carpenter Co., Richmond, VA
Drew Cantor, MSPH (Ramachandran) **Final Essay:** Respirable Crystalline Silica Exposure Assessment of Reused and New Grit During an Abrasive Blasting Operation

Positions: EHS Engineer, Northrop Grumman, San Diego, CA

Kelsey Griffin, MSPH (Koehler)

Final Essay: Indoor Air Quality Assessment of an Office Building that Sustained Water Intrusion in Columbia, Maryland

Positions: Industrial Hygiene Project Manager, Environmental Profiles, Inc., Columbia, MD

Michael Hamill, MSPH, CIH, CSP (Rule)

Final Essay: Silica Exposure Among Concrete and Soils Laboratory Workers

Positions: Industrial Hygienist, US Department of State, Washington, DC

Ajeenah Haynes, MSPH, PhD, MPH (Rule)

Final Essay: Make Us Great Again: An Assessment of Safety Culture as a Leading Indicator for Improving Safety, Health, and Environmental Programs in a Manufacturing Facility

Positions: Lead EHS Management System Specialist, NYC Dept. of Environmental Protection, Office of EHS. Conducts EHS facility audits.

Erik Heithaus, MSPH, CIH (Ramachandran)

Final Essay: Airborne Endotoxin Exposure Assessment During Hormone Extraction Fecal Crushing Procedures in an Endocrine Laboratory

Positions: Lieutenant Commander, US Coast Guard., Chief, Inspections Division, St. Petersburg, FL

Kavita Mizin, MSPH, CIH, CSP (Koehler)

Final Essay: Chemical Exposure Assessment of Cooling Tower Aerosols

Positions: Production Manager, Saint-Gobain Performance Plastics, Madison, WI

Priscilla Samuel, MSPH (Rule)

Final Essay: Ergonomic Assessment at an Assembly Unit within a Manufacturing Plant in India

Positions: Program/Environmental Coordinator, Frontline Community Services, Gaithersburg, MD

Benjamin Williams, MSPH, PhD (Ramachandran)

Final Essay: An Environmental Assessment of Thermal Stress at Hot Processes in a Petrochemical Refinery

Positions: Chemical Hygiene Officer, Northwestern University Office of Research Safety, Chicago, IL

2019

Fatima (Effy) Castaneda, MSPH (Rule)

Final Essay: Assessing Potential Exposures to Silver Nanoparticles During Spray-Painting and Sanding Work Tasks: Characterization of Size Distributions and Overview of Integrated Results

Positions: Occupational Health & Safety Specialist, R.T. Vanderbilt Co., Towson, MD

Pearl Lee, MSPH, CIH (Ramachandran)

Final Essay: Assessment of Hydrogen Sulfide Exposure During Sulfur Loading Activities

Positions: Team Lead, Field Safety, Chevron, Los Angeles, CA

Ashley Newton, PhD (Koehler)

Dissertation: Improving Exposure Assessment of Airborne Metals: A Lung Deposition Sampler to Estimate Body Burden of Welding Fume Exposure

Positions: Chemist, US Army

Irene (Yinuo) Wang, MSPH (Ramachandran)

Final Essay: Industrial Hygiene Workspace Evaluations in a Silicone Molding Manufacturing Facility

Positions: Industrial Hygiene Consultant, SafeX, Westerville, OH

Jason Yu, MSPH (Peter Lees)

Final Essay: Analysis of Spices Collected During Lead Poisoned Child Investigations in Maryland (2019)

Positions: Section Head, Lead Poisoning Prevention Program, Maryland Department of the Environment

2020

Amanda Bewley, MS (Quirós-Alcalá)

Final Essay: Dust in Two Mineral Crushing, Milling, and Packaging Operations

Positions: Industrial Hygienist, University of Pennsylvania, Philadelphia, PA

Audrey Bowen, MS (Koehler)

Final Essay: Occupational Inhalation Exposure to Active Pharmaceutical Ingredient Particles During the Spray Drying Manufacturing Process

Positions: Environmental Health and Safety Engineering Site Lead, Juul Labs, Raleigh, NC

Kathryn Dalton, PhD (Davis)

Dissertation: Infection Control Insights for Hospital Animal-Assisted Intervention Program Implementation: From Stakeholder Perspectives to Microbial Dynamics

Positions: Postdoctoral Fellow, JHU

Danielle Edwards, MS, CIH (Koehler)

Final Essay: Ethylene Oxide Inverse Emission Modeling and Assessment for Smyrna, Georgia

Positions: NA Standards & Procedures Manager, Amazon, Atlanta, GA

Charles (Andy) Glode, MS, CIH (Rule)

Final Essay: Evaluation of Chemical Fume Hood Inspection Protocols for Chemical Hygiene Officers

Positions: Director, Office of Environmental Health & Safety, University of New Hampshire, Dover, NH

Juliana Rico, MS (Rule)

Final Essay: Noise Assessment Within a Food Manufacturing Plant

Positions: Safety, Health & Environment Process Coordinator, AECOM, St. Petersburg, FL

2021

Caleb Ginorio Gonzalez, MS, CSP (Ramachandran)

Final Essay: Measuring and Describing the Relationship between Respirable Mass, Airborne Mass, Bulk Powder Dispersibility and Dustiness for Nuclear Material Storage Container Evaluation

Positions: Senior Industrial Hygienist, Savannah River Mission Completion, Augusta, GA

Ryan Hines, MS (Ramachandran)

Final Essay: Modeling in Support of Industrial Hygiene Assessment: Aerospace Large Part Solvent Cleaning

Positions: Currently a doctoral student in the OEH program.

Jessica Mclellan, MS (Koehler)

Final Essay: Fugitive Combustible Dust Abatement in the Aerospace Industrial Manufacturing Sector

Positions: Environmental Health & Safety Engineer II, SpaceX, Santa Barbara, CA
Andrew Patton, PhD (Koehler) **Dissertation:** Novel Methods for Occupational and Non-Occupational Exposure Assessment for Improved Risk Assessment and Decision Making **Positions:** Director of Health and Safety Data Science, National Football League
John Wyluda, MS, CIH (Ramachandran) **Final Essay:** Evaluating Exposures at a New and Expanding Waste Sterilization and Recycling Facility **Positions:** EHS Specialist at Best Plus Lumber, a division of Triumvirate Environmental. Manages EHS programs and initiatives to reduce incidents and decrease exposure potential, Pittsburgh, PA
2022
Yipeng Liu, MS (Koehler) **Final Essay:** The use of Measurements and Two-Zone Model to Estimate Occupational Nanoparticle Exposure During Spray Application
Casey McPhillips, MS (Quirós-Alcalá) **Final Essay:** Noise Exposure Among Ground Maintenance Workers
Melissa Edmondson, PhD (Ramachandran) Graduating May 2022 (anticipated) **Dissertation:** Mathematical Modeling Approaches for Managing Infectious Disease Exposure in the Workplace **Positions:** Deputy Chief, Risk Evaluation Branch, NIOSH
Emma Moynihan, PhD (Ramachandran) Graduating May 2022 (anticipated) **Dissertation:** Pesticide Exposures and Heat Stress as Risk Factors for Kidney Disease in the Agricultural Health Study **Positions:** Exponent, Inc.

PROGRESS REPORT—OCCUPATIONAL AND ENVIRONMENTAL HEALTH NURSING

The ERC Occupational and Environmental Health Nursing Program has recruited and retained a strong, diverse cohort of students for our master's and doctoral programs, and with NIOSH support, we have provided an outstanding, interdisciplinary learning environment. Below are some trainees' highlights:

- MPH student Lindsey Gaydos graduated in December 2021 and now works as a nurse for the public health sector of the University of California Davis's Student Health and Counseling Services.
- Fifth-year Ph.D. trainee Caitlin Ceryes' research on injuries of workers in the aquaculture sector had to be discontinued due to the COVID-19 pandemic, and so she pivoted to conduct research on food service workers via survey data collected from more than 1,000 volunteers and participants in the U.S. Food Worker COVID-19 Survey. Dr. Ceryes graduated in May 2022 and is now an assistant professor in public health at Towson University, where she is focusing on worker safety and health in the U.S. and food systems.
- Fourth-year DrPH student Bakary Jallow, an occupational health nurse in the U.S. Air Force, is identifying data sources for his proposed dissertation that will address injuries among military personnel, particularly Air Force pilots. As an occupational health professional, Mr. Jallow has been doing COVID-19 education and training for many different sectors in the Air Force.
- The program had three new first-year DrPH students during this period: William Fritch works for the Vermont Department of Public Health; Matt Lindsley is a U.S. Public Health Service Commission Corp Officer; and Christina Khaokham is a former federal Epidemic Intelligence Service officer who now works for a private health plan. Both Mr. Lindsley and Ms. Khaokham are returning ERC trainees who also earned their master's degrees in our program.

Following the retirement of our former ERC Occupational and Environmental Health Nursing Program director and longtime faculty member Dr. Maureen Cadorette as of March 2022, our center has decided not to seek NIOSH renewal funding for this program, as we were unable to identify and recruit a qualified individual to assume the directorship. Meanwhile, program graduate Dr. Lori A. Edwards has agreed to serve as interim director. Dr. Edwards is the interim associate dean for the Master of Science in Nursing Program in Family and Community Health at the University of Maryland School of Nursing.

Highlights of our Occupational and Environmental Health Nursing faculty's outreach activities during this reporting period include:

- Dr. Cadorette served on the federal Joint Outreach Task Group, which sponsors town hall meetings for Department of Energy sites throughout the country and includes members from the U.S. Department of Energy, the U.S. Department of Energy Former Workers Program, the National Institute for Occupational Safety and Health, the Department of Labor Office of Workers Compensation Programs, and the U.S. Department of Labor Ombudsman for the Energy Employees Occupational Illness Compensation Program. Dr. Cadorette attended those town hall meetings specific to her Former Worker Program sites at Los Alamos and Sandia, New Mexico, to recruit and educate program participants.
- Ms. Mary Doyle lent her expertise as an external reviewer for the NIOSH Director's Intramural Award for Extraordinary Science Scientific Support. Ms. Doyle serves as an external advisory board member for the Mountains and Plains ERC and for New York University's OEHN program, and she holds leadership positions in the Washington, D.C., chapter of the American Association of Occupational Health Nurses. More of Ms. Doyle's activities are highlighted in the Continuing Education and Outreach section of this report.

PROGRESS REPORT—OCCUPATIONAL AND ENVIRONMENTAL MEDICINE RESIDENCY

The Johns Hopkins ERC's Occupational and Environmental Medicine Residency has successfully navigated the past three years during the Covid-19 pandemic, within the constraints imposed by the university and the school, as well as our residency partners and practicum rotation sites. Classes transitioned from a mix of in-class and online to fully online during the early pandemic, to even greater flexibility now, with a variety of course offerings, including hybrid and asynchronous. Many practicum sites allowed similar flexibility, having transitioned from fulltime onsite, to fully online, and now to a flexible hybrid approach to education and training.

FACULTY ACCOMPLISHMENTS

Selected faculty accomplishments during this reporting period (2018-present) include:

- Our Occupational and Environmental Residency Director Dr. Brian Schwartz, who provides 14 hours of lectures and 7 hours of question-and-answer sessions to the approximately 260 new MPH students in the required summer course *Environmental Health*, acquired and expanded his two-hour occupational health lecture to include information on NIOSH, the ERC, and the Occupational and Environmental Medicine Residency, so that all MPH students in the school are aware of these programs.
- Dr. Schwartz is the doctoral advisor for second-year PhD candidate Margaret Tomann, who is funded by the ERC's Occupational Epidemiology Biomarkers Program. Ms. Tomann has successfully passed her written comprehensive examination and will have prominent occupational and biomarker components as part of her dissertation research.
- OEM Residency Deputy Director Dr. Aisha Rivera Margarin presented occupational and environmental medicine lectures for the Johns Hopkins undergraduate course *The Environment and Your Health* in 2020 and 2021, the Johns Hopkins School of Public Health *Principles of Environmental Health* course in fall and spring 2019, 2020, and 2021, and the *Fundamentals of Clinical Preventive Medicine* course offered each fall since 2017. Dr. Schwartz has been asked to provide occupational safety and health and occupational and environmental medicine content in the undergraduate course for fall 2022.
- Drs. Rivera and Schwartz revised the Occupational and Environmental Residency seminar series and meet regularly with residents for administrative and teaching purposes, delivering many hours of topical and board review content.
- Dr. Rivera is the premedical advisor for master's students in our school's Master of Environmental Health Sciences program, and she has presented on a range of premedical advising topics for schoolwide student audiences by partnering with the school's Career Services Office.
- Our former residency director, Dr. Virginia Weaver, is now the rotation preceptor for the Occupational Safety and Health Administration rotation. Dr. Weaver is the medical officer and lead physician for OSHA's Occupational Medicine Resident Elective and Graduate Nurse Internship Programs in the Office of Occupational Medicine and Nursing.
- Dr. Rivera engages in outreach via presentations and email communication with Baltimore area primary care residency programs (e.g., internal medicine at Johns Hopkins), general preventive medicine and occupational medicine residency programs (e.g., Uniformed Services University of the Health Sciences). She is also a member of the National Hispanic Medical Association and has done virtual outreach activities for the Latino Medical Student Association.
- Dr. Rivera presented at the American Occupational Health Conference in 2021 and 2022. In 2021, her presentation was part of a project with the International Occupational Medicine Society Collaborative on the International OEM Pipeline, while her 2022 presentation was in partnership with Dr. Pamela Krahl (residency director for the Uniformed Services University of the Health Sciences) on a framework analysis of factors contributing to the changing landscape of the field of occupational and environmental medicine.

- Dr. Rivera is working with a group of occupational medicine physicians on the American College of Occupational and Environmental Medicine's initiative to develop a virtual lecture access point and library, "PoLi."
- Dr. Rivera has served on two of the American College of Occupational and Environmental Medicine's Presidential Taskforces, one on the "Future of OEM" and the other on "OEM Visibility."
- Dr. Rivera was selected for the 2022 Cohort of the National Hispanic Medical Association's Leadership Fellowship Program.
- Dr. Rivera was selected as a Johns Hopkins University SOURCE Service-Learning Fellow for the 2021-2022 academic year.
- In 2021, Dr. Rivera began a new collaboration with Dr. Krahl, director of the Uniformed Services University of the Health Sciences' occupational and environmental medicine residency, to have our residents and faculty do objective structured clinical evaluations with USUHS faculty and residents.

TRAINEE ACCOMPLISHMENTS

Our Occupational and Environmental Medicine residents perform at a high level and achieve outstanding employment. Occupational and Environmental Medicine Residents do not complete a thesis or a dissertation but are required instead to complete a research project that is documented when formally presented or published. Some additional details include:

- Our Occupational and Environmental Medicine residents continue to achieve at a very high level, and many have been nominated and elected to the school's Delta Omega Public Health Honor Society.
- One of our residents was the first to receive the American College of Occupational and Environmental Medicine's Corporate Rotation Scholarship, which led to establishing a corporate rotation for residents at General Motors in May 2021.
- From 2017-2021, nine of our graduates sat for the American Board of Preventive Medicine certifying examination in occupational medicine, and all nine received a passing grade.
- Each year, our residents apply and receive American Occupational Health Conference scholarships, in 2022, three out of our four residents applied and received scholarships to attend the conference, where our residents Dr. Alfredo Harb and Dr. Matthew Feeley presented a poster on a clinical case.
- Our residents have presented in every year of the current reporting period (since 2018) in seminars for practicum rotations and at regional and/or national conferences.

PROGRESS REPORT—OCCUPATIONAL EPIDEMIOLOGY AND BIOMARKERS PROGRAM

The Johns Hopkins ERC's biomarkers training program trainees continue to make satisfactory progress, with the majority successfully completing or on track to complete their training within five years of entering the program. This program has graduated a total 40 doctoral students, 16 of whom are working in occupational health-related fields, whereas the remaining are doing research related to toxicologic mechanisms, epigenetic mechanisms, epidemiology, or biomarker development in support of the overall NIOSH effort. Appendix 4 lists the impressive accomplishments and productivity of our past (prior to 2018) program graduates, while our more recent trainees are discussed below. The OEB Program has also been influential in the design and completion of research by doctoral students in other ERC programs as well, including Occupational and Environmental Health Nursing and Occupational and Environmental Hygiene. In addition, our faculty have made significant contributions to interdepartmental research utilizing biomarkers by co-advising doctoral students in the departments of Epidemiology and International Health.

We have made additions to our curriculum and faculty to improve student training in (epi)genomics, metabolomics, proteomics, and bioinformatics. All students will be required to take *Molecular Toxicology*, which contains extensive coverage of recent technological advances in the molecular and genetic tools available to study toxicological problems, including (epi)genomics, proteomics, metabolomics, next-generation sequencing, and transgenic animal models. For students undertaking research projects requiring more extensive knowledge of these methodologies, three further courses are available: *Genome Integrity*, *Molecular Biology and Genetics*, and *Principles of Genetic Epidemiology*. More advanced courses are also available for those students wishing further training in bioinformatics, including *PERL for Bioinformatics*, *Analysis of Biological Sequences*, and *Statistics for Genomics*.

NIOSH ERC funding for this program has strengthened our academic and research training efforts in several dimensions. First, through the availability of stipends and tuition support, it has facilitated the recruitment of new students, particularly those from the United States, and has aided in the retention of existing students. Second, program funding has allowed OEB Program Director Dr. Christopher Heaney to direct a larger portion of his effort toward identifying, selecting, advising, and mentoring the best students for training. In addition, Dr. Heaney has had time to expand the curriculum and supplement program faculty to broaden the expertise directly available to students. Third, the expansion and formal recognition of this training program contributed, in part, to the school's development of a joint interdepartmental MSc/PhD program in Molecular Epidemiology. Students in the departments of Epidemiology, Environmental Health and Engineering, Biochemistry and Molecular Biology, and Microbiology and Molecular Immunology are eligible for the program, obtaining a PhD from one department and a MSc degree from one of the other departments listed.

FACULTY ACCOMPLISHMENTS

All program goals for the 2018-2023 period have thus far been met. Our faculty offer strong coursework and ensure that the highest caliber of research projects are undertaken by our students. Our Occupational Epidemiology and Biomarkers faculty and trainees have extensive interdisciplinary research support and a productive publication record. Dr. Heaney has given numerous presentations and interviews on his COVID-19 work, and he has published multiple papers on the topic.

Our faculty have extensive interdisciplinary research support and a productive publication record with 112 contributions to the peer-reviewed literature, 52 of which have trainee lead- or co-authors. Please refer to our full publication list for details. Our faculty also conducted numerous, diverse outreach activities during this reporting period, and they held positions of leadership within national and international professional groups and editorial boards.

During this reporting period, Dr. Heaney and members of his lab have focused much of their work on projects related to the COVID-19 pandemic. Dr Heaney's research is funded by the NIH, the CDC, and private foundations, and he is collaborating with the U.S. Department of Defense and other major universities to help them with an application of his lab's multiplex oral fluid SARS-CoV-2 antibody assay, which is being used to determine SARS-CoV-2 IgG seroprevalence within cohorts at Johns Hopkins University (Homewood students, staff, and faculty), Johns Hopkins Medical Institutions (long-term care facility staff and residents), Uniformed Services University (staff and faculty), the U.S. Naval Academy (midshipmen), Georgia Institute of Technology (students), Howard County, Maryland (essential and other county workers and the general population), and

Emory University (healthcare workers). See https://www.medrxiv.org/content/10.1101/2020.05.24.20112300v1. This assay is an example of the frontline impact on the pandemic of the non-invasive biomarkers that Dr. Heaney is creating in ERC's Occupational Epidemiology and Biomarkers Program. Dr Heaney's lab is also leading a COVID-19 study among livestock industry workers and their household members in North Carolina, with plans to expand the enrollments to other major livestock production states (Delaware, Maryland, Virginia, Iowa). To date, Dr. Heaney and his colleagues have 22 COVID19 studies with 34, 882 participants enrolled and over 2.1 million dollars in funding.

Dr. Heaney supported students in his *Community-Driven Epidemiology and Environmental Justice* class who drafted and gave testimony about the environmental and occupational health effects of solid waste incineration to inform the Maryland General Assembly's consideration of legislation to increase wind and solar energy production by 2030 and to remove waste-to-energy from the tier one renewable energy portfolio standards.

Dr. Heaney was invited to deliver a keynote lecture at the April 2019 North Carolina Breathe conference in Wilmington, North Carolina. He presented findings from his occupational epidemiologic studies with North Carolina industrial hog operation workers regarding the exposure to and infection with livestock-associated antimicrobial-resistant *Staphylococcus aureus*.

Dr. Schwartz was appointed to serve as a 2021-2023 member (special government employee) of the U.S. Environmental Protection Agency's Clean Air Scientific Advisory Committee, Lead Review Panel, and he was also appointed as a 2021-22 member of the National Academies of Sciences, Engineering, and Medicine's ad-hoc committee to review the potential impacts of gold mining in Virginia.

TRAINEE ACCOMPLISHMENTS

Training Record: Program Completion and High-Impact Career Experience

The OEB Program has been extremely successful in training and graduating doctoral candidates. Of the 40 students entering the program since its inception in 2000, only three candidates have not completed successfully (two of whom left due to spousal relocation and opted to transfer to our department's MHS program). Most program candidates have completed their degrees in the expected timeframe of four to five years. Three students are currently working towards their doctoral degrees with NIOSH ERC support. Program graduates have been successful in establishing careers in fields directly or indirectly related to occupational health and safety. Examples of OEB graduate "star" career paths are listed below:

Academia—

- Joan Casey, assistant professor, Columbia University Mailman School of Public Health
- Jordan Kuiper, assistant scientist, EHE, Johns Hopkins Bloomberg School of Public Health
- Josiah L. Kephart, Environmental and Occupational Health, Dornsife School of Public Health, Drexel University
- Tara McAlexander, Epidemiology and Biostatistics, Dornsife School of Public Health, Drexel University
- Miranda Spratlen Jones, associate research scientist, Columbia University Mailman School of Public Health
- Nicole Cardello Dezeil, assistant professor, Yale School of Public Health
- Ellen M. Wells, assistant professor, Purdue University

Private Sector—

- Pranay Randad, associate, Flagship Pioneering, Cambridge, Massachusetts
- Alexis Brown, life sciences strategy, policy, and operations expert at Booz Allen Hamilton
- Shannon Henshaw Gaffney, principal health scientist, Cardno ChemRisk, San Francisco
- Kristen Clarkson, clinical scientist at Horizon Therapeutics in Gaithersburg, Md.

2018-2023 Graduates

In the most recent funding period, 10 doctoral trainees completed their research and were awarded degrees. A summary of their accomplishment follows:

Lindsay Avolio, PhD (advisor Chris Heaney) finished her dissertation in 2022 on developing novel multiplex immunological biomarkers of enteric and respiratory pathogen exposure and infection using non-invasive saliva specimens. Dr. Avolio is now a postdoctoral fellow focusing on applying non-invasive integrated-serological assays she developed in epidemiologic studies of intervenable factors that can mitigate infection risk among worker populations in the livestock, healthcare, and first-responder sectors.

Kristen Clarkson, PhD (advisor Chris Heaney) finished her dissertation in 2020 on novel immunological biomarkers that are correlates of protection from Shigellosis. Dr. Clarkson assumed the role of immunology team lead within the Department of Diarrheal Disease Research, Bacterial Diseases Branch, Walter Reed Army Institute of Research, Silver Spring, Maryland, and is now a clinical scientist at Horizon Therapeutics in Gaithersburg, Maryland.

Josiah Kephart, PhD, MPH, CPH (advisor Kirsten Koehler) finished his dissertation in 2019 on air pollution exposure assessment and health effects analysis related to homemaker use of alternative cook-stove fuels and technologies and is now an assistant professor of Environmental and Occupational Health at the Dornsife School of Public Health, Drexel University.

Angela Herrera, DrPH (advisor Ana Rule) finished her dissertation in 2019 on the characterization of toxic metal exposure from electronic cigarette use and was awarded a postdoctoral fellowship in EHE at the JHSPH.

Jordan Kuiper, PhD (advisor Brian Schwartz) completed his doctoral research in 2019 on chronic rhinosinusitis exacerbations, workplace impacts, and improvements to diagnostic criteria and subsequently matriculated into a postdoctoral fellowship with Dr. Jessie Buckley, assistant professor of EHE and Epidemiology at the JHSPH. Dr. Kuiper is now an assistant scientist in our Department of EHE.

Tara McAlexander, PhD, MPH (advisor Brian Schwartz) finished her dissertation in 2019 on environmental and occupational epidemiology of heart failure, including innovative use of biomarkers via extrapolation of data from electronic health records. She is now an assistant professor of Epidemiology and Biostatistics at the Dornsife School of Public Health, Drexel University.

Martha Powers, PhD, MPH (advisor Ana Navas-Acien) finished her dissertation in 2019 on the effects of arsenic exposure on respiratory health among American Indian and Tribal Nation communities. Dr. Powers is now an epidemiologist with the United States Environmental Protection Agency, Office of Research and Development, Center for Public Health and Environmental Assessment, Chemical and Pollutant Assessment Division, Washington, D.C.

Pranay Randad, PhD, MS (advisor Chris Heaney) completed his doctoral research in 2019 on biomarkers of the immunopathogenesis of livestock-associated, antimicrobial-resistant *S. aureus* among industrial livestock operation workers, their household contacts, and community residents. Dr. Randad transitioned from a postdoctoral fellowship at JHSPH to an associate position with Flagship Pioneering, where he is leading the development, validation, and application of novel biomarkers and diagnostics, and coordinating trans-disciplinary collaborations.

Alexis Brown, PhD, PMP (advisor Chris Heaney) successfully defended her dissertation in 2019 on antimicrobial resistance and meta-genomic sequencing biomarkers applied to industrial livestock operation worker health risks. Dr. Brown has supported the U.S. Food and Drug Administration, Office of Laboratory Safety for the past three years to develop and implement a centralized and standardized Environmental and Occupational Safety and Health safety training program. She supervises the development of training courses, safety training communications, and engages with FDA stakeholders to keep employees safe and prioritizes courses based on agency needs. Recently, Dr. Brown also became the lead for the FDA's institutional biosafety committee to improve compliance, centralize and standardize processes, and improve participation agencywide. Dr. Brown was awarded the 2020 Women of Color Technology Rising Star award.

Vanessa Coffman, PhD, MPH (advisor Chris Heaney) successfully defended her dissertation in 2018 on chemical and biological exposures and respiratory health effects among industrial hog operation workers. She

was awarded a postdoctoral fellowship at the University of Illinois Chicago and is now director of the Alliance to Stop Foodborne Illness, an initiative involving 15 leading food companies committed to strengthening food safety culture, including Walmart, Costco, Kellogg's, Amazon, Coca-Cola, and Conagra, among others.

Current (2022-2023) OEB Trainees

Fourth-year PhD trainee **Carolyn Gigot** (advisors Kirsten Koehler and Chris Heaney) is interested in pursuing research at the intersection of occupational epidemiology/biomarkers and environmental/industrial hygiene, and she is jointly advised by Drs. Heaney and Kirsten Koehler, the director of our ERC's Occupational and Environmental Hygiene Program. Her research is focused on COVID-19 risk in animal production workers. During this period, Ms. Gigot received a Johns Hopkins ERC Pilot Project Research Training award to study occupational risks and mental health of industrial livestock operations on workers related to the COVID-19 pandemic using a qualitative, mixed-methods approach.

Third-year PhD trainee **Kathleen Kurowski** (advisors Chris Heaney and Ana Rule) successfully passed her written and oral qualifying exams and is now pursuing dissertation research focused on the disproportionate impacts of industrial livestock production on workers and neighbors. Her research lies at the intersection of occupational epidemiology, biomarkers, and environmental and industrial hygiene, and she is advised by both Drs. Heaney and Ana Rule, the director of our ERC's Pilot Project Research and Training Program and a faculty member in our Occupational and Environmental Hygiene Program.

Second-year PhD trainee **Margaret Tomann** (advisor Brian Schwartz) completed her written doctoral quality exam and is focusing her research on the occupational and environmental health effects of coal production. Prior to joining our program, she was director of the Black Lung Clinic Program at a Federally Qualified Health Center in Southwest Virginia, where she worked at the intersection of medical, legal, and environmental and occupational health.

PROGRESS REPORT—ERC OCCUPATIONAL INJURY EPIDEMIOLOGY AND PREVENTION PROGRAM

FACULTY ACCOMPLISHMENTS

All program goals for the 2018-2023 period have thus far been met. Our faculty offer strong coursework and ensure that the highest caliber of research projects were undertaken by our students. Our ERC faculty and trainees have extensive interdisciplinary research support and a productive publication record. Drs. Pollack Porter, Crifasi and Lippy gave presentations at numerous conferences during the funding period. Our program also participates in a wide range of interdisciplinary centers and institutes that afford opportunities to enrich student training and student research and provide practice opportunities.

Our faculty have extensive interdisciplinary research support and a productive publication record, with 65 contributions to the peer-reviewed literature during this reporting period. Our faculty also conducted numerous, diverse outreach activities during this period, and they held positions of leadership within national and international professional groups and editorial boards. Some examples include:

- Dr. Pollack Porter continued her service on the Fire Protection Research Foundation's Research Advisory Committee and partnership with Major League Baseball and her work exploring injuries in professional baseball.
- Dr. Pollack Porter served as the lead expert for the American Heart Association CEO Roundtable's initiative to provide guidance to employers to identify and dismantle practices and policies that contribute to structural racism and inequities, with a focus on health, through the workplace.
- Dr. Pollack Porter continued as a member of the NIOSH National Occupational Research Agenda (NORA) Traumatic Injury Prevention (TIP) Council and helped develop a slide deck to introduce students across disciplines to NORA and the TIP Research Agenda. Download your copy: https://go.usa.gov/xsmDU
- Dr. Bruce Lippy participated on a National Academies of Sciences, Engineering, and Medicine Committee on the Use of Elastomeric Respirators in Health Care. He served as a representative of the construction industry.
- Dr. Lippy is working with several partners, including the NIOSH Nanotechnology Center, NIOSH Office of Construction Safety and Health, and EU Nanotechnology Researchers, on the SCAFFOLD Project, ANSI/ASSE A10 committee on construction safety and health and ISO TC 229 WG3 working group on nanotechnology.
- Dr. Lippy continued his work with NIOSH, CPWR (Center for Construction Research and Training) and the American Industrial Hygiene Association's working group on nanomaterials and his service on the National Academies of Sciences, Engineering and Medicine's Health and Medicine Division's Committee on Respiratory Protection for the Public and Workers without Respiratory Protection Programs at their Workplaces.
- Dr. Crifasi joined the editorial board of *Injury Epidemiology*.
- Dr. Crifasi has ongoing partnerships with law enforcement agencies, including the Baltimore Police Department (to better understand voluntary separation and improve retention), Anne Arundel County Executive's Office and Police Department (on strategies to improve oversight and accountability) and the State's Attorney Office of Baltimore City, and the Governor's Office of Crime Control and Prevention.
- Dr. Pollack Porter received our school's 2018-2019 Public Health Practice Award for furthering health equity by promoting health impact assessments and the Health in All Policies approach. She piloted the health note with the Health Impact Project and the Center on Budget and Policy Priorities. The health note provides legislators with objective information on how policies in other sectors, such as housing or education, may impact health.

- Faculty affiliate Dr. Maria Bulzacchelli continued to partner with the Northeast Center for Occupational Safety and Health in Agriculture, Forestry, and Fishing (NIOSH 2U54OH007542). She is leading a research project to examine the acceptance and use of mobile apps for commercial fishing safety.
- OIEP faculty are collaborating on a project to examine the impact of California's Workplace Violence Prevention in Healthcare Safety Standard on nonfatal violence involving days away from work.
- In January 2021, our former trainee Dr. Mitch Doucette officially joined our faculty and has taken on a core role within the program, including serving as faculty lead for the *Graduate Seminar in Injury Research and Policy* and as an informal mentor for doctoral students interested in advance statistical methods such as comparative interrupted time series and augmented synthetic control modeling.
- Faculty affiliates Drs. Stephen Wegener and Renan Castillo continued leading an evaluation of the Amputee Coalition, a federally funded center that provides information and programs for persons with limb loss. This process and summative evaluation will address the program impact on major stakeholders.

The work and findings of this ERC program also reach the larger community when our people and their work are featured in the news. During this reporting period, Drs. Pollack Porter, Crifasi and Lippy were interviewed or quoted by various media outlets throughout the country and the world on their research, and our OIEP faculty contributed to myriad COVID outreach activities with other ERC faculty.

TRAINING RECORD

Program Completion and Career Experience

OIEP trainees complete their degree in an appropriate timeframe (the average length of time to complete the PhD in the Department of Health Policy and Management is four years). Along the way, they gain the skills and experience to be successful in the workforce, and our trainees are highly sought after for a number of reasons:

- First, they have significant research experience. PhD students in our HPM department are required to engage in or be exposed to at least two research projects, for a minimum of 300 hours, to understand different research approaches. While the department encourages work within the department, students are free to pursue opportunities of interest throughout the school, university, or off campus. These research project hours must be completed prior to the trainee sitting for their preliminary oral exam that, when passed, advances the trainee to PhD candidate status.
- Second, our trainees have publications. One benefit of being a trainee at a level one research institution is the tremendous opportunities to become involved in scholarship. All trainees have opportunities to be coauthors on publications, and they also receive valuable mentorship as they produce first-author publications. In fact, many trainees produced their first first-author publication while still in the program.
- Third, they have experience presenting at national meetings, which helps build their confidence as scholars in the field. These experiences also provide trainees with exposure to experts and opportunities to interact with leaders in the field. OIEP trainees have presented at a number of meetings, including the American Public Health Association Annual Meeting, the Society for the Advancement of Violence and Injury Research, the National Occupational Injury Research Symposium, and Academy Health.
- Finally, our trainees graduate with key skills. In addition to skills in research, all trainees have strong written and oral communication skills and experience in translating research to policy and practice. Many of our trainees also graduate with skills in managing research projects, working with various partners and sectors, building interdisciplinary teams, time management, and task prioritization. These are transferrable skills that can bolster success in academic, government, nonprofit, and private sector positions.

Trainee Accomplishments

The OIEP had one graduate during this reporting period, who is already making significant contributions to the field.

- Molly Merrill-Francis completed the PhD program in December 2020. Her dissertation research focused on the association between state minimum wage laws and occupational safety. After

graduating, she served as a Public Health Scientist at the U.S. Army Public Health Center. In May 2022, she joined the Centers for Disease Control and Prevention as a Health Scientist.

In addition to our recent graduates, we have several outstanding alumni making important contributions to the field. Please see Table OIEP-1 (below) for some of our OIEP Program's "all-star" graduates.

Table OEIP-1. OIEP Program All-Star Graduates

Graduate Name & Degree Received	Title of Dissertation	Current Position & Major Accomplishments and Awards
Jennifer Lincoln, Ph.D. 2006	Fresh Seafood at a Price: Factors Associated with Surviving Fishing Vessel Sinkings in Alaska	Associate Director for the NIOSH Office of Agricultural Safety and Health. In 2015, established the NIOSH Center for Maritime Safety and Health Studies. Recognized in 2022 but the Journal of Agromedicine as a "Leader in the Field"
Jennifer Taylor, Ph.D. 2007	Comparison and Application of Patient Safety Event Case-Finding Methods using Administrative Data and an Error Reporting System	Arthur L. and Joanne B. Frank Professor of Environmental and Occupational Health at the Drexel University Dornsife School of Public Health (inaugural recipient). In 2013, established the FIRST Center – the Firefighter Injury Research and Safety Trends Center.
Whitney Austin Gray, Ph.D. 2011	Green Buildings, Health, and Safety: An Investigation of the Effects of the Physical Work Environment on Occupant Health and Safety in Health Care Settings	Senior Vice President at International WELL Building Institute. Has launched more than 100 educational sessions on best practices in building design and operations to improve health. Co-Founder of the NIH Health in Buildings Roundtable and the first public health professional to become a LEED Accredited Professional (LEED AP).

PROGRESS REPORT—ERC PILOT PROJECT RESEARCH TRAINING

Funded projects, trainees, and additional research awards based on pilot project data are described below.

PPRT AWARDS (2017-2022)

In the last five PPRT funding cycles (2017-2022) combined, 5 requests for proposals were issued; in response, 42 pilot project applications were received and 22 projects (approximately 52%) were funded. Researchers from six institutions received awards during this period, 11 from within Johns Hopkins and 11 from other institutions. Awards were given to 8 underrepresented minority applicants. The complete list of the 22 pilot projects funded during the last two PPRT cycles follows.

Awarded 2017-2018

Name: Sara Lupolt, MPH **Awarded**: **$6,000**
Status: PhD Candidate, Johns Hopkins Bloomberg School of Public Health
Project Title: Characterizing Urban Farmers' Activities and Rates of Soil Contact (occ. hygiene)

Name: Lesliam Quiros-Aclala, MS, PhD (URM) **Awarded**: **$11,000**
Status: Assistant Professor, School of Public Health, University of Maryland
Project Title: The Hair Salon Study: A Pilot Study to Evaluate Occupational Exposures in Hair Salons (occ. hygiene)

Name: Leigh J. Allin, MS **Awarded**: **$14,000**
Status: PhD Candidate, Virginia Polytechnic Institute and State University
Mentor: Michael L. Madigan, Ph.D.
Project Title: Evaluating the Effects of Occupationally-Relevant Fatiguing Work of Trip-Induced Fall Risk (occ. injury)

Awarded 2018-2019

Name: Yuan Shao, PhD **Awarded**: **$10,000**
Status: Post-Doctoral Fellow, Johns Hopkins Bloomberg School of Public Health
Project Title: Tomographic Reconstruction of Spatial Aerosol Distribution using Multispectral Light Extinction Measurement - A Chamber Study (other)

Name: Kimeran Evans PT, DPT **Awarded**: **$6,480**
Status: Ph.D. Student, West Virginia University
Project Title: An In-Depth Exploration of Hospital-Based Physical and Occupational Therapists' Needs, Perceptions and Involvement Regarding Safe Patient Handling and Mobility Programs (occ. med.)

Name: Katie Overbey, MS **Awarded**: **$14,000**
Status: PhD candidate, Johns Hopkins Bloomberg School of Public Health
Project Title: Occupational Exposure to Human Norovirus in Hospitals: Capacity Building and Surface Sampling to Inform Large Scale Studies (occ. hygiene)

Name: Jillian Fry, PhD, MPH **Awarded**: **$10,000**
Status: Assistant Scientist, Johns Hopkins Bloomberg School of Public Health
Project Title: Identifying Occupational Safety and Health Research Priorities in Aquaculture: A Mixed Methods Pilot Study (other)
Note: Dr. Fry moved to Towson University shortly after receiving the award notification and returned the funds, which is why we have more recipients in 2019-2020

2019-2020 (Awarded January-March 2020)

Name: Sean Banaee, PhD, CIH, CSP **Awarded: $6,578**

Status: Assistant Professor, Old Dominion University

Project Title: Study of Musculo-Skeletal Disorders amongst Dental Hygiene Students (ergo)

Name: Lucy Kavi, MSc (URM) **Awarded: $10,000**

Status: PhD student, University of Maryland SPH

Mentor: Lesliam Quiros-Alcala, PhD, MSc

Project Title: Workplace exposures to current and emerging contaminants of concern among minority workers (occ. hygiene)

Name: Cynthia T. Pugh, MS, CSP, CHO (URM) **Awarded: $7,342**

Status: PhD student, Indiana University of PA

Project Title: Evaluation of occupational exposures to nanomaterials in Electronic Recycling (E-Cycle) facilities. (Occ. Hygiene)

Name: Keisha A. Robinson, CNM, C-EFM (URM) **Awarded: $7,500**

Status: PhD Student, UMD School of Nursing

Project Title: Clinician Resilience after Traumatic Child Birth Exposure (occ. medicine)

Name: Lesliam Quirós-Alcalá, PhD, MSc (URM) **Awarded: $10,000**

Status: Assistant Professor, Johns Hopkins SPH

Project Title: Exposures to respiratory irritants among hairdressers and their role on the nasal microbiome (occ. hygiene)

Name: Kathryn R. Dalton, VMD MPH **Awarded: $10,000**

Status: PhD student, JHSPH

Project Title: Identifying Occupational Health Benefits and Concerns of Key Stakeholders Regarding Hospital-Based Animal-Assisted Intervention Programs: A Pilot Study to Inform Program Implementation. (other)

Name: Molly Francis, MPH **Awarded: $625.00**

Status: PhD Student, JHBPH

Project Title: Minimum Wage and Fatal Occupational Injury (injury)

2020-2021 (Awarded January 2021)

Name: Lydia Louis / Magdalena Fandino (URM) **Awarded: $10,000**

Status: Post-Doctoral fellows, JHSPH

Project Title: The role of phtalate exposure on biomarkers of oxidative stress and inflammation among hairdressers (occ. hygiene)

Name: Brenda Berumen, MS (URM) **Awarded: $9,500**

Status: PhD student, ODU

Project Title: Assessing the Impacts of the COVID-19 Pandemic on US Hispanic/Latino Farmworkers (occ. hygiene)

Name: Jessica Suedbeck, PhD **Awarded: $10,000**

Status: Assistant Professor, ODU

Project Title: Ergonomic Instrument Selection for Dental Hygiene Students (ergo)

Name: Joyce Lin **Awarded: $10,000**

Status: PhD student, JHBSPH

Project Title: Characterizing Metal Exposure in Cleanup Workers involved in the Deepwater Horizon Oil Spill: Qualification of a Toenail Biomarker and Implications for Neurobehavioral Health (occ. hygiene)

Name: SueAnn Woods **Awarded: $5,000**

Status: PhD student, WVU

Project Title: The impact on disability on mortality among workers with upper extremity disorder claims: a retrospective cohort study (ergo)

Name: Caitlyn Ceryes **Awarded: $10,000**

Status: PhD student, JHBSPH

Project Title: Impact of COVID-19 on food distribution essential workers (other)

2021-2022 (Awarded January 2022)

Name: Melissa DeSantiago (URM) **Awarded: $7,500**

Status: PhD student, JHBSPH

Project Title: The METALES Study: Measuring E\xposures To Agrochemicals; Link to rEnal disease (occ. hygiene)

Name: Jonathon Ehsani, PhD **Awarded: $7,500**

Status: Assistant Professor, HPM-JHPSPH

Project Title: Motor vehicle crash risk among au pairs in the U.S. (other)

Name: Sunwook Kim, PhD **Awarded: $7,500**

Status: Research Assistant Professor, VA Tech

Project Title: Assessing the Potential Adverse Impacts of Back-Support Exoskeletons on Fall Risks (ergo)

PPRT PROGRAM PRODUCTS

In the last five-year funding cycle (2017-2022), PPRT-funded investigators published 28 peer-reviewed manuscripts and have at least 12 in preparation, detailed below, and they made 41 presentations (see the attached PPRT Publications for a list of these presentations). Of the 22 applications submitted for additional research funding, 13 were successful, including an EPA award for **$1,300,000**, a CDC award for **$2,165,000**, and an NIH Intramural Research Training Award for **$70,000**. In addition, PhD students and postdoctoral fellows received career development awards totaling $64,700, **for a combined total awarded of $3,907,000** out of $7,122,000 attempted. This is a 22:1 return on investment of the 175,000 awarded in pilot grants.

Awards Resulting from PPRT Projects Funded 2017-2022

- **Lin, Joyce** [2020] 21st Century Cities Initiative Award for Doctoral Research on Urban Issues, **$5,000**
- **Banaee, Sean** [2019] OBICI Healthcare Foundation, **$5,000** in 2020
- **Dalton, K.** [2019] NIH Intramural Research Training Award PDF, **$70,000** awarded 2021
- **Francis M.** [2019] Horowitz Foundation, **$10,000** in 2021; Susan P. Baker Scholarship, **$8,700** in 2021
- **Overbey K**. [2018] Prevention Epicenters Program: Protecting from Infections, Antibiotic Resistance and Other Adverse Events, CDC, **$2,165,000** in June 2021; Second Place, Johns Hopkins Three Minute Thesis Competition, April 2019, **$500**
- **Shao, Y.** [2018] Conference Award 2019 International Society for Exposure Science, **$2,500**
- **Lupolt S.** [2018] EPA STAR grant for estimation of exposure factors, **$1,300,000**; Conference Award 2019 ISES, **$2,500**; 21st Century Cities Initiative Award for Doctoral Research on Urban Issues, **$5,000**; Northeast Sustainable Agriculture Research Council Graduate Student Grant, $**15,000**
- **Quirós-Alcalá L.** [2018] Maryland Cigarette Restitution Fund 2020, **$50,000**

- **Doucette M.** [2017] New Investigator Award, APHA, Awarded July 2019, **$7,500**

Unsuccessful Grant Applications

- **Lin, Joyce** [2021] Bloomberg American Health Initiative Spark Award, **$60,000**; Canadian Institute of Health Research (CIHR), $90,000 in 2021
- **Banaee, Sean** [2020] NIEHS R03 for $72,475; Old Dominion University (ODU) Perry Honors College Undergraduate Research Program, $10,000; Commonwealth Health Research Board [CHRB], $133,000
- **Dalton, K.** [2020] Human Animal Bond Research Institute (HABRI), $100,000 in 2021; K99, $930,000 in 2021
- **Quirós-Alcalá L.** [2018] Maryland Cigarette Restitution Fund, $100,000; Submitted R01 in 2021 to NIEHS for $4,250,000, Score 29, 19 percentile; resubmitted 2022 and will resubmit 2023. (This R01 includes pilot data from Kavi, Fandino, and Quiros-Alcala awards)

Publications Resulting from JHU PPRT-Funded Research (awardee names are underlined)

1. Louis L.M., Kavi, L., Boyle M., Pool W., de Jesus V., Pollack A., Thomas S., Sun A., McLean S., Rule A.M., Quirós-Alcalá L. A pilot study: Exposure to volatile organic compounds (VOCs) among hairdressers in salons primarily serving women of color. **2021** Sept; 154:106655. Environment International.
2. Shao Y., Kavi L., Boyle M., Louis L.M., Pool W., Thomas S.B., Wilson S., Rule A.M., Quirós-Alcalá L. Real-Time Air Monitoring of Occupational Exposures to Particulate Matter among Hairdressers in Maryland: A pilot study. **2021** July; 31(4):1144-1153. Indoor Air.
3. Boyle M., Pollack A.Z., Kavi L., Louis L.M., Pool W., Sapkota A., Zhu L., Thomas S., Rule A.M., Quirós-Alcalá L. Occupational exposures to phthalates among Black and Latinx U.S. hairdressers serving an ethnically diverse clientele: a pilot study. **2021** June 15; 55 (12):8128-8138. Environmental Science and Technology.
4. Quirós-Alcalá L, Pollack AZ, Tchangalova N, DeSantiago M, and Kavi LK£. Occupational exposures among hair and nail salon workers: a scoping review. Curr Environ Health Rep **2019** Dec;6(4):269-285. (invited review)
5. Allin LJ, Madigan ML. Effects of manual material handling workload on measures of fall risk. IISE Transactions on Occupations Ergonomics and Human Factors (**2020**) 8(3): 155-165. https://doi.org/10.1080/24725838.2020.1850552
6. Lupolt SN, Agnew J, Burke TA, Kennedy RD, Nachman KE*. Key considerations for assessing soil ingestion exposures among agricultural workers. **(2022)** J Expo Sci Environ Epidemiol 32, 481–492.
7. Lupolt SN, Santo, RE, Kim BF, Burke TA, Nachman KE (**2022**). Urban soil safety policies: The next frontier for mitigating lead exposures and promoting sustainable food production. GeoHealth (**2022**) https://doi.org/10.1029/2022GH000615
8. Lupolt SN, Agnew J, Ramachandran G, Burke TA, Kennedy RD, Nachman KE. A qualitative characterization of meso-activity factors to estimate soil exposure for agricultural workers. J Expo Sci Environ Epidemiol (2022).
9. Lupolt SN, Santo RE, Kim, BF, Green CE, Codling EE, Rule A, Chen R, Scheckel K, Strauss M, Cocke A, Little N, Rupp V, Viqueira R, Illuminati J, Epp Schmidt A, Nachman KE. The Safe Urban Harvests study: A community-driven cross-sectional assessment of metals in soil, irrigation water, and produce from urban farms and gardens in Baltimore, MD. Environmental Health Perspectives. https://doi.org/10.1289/EHP9431.
10. Santo RE, Lupolt SN, Kim BF, Burrows RA, Evans E, Evenson B, Synk, CM, Viqueria R, Cocke A, Little NG, Rupp V, Strauss M, Nachman KE. Characteristics and growing practices of Baltimore City urban farms and community gardens. Urban Forestry & Urban Greening. https://doi.org/10.1016/j.ufug.2021.127357.
11. Evans KW, Myers D, Rockefeller K, Rauscher K, Allen A, Gao W. A Qualitative Exploration of the Lift Equipment Uses and Needs of Physical and Occupational Therapists and Assistants Participating in Safe Patient Handling and Mobility Programs. International Journal of Safe Patient Handling. June 2021: 11(20); 76-85.
12. Overbey KN, Zachos NC, Coulter C, Jacangelo JG, Schwab KJ. Recovery of infectious human norovirus GII.4 Sydney from fomites via replication in human intestinal enteroids. Front. Cell. Infect. Microbiol., **2021** | https://doi.org/10.3389/fcimb.**2021**.693090. 2021.

13. Overbey KN, Zachos NC, Coulter C, Schwab KJ. Optimizing human intestinal enteroids for environmental monitoring of human norovirus. **2021** Food and Environmental Virology 213:470–484.
14. Overbey KN, Hamra GB, Nachman KE, Rock C, Schwab KJ. Quantitative microbial risk assessment of human norovirus infection in environmental service workers due to healthcare-associated fomites. **2021** J of Hosp Inf. 177:52-64.
15. Banaee, S., Claiborne, D., Akpinar, M. (**2021**). Occupational Health and Safety Practices among Dental Care Professionals During SARS-CoV-2 Pandemic. Work; A Journal of Prevention, Assessment & Rehabilitation. 68(**2021**), 993–1000.
16. Pugh, C., Cekada, T., Wachter, J., Marin, L.S. An exploratory study on occupational exposure to airborne engineered nanomaterials during the recycling operations of electronic devices. (**2022**) J Nanopart Res 24, 36.
17. Robinson, K., Johantgen, M. Storr, C., Gaitens, J., Atlas, R., Ogbolu, Y. (**2022**) Cross-sectional Study of the Frequency and Severity of Traumatic Childbirth Events and How They Affect Maternity Care Clinicians. J Obstet Gynecol Neonatal Nurs. **2022** Sep 30;S0884-2175(22)00316-1. doi: 10.1016/j.jogn.2022.08.006.
18. Dalton, K.R., Louis, L.M., Fandiño-Del-Rio, M., Rule, A.M., Pool, W., Randolph, K., Thomas, S., Davis, M.F., Quirós-Alcalá, L., **2022**. Microbiome alterations from volatile organic compound (VOC) exposures among workers in salons primarily serving women of color. Env Research 114125. https://doi.org/10.1016/j.envres.2022.114125
19. Dalton, K.R., Fandiño-Del-Rio, M., Rule, Louis, L.M., Garza, M.A., Quirós-Alcalá, L., Davis, M.F. **2022**. Microbiome alterations associated with phthalate exposures in a US-based sample of Latino workers. Environmental Research. 2022 Nov;214(Pt 4):114126. doi: 10.1016/j.envres.2022.114126.
20. Dalton KR, Altekruse W, Campbell P, Ruble K, Carroll KC, Thorpe RJ, Agnew J, and Davis MF. Perceptions and Practices of Key Worker Stakeholder Groups in Hospital Animal-Assisted Intervention Programs on Occupational Benefits and Perceived Risks. People and Animals: The International Journal of Research and Practice. **2022**. 5(1), 4. DOI: 10.1101/2020.12.18.20248506.
21. Dalton KR, Ruble K, Redding LE, Morris DO, Mueller NT, Thorpe RJ, Agnew J, Carroll KC, Planet P, Rubenstein RC, Chen AR, Grice EA, and Davis MF. Microbial sharing between pediatric patients and therapy dogs during hospital animal-assisted intervention programs. Microorganisms. **2021**. 9(5), 1054. DOI: 10.3390/microorganisms9051054.
22. Dalton KR, Campbell P, Altekruse W, Thorpe RJ, Agnew J, Ruble K, Carroll KC, and Davis MF. A conceptual framework to address administrative and infection control barriers for animal-assisted intervention programs in healthcare facilities: Perspectives from a qualitative study. Infection Control & Hospital Epidemiology. **2021**. 1-2. DOI: 10.1017/ice.2021.24.
23. Dalton KR, Rock C, Carroll KC, and Davis MF. One Health in Hospitals: How understanding the dynamics of people, animals, and the hospital built environment can be used to better inform interventions for antimicrobial-resistant Gram-positive infections. Antimicrobial Resistance & Infection Control. 2020, June;9(78). DOI: 10.1186/s13756-020-00737-2.
24. Merrill-Francis, M., Webster, D. W., & **Crifasi, C. K**. The association between state minimum wage laws and fatal occupational injuries, American Journal of Preventive Medicine, 2022 Jun;62(6):878-884. doi: 10.1016/j.amepre.2021.09.022.
25. Merrill-Francis, M., McGinty, E. E., Barry, C. L., Webster, D. W., & **Crifasi, C. K**. (2021). Association between gun owner attitudes and their behavior in private firearm sales. Preventive Medicine, 147, 106454.
26. Newcomb, A. B., Zadnik, M., Carlini, A. R., Francis, M. M., Frey, K. P., Heins, S. E., Castillo, R. C. (2020). Barriers and facilitators to the implementation of injury prevention programs: a qualitative exploration and model development. Journal of Trauma Nursing, 27(6), 335-345.
27. Martin, Christopher; Woods, SueAnn; Bertke, Stephen; Jin, ChuanFang; Pinkerton, Lynne. Increased mortality among workers with disabling upper extremity neuropathies. Under Review in Occupational Medicine. Manuscript Number: OM-22-OP-122
28. Ceryes CA, Robinson J, Biehl E, Wirtz A, Barnett D, Neff RA. Frequency of workplace controls and associations with safety perceptions among a national sample of U.S. food retail workers during the COVID-19 pandemic. *Journal of Occupational and Env Medicine.* July 2021 - Volume 63 - Issue 7 - p 557-564.

Publications Submitted and In Preparation

1. Kavi LK, Louis LM, Shao Y, Ramachandran G, Boyle M, Pool W, Randolph K, Wilson S, Thomas S, Rule AM, Quirós-Alcalá L. A pilot study to assess indoor airborne concentrations of volatile organic compounds (VOCs) in hair salons primarily serving women of color. Submitted to Environmental Research Dec 2022
2. Kavi LK, Newmeyer MN, Quirós-Alcalá L, and Prasse C. Exploring occupational chemical exposures in a cohort of U.S. hairdressers via high-resolution mass spectrometry. Submitted to JESEE. Oct 2022.
3. Lupolt SN, Agnew J, Ramachandran G, Burke TA, Kennedy RD, Nachman KE. Environmental, Activity, Timing and Receptor (EAT-R) Factors: A meso-activity centered approach for characterizing soil exposure for agricultural workers. In preparation
4. Evans KW, Myers D. A Qualitative Exploration of the Unique Work-Related Hazards and Injury Experiences among Rehabilitation Professionals Participating in a Safe Patient Handling and Mobility Program (In preparation)
5. Pugh, C., Marin, L.S. Occupational Exposure to Metals from Airborne Engineered Nanomaterials during the Recycling Operations of Electronic Devices. In preparation
6. Carlini, A.R., Merrill-Francis, M., Newcomb, A., McNamara, L., Frey, K., Zadnik, M., Castillo, R.C. A national survey of injury prevention professionals at trauma centers. (In preparation, anticipated submission 5/2022)
7. Merrill-Francis, M., McGinty, E.E., Barry, C., Webster, D.W., & **Crifasi, C.K**. Seller concerns associated with checking purchasers for eligibility in the private market. (In preparation, anticipated submission 5/2022)
8. Brenda Berumen-Flucker, Hadiza Galadima, Michele Kekeh, Sylvia Shangani, Muge Akpinar-Elci; Assessing the Impacts of the COVID-19 Pandemic on U.S. Hispanic/Latino Farmworkers. Manuscript in preparation
9. Lin JY*, Koffman LJ, Tehrani MW, Chen R, Han SG, Sandler DP, Lawrence KG, Jackson WB, Dickerson AS, Ramachandran G, Engel LS, Rule AM. Reliability of low mass toenail samples as biomarkers of chronic metal exposure. Submitted Sept 2022 to Journal of Exposure Science and Environmental Epidemiology.
10. Ceryes CA, Biehl E, Agnew J, Wirtz A, Barnett D, Neff RA. Exploring workplace factors associated with presenteeism intentions among food chain workers during the early COVID-19 pandemic. *In preparation.*
11. Gorski-Steiner I, Ceryes CA, Biehl E, Neff RA. Food worker mental health during the early COVID-19 pandemic. *In preparation.*
12. Stephen D, Kim S, Nussbaum M, Madigan M. Chairless chair exoskeleton adversely affects reactive balance after simulated slips and trip. Journal of Biomechanics, in preparation.

PROGRESS REPORT—ERC CONTINUING EDUCATION PROGRAM

To date in the current grant period (since July 2018), the Johns Hopkins Continuing Education Program has trained 3,678 occupational safety and health professionals (27,966 person-hours) in a total of 85 courses. Our CE Program has provided excellent, high-quality continuing education, despite COVID restrictions, through courses, seminars, and workshops covering a multitude of broad and innovative topics.

EXTERNAL PARTNERSHIPS

Ms. Doyle has strengthened the CE Program by developing and expanding numerous internal and external partnerships and increasing our visibility within Region III occupational safety and health professional organizations, federal, state, and local agencies and organizations, unions, and nonprofit organizations. Partnerships with various organizations have enhanced the CE Program by providing speakers, trainers, advisory board members, course participants, and needs assessments for course topics. Based on needs assessments within our partnering professional organizations, Ms. Doyle has been able to collaborate with these groups to develop new training to meet their specific continuing education needs. During the current grant period, Ms. Doyle has also served on numerous planning committees for local and regional meetings and conferences involving occupational safety and health professionals, as well as serving as a board member for the Public Employees Safety Association of Maryland and as an advisory board member for the MAP ERC and for New York University's occupational and environmental health nursing program. Examples and details of details of these collaborations follow.

Private Company Partnerships

Our private company partnerships include: Bimonthly Abbott Global Occupational Health Services continuing education conference calls on a variety of occupational safety and health topics (since 2004); the National CAOHC *Professional Supervisor of the Audiometric Monitoring Program Course*; the biannual *CAOHC-approved Hearing Conservation Course* and *Refresher* Courses with EarMark Hearing Conservation and Dr. Frank Wartinger, for which Ms. Doyle is a practicum instructor; the biannual virtual *NIOSH-Approved Spirometry* and *Refresher* courses with MC Townsend and Associates, for which Ms. Doyle serves as a practicum instructor; and the biannual NSC/ORCHSE, LLC Corporate Health Directors Network Conference (since 2010). This network of Fortune 200 companies—primarily in the manufacturing, telecom, transportation, and energy sectors—discusses current and emerging corporate occupational health problems, practices, and solutions. Our program is instrumental in identifying subject matter experts and obtaining CE credits.

Professional Association Partnerships

Examples of our professional association partnerships during this grant period include: Maryland College of Occupational and Environmental Medicine biennial conferences; Mid-Atlantic Regional Conference in Occupational and Environmental Medicine each fall; Maryland College of Occupational and Environmental Medicine webinar series; Southeastern Atlantic College of Occupational and Environmental Medicine (SEACOEM) 2-day conference in Greenville, SC on December 1-2, 2018, and Asheville, NC on August 24-25, 2019; Maryland Area, Metropolitan Washington, Seneca Valley of Maryland, and Northern Virginia Associations of Occupational Health Nurses dinner meeting (since 2008), for which we identify speakers and objectives and obtain CNE contact hours from the Washington, D.C., Board of Nursing; biennial Regional Occupational Health Conference (2006-2018) with four regional occupational health nursing chapters (listed above) of the American Association of Occupational Health Nurses; annual joint professional development conference with the Chesapeake Sections of the American Industrial Hygiene Association and the American Society of Safety Engineers (2008-2021); annual professional development conference with the National Capital Chapter of the Alliance of Hazardous Materials Professionals and the Potomac section of the American Industrial Hygiene Association (since 2009); and our annual four-day *Essentials of Hazardous Materials Managers* course (2008-2021). We additionally proctored the Certified Hazardous Materials Manager exam for the Institute of Hazardous Materials Management from 2009 until it became computerized. Ms. Doyle is now working with the *American Industrial Hygiene Association's* Museum and Cultural Heritage Industry Working Group and with the federal Occupational Safety and Health Administration's on-site consultation on respiratory protection programs for conservation and collection care professionals. This outreach is aimed at small businesses without occupational safety and health resources.

Nonprofit Partnerships

Our nonprofit partnerships include: biannual Public Employees Safety Association of Maryland (PESA) conferences for public occupational safety and health workers, managers, and human resources personnel, for which our program is responsible for marketing, registration, course logistics, and course accounting; *How the Pandemic is Hindering Legionnaires' Disease Diagnosis and Reporting* with the Alliance to Prevent Legionnaires' Disease, November 10, 2020; and a four-part series, *Preventing Occupational Exposure to Bloodborne Pathogens in Healthcare* with The International Safety Center (online modules). We additionally cosponsored *National Farmworkers Awareness Week: Addressing Occupational Health Issues Among Agricultural Workers Seminar* with the Migrant Clinicians Network and the Northeast Center for Occupational Health and Safety: Agriculture, Forestry, Fishing in March 2022.

Academic Partnerships

Our CE Program's partnerships with other academic institutions—in particular, other NIOSH ERCs and training project grantees, including the University of Maryland and the University of Illinois at Chicago—have increased the visibility of our program and have enabled us to offer conferences and seminars that attract broader groups of occupational and environmental safety and health professionals. Our academic collaborations during this period have included our partnership with MAP ERC to offer the online *Occupational Health Nursing Prep,* 19 modules to help nurses prepare for the American Board of Occupational Health Nursing certification exam, as well as our co-sponsorship of *Orientation to Sustainable Environmental Assessment*, which is taught by adjunct faculty from University of Illinois at Chicago ERC, federal officials from Housing and Urban Development and the Environmental Protection Agency, and representatives of the Maryland Department of the Environment and the Maryland Historical Trust. We additionally partnered with Rutgers Clinical Research and Occupational Medicine Division to plan the 2018 Mid-Atlantic Regional Conference in Occupational and Environmental Medicine (MARCOEM), and we partnered with the University of Pennsylvania occupational medicine faculty to plan the 2019 MARCOEM. We are working with the New York-New Jersey ERC on the 2023 International Commission on Occupational Health Scientific Committee on Occupational Health for Health Care Workers. We are also working with an interdisciplinary team of investigators from the University of Maryland Schools of medicine and Nursing to create and evaluate a brief online training in motivational interviewing geared towards occupational health providers to address vaccine hesitancy among employees.

Federal Partnerships

Our CE Program cosponsored the Federal Occupational Health Nursing Symposium in 2018 and 2019, for which Ms. Doyle helped develop objectives and an evaluation tool and obtained CNE credits from the Washington, D.C., Board of Nursing. We also worked with the planning committee of the Smithsonian National Collections Program's 2021 Safety and Cultural Heritage Summit: Preserving our Heritage and Protecting our Health, to obtain CE credits and develop online modules for this professional development conference.

Regional Partnerships

We partnered with the Southeastern Atlantic College of Occupational and Environmental Medicine for a symposium and scientific meetings in 2018 and 2019, as noted above. While this is outside our region, SEACOEM approached Ms. Doyle for assistance, as their local ERC leadership was in transition. We regularly coordinate with MARCOEM, a regional partnership of occupational medicine physicians from Maryland, Delaware, Pennsylvania, New York, and New Jersey.

International Partnerships

As noted above, we are currently partnering with international members of the International Commission on Occupational Health Scientific Committee on Occupational Health for Health Care Workers to plan an October 2023 conference in New York City.

Response to Requests for Training and Consultation

Ms. Doyle and the CE Program faculty routinely receive requests for training and consultation in Region III. Over the past three years, we received numerous requests for consultation and training related to the COVID-19 outbreak and return-to-work issues. These activities included a multidisciplinary effort of ERC faculty in response to regional needs. Some highlights of this activity during the current grant period include:

- We respond to requests for expert occupational safety and health advice by identifying resources within our professional network. For example, we may refer hospital occupational health inquiries to one of the ERC faculty, to the associate director of health, safety, and environment at Johns Hopkins Hospital, or to research scientists at NIOSH or the federal Occupational Safety and Health Administration.
- Ms. Doyle receives numerous requests for information on occupational health nursing. In response, she authored an article on our website, titled “So You Want to Be an Occupational Health Nurse?”
- Ms. Doyle provided consultation to a former CE student who was starting a new position as director of occupational health services. (For more information, see our letter of support from Sharon Wood.)
- Both Dr. Brian Schwartz and Aisha Rivera Margarin presented at numerous scientific meetings and taught major board-review courses for certification in occupational and preventive medicine.
- Ms. Doyle and Dr. Rivera provided board service to their professional associations.
- Dr. Rivera served as medical advisor to the International Association of Fire Fighters (IAFF) at the National Fire Protection Association's meeting to revise NFPA 1582 medical standards for firefighters.
- Dr. Rivera, Dr. Virginia Weaver, and the ERC medicine residents continued to support the IAFF, through which they have been involved with a number of COVID-19-related requests to revise protocols for local fire departments, and they also provide input on informational documents posted on the IAFF website (such as return-to-work guidance, endorsing universal masking, etc.), and provide expert opinions on calls with membership.
- Dr. Ramachandran advised Amtrak Corporation, the American Public Transit Association, and the NYC Metro Transit Authority on its COVID-19 response regarding the safety public transit and the subway.
- Dr. Crifasi has partnerships with law enforcement agencies, including the Baltimore Police Department (to better understand voluntary separation and improve retention), Anne Arundel County Executive’s Office and Police Department (on strategies to improve oversight and accountability), and the Maryland State’s Attorney Office of Baltimore City and Governor’s Office of Crime Control and Prevention.
- Ms. Doyle has identified topics and speakers for Delaware National Guard’s yearly safety conference.
- The CE Program is approved to grant nursing credits in Delaware and in the District of Columbia.

INTERNAL PARTNERSHIPS

Within the Johns Hopkins Bloomberg School of Public Health, Ms. Doyle has established links between the ERC and several other centers relevant to professional continuing education training, including the new POE Total Worker Health Center in Mental Health, the Institute for Johns Hopkins Nursing, the LuvU Project Center for Workplace Mental Health, the Center for Injury Research and Policy, and **the Department of Environmental Health Engineering’s Summer Institute. Resulting CE offerings and sponsorships have included: t**he POE Total Worker Health Center Mental Health in the Workplace Fall Summit in October 2022; monthly ERC seminars cosponsored with the Center for Injury Research and Policy; and our collaboration (since 2009) with the Johns Hopkins Center for Injury Research and Prevention to hold the *Institute for Injury Research and Policy Summer Institute*, which can be taken for continuing education or academic credit. Students can additionally take the Environmental Health and Engineering’s summer institute for continuing education or academic credits. From 2014 to 2022, 94 students have registered for continuing education credits, while 1,913 students (most of whom were trainees in our ERC programs or certificate program) have registered for academic credits. Ms. Doyle has a join appointment in the Johns Hopkins School of Nursing, where classroom space is frequently utilized to expand our program offerings.

NEW COURSE DEVELOPMENT

Needs assessments from various occupational health and safety professional organizations have been instrumental in identifying course topics for the program, which are discussed and planned in coordination with the ERC Executive Committee and our CE Advisory Board. During this grant period, we have utilized and plan to expand several new course methods. Hybrid format for conferences and seminars has greatly increased the number of occupational health and safety professionals who can access our trainings, while developing

individual on-line modules from conference materials and making them available with appropriate CE credits expands our reach. Although the foundation of our continuing education program is built on the various courses that will prepare occupational and environmental health practitioners for professional certification in their specialty area, we are continually assessing which new and innovative courses are needed to keep practitioners current in the knowledge and trends key to their field. We plan to develop several exciting new courses and seminars with the POE Total Worker Health Center and with the proposed ERC Occupational Health Psychology programs, and each will have the appropriate continuing education credits for the different specialties. Examples of course development are outlined below under each academic program area.

Occupational and Environmental Hygiene

Sponsorship of professional development conferences for the Chesapeake and Potomac sections of the American Industrial Hygiene Association has increased our program's integration with the industrial hygiene community. Ms. Doyle coordinates the conference poster sessions, where master's and doctoral students in our department have an opportunity to present their research. Lecture opportunities are available for students and junior faculty and are welcomed by the conference planning committee. Ms. Doyle is on the planning committee and identifies "hot topics" and qualified speakers, develops objectives and evaluation tools, handles registration and conference logistics, and summarizes evaluations and feedback. Johns Hopkins does not have a Hazardous Substance Training CE Program, but Ms. Doyle is committed to the hazardous materials management professionals in the occupational safety and health community. She continues to participate on the planning committee for the annual Hazardous Materials Management conference held in February of each year, which is cosponsored with the National Capital Chapter of the Alliance of Hazardous Materials Professionals and the Potomac section of the American Industrial Hygiene Association. Also, we will continue to cosponsor the four-day *Essentials of Hazardous Materials Management* course.

Occupational and Environmental Health Nursing

Although we are not renewing our ERC Occupational and Environmental Health Nursing Program due to lack of leadership, we will continue our dedication to continuing education for nurses. In additional to the JHU- MAP ERC *OHN Review* online course that prepares occupational and environmental health nurses for the American Board for Occupational Health Nurses certification exam, two other courses are considered core continuing education offerings for nurses: *CAOHC-Approved Occupational Spirometry* and *NIOSH-Approved Occupational Hearing Conservation*. In addition, Johns Hopkins students, faculty and staff take these courses to acquire skills needed for research studies, and we will continue to offer them twice a year. Since 2004, the CE Program and Abbott Laboratories have cosponsored a web-based bi-monthly continuing education program open to ERC students and Abbott Laboratories nurses. Each one-hour session is recorded and available for 30 days after the session, while post-session evaluations are completed via SurveyMonkey.

Occupational and Environmental Medicine

We will continue to support the American College of Occupational and Environmental Medicine's regional Mid-Atlantic Regional College of Occupational and Environmental Medicine (MARCOEM) for their continuing medical education needs. Ms. Doyle works with MARCOEM to identify hot topics for webinars and the annual conference. The October 2023 conference will be held sequentially with the International Commission on Occupational Health Scientific Committee on Occupational Health for Health Care Workers conference. The ERC also cosponsors and obtains CME/CNE credits for the biannual NSC/ORCHSE Corporate Health Directors Network meetings for this group of Fortune 200 companies—primarily in the manufacturing, telecom, transportation, and the energy sectors—to discuss current and emerging corporate occupational health problems, practices, and solutions. The meetings discuss hot topics, best practices, and research, and feature presentations by content experts, and ERC faculty often attend to network with the corporate occupational health community to assess their needs, while NSC/ORCHSE keeps us apprised of trends in the occupational and environmental health arena in the areas of legislation, regulation, policy, human resources, and more.

Occupational Injury Epidemiology and Prevention

Annual conferences are cosponsored with the Chesapeake and Potomac Sections of the American Society of Safety Professionals, which provides a rich opportunity to interact with the safety community. Ms. Doyle has served on the board of the Public Employees Safety Association of Maryland since 2011, and the CE Program

cosponsors their biannual safety conferences. A one-week intensive summer course, *Principles and Practice of Injury Prevention*, is sponsored by the Bloomberg School's Department of Health Policy and Management through the Center for Injury Research and Policy in the summer institute. Several ERC faculty have appointments in the Center for Injury Research and Policy and teach in this course.

Occupational Health Psychology

Partnerships with the new POE Total Worker Health Center in Mental Health and the LuvU Center for Workplace Mental Health have provided new opportunities for CE activities. Building upon our success with the fall Summit in Mental Health, we are analyzing the breakout sessions and summit evaluations to identify future summit topics, which thus far include burnout, stress, shift work and substance abuse, and sleep issues. We are working with the POE Center and with the Occupational Health Psychology faculty to plan activities for the new grant period, such as live courses, online modules, and another fall summit in mental health. Topics identified in the recent ERC CE needs assessment—including chronic disease management, prevention of job stress, fatigue, and stress prevention, the aging workforce, work-life programs, shared commitment to safety, health, and wellbeing, and supportive management—can be addressed with the added expertise of the POE Center and of the proposed ERC Occupational Health Psychology Program.

FINANCIAL MANAGEMENT

Organized and innovative fiscal management allows us to provide the most CE training to the widest audience, and Ms. Doyle has instituted many measures to improve efficiency and allow the greatest return for NIOSH funding. Measures undertaken by Ms. Doyle during the current grant period that have increased the scope, size, efficiency, and value of the Johns Hopkins Continuing Education Program include: using her knowledge of our school's fiscal management systems to carefully track the flow of all funds to ensure that only properly incurred charges are paid and that all charges are correctly allocated; finding the most effective means for obtaining supplies and materials required for CE trainings, including the purchase of bulk food and beverages, where appropriate, rather than incurring expensive catering services; and carefully assessing the costs and benefits of each course, including proper class size for profitability. We have streamlined our registration process by using JotForm, and we allow credit cards for course payment, thus increasing the convenience and potential base of trainees, as well as ensuring that all payments owed are collected with the additional use of late fees to compensate for the extra costs of registering students late in the course planning cycle. Finally, Ms. Doyle obtains salary support from many internal and external sources using the conference management capabilities she developed within the CE Program.

PROGRESS REPORT—ERC OUTREACH PROGRAM

The Johns Hopkins ERC undertakes numerous initiatives that impact occupational safety and health both directly and through contributions to other programs, institutions, and organizations. The Outreach Program is important to our center's core mission and is key to reaching and serving practicing occupational safety and health professionals in our region, throughout the nation, and (with increasing frequency) in global settings. Starting in spring 2020, much of the ERC's outreach activities focused on questions and response to the COVID-19 outbreak, which required a coordinated and multidisciplinary effort on the part of our faculty. Below are some highlights of our ERC Outreach activities during the current grant period.

Occupational and Environmental Hygiene

ERC Occupational and Environmental Hygiene faculty participate in a wide range of interdisciplinary centers and institutes such as Baltimore BREATHE (Bridging Research, Lung Health & the Environment), Institute for Global Tobacco Control, Center for a Livable Future, and the Bloomberg American Health Initiative. These important collaborations and interactions afford opportunities to enrich student training and student research, and they also provide practice opportunities. Program Director Dr. Kirsten Koehler chairs the American Association for Aerosol Research's education committee, serves on NIOSH's Safety and Occupational Health Study Section, and helped developed a fact sheet on consumer aerosol monitors for the American Industrial Hygiene Association. During this period, ERC Director Dr. Gurumurthy Ramachandran chaired the International Scientific Committee of the 2018 International Occupational Hygiene Association International Scientific Conference, was a member of the National Academies of Sciences, Engineering, and Medicine committee to review the U.S. DoD's proposed occupational exposure limits for lead, and served on NIOSH's Safety and Occupational Health Study Section (2014-2019). Also in the current grant period, Dr. Ramachandran advised Amtrak Corporation, the American Public Transit Association, and the NYC Metro Transit Authority on its COVID-19 response regarding the safety public transit and the subway. He serves on the editorial boards of *Environmental Research: Health, Annals of Work Exposures and Health*, and the *Journal of Occupational and Environmental Hygiene.* In 2021, he was appointed to the Transportation Research Board's Transit Cooperative Research Program at the NAS Engineering and Medicine.

Dr. Ana Rule is a member of the stakeholder working group for the Maryland Department of the Environment's Methane Emissions Minimization Plan, participated on the Maryland Commission on Climate Change's Mitigation Working Group, has been a member and expert advisor of the Maryland Environmental Health Network since 2012, and was co-organizer of the Black Lung Disease in Mining Round Table for the AIHA's 2019 expo meeting. In February 2020, Dr. Rule sent comments to the Maryland Senate Committee on Finance and Education Heath and Environmental Affairs on legislation regarding electric generation and transition from fossil fuels. She is a member of Community of Communities, which aggregates communities across Maryland that are impacted by natural gas infrastructure development and expansion, and she collected data to support an ongoing lawsuit that aims to protect mostly African American communities in North Carolina from environmental pollution. Dr. Rule maintains a close relationship with the Turner Station Conservation Teams, an environmental justice community group in Baltimore, for whom she has attended monthly meetings since 2010, has helped with a food pantry since 2018, has provided support at the annual health fair and "back-to-school" event, and helped investigate potential expansion of the community park with dredge material. Having set up an air sampling monitoring station in Curtis Bay, Baltimore, Dr. Rule collaborated with students at Benjamin Franklin High School to design a sampling strategy to address pollution. During this period, Dr. Rule chaired the Diversity Committee for the International Society of Exposure Sciences, and she participated on the World Health Organization's Technical Advisory Group on Personal Protective Equipment for COVID-19 and the National Institute of Environmental Health Sciences' working group, SARS-CoV-2/COVID-19 Environmental Health Research Needs Panel. She also served on the editorial board for PLOS One, a peer-reviewed open access scientific journal published by the Public Library of Science, and for the *International Journal of Environmental Research and Public Health* special issue on "Environmental Health Studies with Remote Sensing Technologies: Exposure Assessment and Health Outcomes." Dr. Rule provided testimony, signatory on public comments, and supporting attachments on the Maryland Department of the Environment's tentative determination, in coordination with the Environmental Integrity Project, Turner Station Conservation Teams, Clean Water Action, and others. As a result, the permit was rescinded one week after. In February

2022, Dr. Rule provided testimony before U.S. congressional House and Senate committees in favor of a bill to improved pesticide regulation.

Dr. Lesliam Quirós-Alcalá serves on the Scientific Advisory Board of the Children's Environmental Health Network, as well as on the MD Governor's Commission on Environmental Justice and Sustainable Communities. Dr. Quirós-Alcalá is an associate editor for several journals in her field, including the *Journal of Exposure Science and Environmental Epidemiology* and the *International Journal of Hygiene and Environmental Health*, and she is on the executive board for the International Society of Exposure Science. She was awarded the prestigious Joan M. Daisey Outstanding Young Scientist Award from the International Society of Exposure Sciences, where she is secretary and serves on the Diversity Committee, and she led a symposium on Environmental Disparities and Respiratory Health at the 2021 ISES meeting. During this period, Dr. Quirós-Alcalá provided scientific expert testimony at the Maryland State House in support of bills to prohibit the use of a neurotoxic pesticide to protect children's health. She continues to provide guidance on the use of pesticides and antimicrobial agents in settings with vulnerable populations, including in schools and migrant detention facilities. Following on her hair salon pilot study, Dr. Quirós-Alcalá distributed reports to salons in her study, including educational materials on how to reduce exposures to VOCs and phthalates in an occupational setting, as well as mitigation techniques specific for salon owners. These materials were available in Spanish. Dr. Quiros-Alcala collaborated with the ERC Outreach Program on the October 2022 POE Total Worker Health Center Summit on Mental Health.

Drs. Ramachandran, Koehler, Rule and Quiros-Alcala have provided numerous national and international media interviews, including for CNBC, Vogue, The Scientist, PolitiFact, FactCheck, Elite Daily, The Verge, USA Today, WMAR, and Mic-on aspects of aerosol exposures, mask usage, potential abuse and misuse of chemicals in the healthcare setting, and ventilation related to the COVID-19 pandemic, and they also coauthored articles related to the epidemic, participated in expert panels, wrote a white paper, and participated in numerous COVID-related practice activities.

Occupational and Environmental Medicine

During this period, our Occupational and Environmental Medicine residents presented at grand rounds, journal club, and local American College of Occupational and Environmental Medicine chapter meetings, while opportunities for clinical rotations were gained through our faculty's relationships with groups such as the International Labour Organization and the World Health Organization, government agencies such as NIOSH and the U.S. Department of Homeland Security, labor groups such as the International Association of Fire Fighters, and private industry and corporations. Residency Director Dr. Brian Schwartz directs the Joint Geisinger-Johns Hopkins Environmental Health Institute, is a fellow of the Post Carbon Institute, and has testified to Maryland and Pennsylvania legislators regarding fracking. Dr. Schwartz was appointed to serve as a 2021-2023 member (special government employee) of the U.S. Environmental Protection Agency's Clean Air Scientific Advisory Committee, Lead Review Panel, and as a 2021-22 member of the National Academies of Sciences, Engineering, and Medicine's ad-hoc committee to review the potential impacts of gold mining in Virginia. Both Drs. Schwartz and Residency Deputy Director Dr. Aisha Rivera Margarin are nationally recognized speakers and have presented at numerous scientific meetings and taught major board-review courses for certification in occupational and preventive medicine, and both were members of various scientific planning committees. During this reporting period, Dr. Schwartz was interviewed regarding fossil fuels, fracking, and climate change by media outlets, including Pittsburgh Post-Gazette, WHYY, PBS, and NPR.

Dr. Rivera is a member of the Uniformed Services University of the Health Sciences' occupational and environmental medicine residency advisory committee, as well as its program evaluation committee, oversees the premedical track of the Department of Environmental Health and Engineering's Master's in Health Science and promotes the field of occupational medicine to students, and collaborates on the Maryland Occupational Health and Safety Surveillance and Prevention Project. During this period, she was a medical advisor to the International Association of Fire Fighters at the National Fire Protection Association's standards meeting, served as president of the Pennsylvania Occupational and Environmental Medicine Society, chaired the OEMR directors' group, served on ACOEM's Presidential Taskforce to Increase Occupational and Environmental Medicine Visibility as well as its Future of OEM committee, became a co-investigator for the U.S. Department of Energy Former Works Program at Los Alamos and Sandia National Laboratories in New Mexico upon Dr. Maureen Cadorette's retirement, and participated in the IAFF's Cancer Awareness Podcast Series for Cancer

Awareness Month, as well as Career Day for Students at Doral Charter Upper School, the General Preventive Medicine Residency "Meet the Preceptor"; Black Women in Medicine's "Pursuit of Higher Education" event, the Reproductive Health Group for Women in Fire, and Tour for Diversity in Medicine "Road to Preventive Medicine" (YouTube). In her capacity as an independent consultant, Dr. Aisha Rivera Margarin reviewed content and assisted with a survey tool for a "Global Practices Report" commissioned by the New York City Mass Transit. She was selected as our school's Source Academy Service-Learning Fellow for AY 2021-2022.

Faculty member Dr. Virginia Weaver provided testimony for presumptive legislation for firefighter health coverage in workers' compensation being considered in Maryland. Drs. Weaver and Rivera, as well as the residents, continued to support the International Association of Fire Fighters, through which they have been involved with a number of COVID-19 related requests to revise protocols for local fire departments, provide input on informational documents posted on the IAFF website (such as return-to-work guidance, endorsing universal masking, etc.), and provide expert opinions on calls with membership.

Occupational Epidemiology and Biomarkers

Biomarkers Program Director Dr. Christopher Heaney provided written testimony to the Baltimore City Council and Mayor's Office to summarize what is known about the environmental and occupational health effects of crude oil extraction, transport, and storage. His testimony resulted in a permanent ban on the siting of any new crude oil terminals within the city. Dr. Heaney supported students in his *Community-Driven Epidemiology and Environmental Justice* class who drafted and gave testimony about the environmental and occupational health effects of solid waste incineration to inform the Maryland General Assembly's consideration of legislation to increase wind and solar energy production by 2030 and to remove waste-to-energy from the tier one renewable energy portfolio standards. Dr. Heaney was invited to deliver a keynote lecture at the April 2019 North Carolina Breathe conference in Wilmington, North Carolina. He presented findings from his occupational epidemiologic studies with North Carolina industrial hog operation workers regarding the exposure to and infection with livestock-associated antimicrobial resistant *Staphylococcus aureus*.

During this reporting period, Dr. Heaney and members of his lab have focused much of their work on projects related to the COVID-19 pandemic. Dr Heaney's research is funded by the NIH, the CDC, and private foundations, and he is collaborating with the U.S. Department of Defense and other major universities to help them with an application of his lab's multiplex oral fluid SARS-CoV-2 antibody assay, which is being used to determine SARS-CoV-2 IgG seroprevalence within cohorts at Johns Hopkins University (Homewood students, staff, and faculty), Johns Hopkins Medical Institutions (long-term care facility staff and residents), Uniformed Services University (staff and faculty), the U.S. Naval Academy (midshipmen), Georgia Institute of Technology (students), Howard County, Maryland (essential and other county workers and the general population), and Emory University (healthcare workers). See https://www.medrxiv.org/content/10.1101/2020.05.24.20112300v1 This assay is an example of the frontline impact on the pandemic of the non-invasive biomarkers that Dr. Heaney is creating in ERC's Occupational Epidemiology and Biomarkers Program. Dr Heaney's lab is also leading a COVID-19 study among livestock industry workers and their household members in North Carolina, with plans to expand the enrollments to other major livestock production states (Delaware, Maryland, Virginia, Iowa). To date, Dr. Heaney and his colleagues have 22 COVID19 studies with 34, 882 participants enrolled and over 2.1 million dollars in funding. Dr. Heaney has given numerous presentations and interviews on his COVID-19 work, and he has published multiple papers on the topic.

Occupational Injury Epidemiology and Prevention

ERC Occupational Injury Epidemiology and Prevention Program Director Dr. Cassandra Crifasi has ongoing partnerships with law enforcement agencies, including the Baltimore Police Department (to better understand voluntary separation and improve retention), Anne Arundel County Executive's office and Police Department (on strategies to improve oversight and accountability) and the State's Attorney Office of Baltimore City, and the Governor's Office of Crime Control and Prevention. During this period, Dr. Crifasi joined the editorial board of *Injury Epidemiology*. Dr. Crifasi and other program faculty gave presentations at numerous conferences during this period, contributed to COVID outreach activities along with other ERC faculty, and were interviewed or quoted by various media outlets throughout the country and the world on their research.

Faculty member Dr. Keshia Pollack Porter—who directed this program through June 2021, when she was selected to chair the Department of Health Policy and Management—continued her service on the Fire

Protection Research Foundation's Research Advisory Committee and partnership with Major League Baseball and her work exploring injuries in professional baseball, and as a member of the NIOSH National Occupational Research Agenda (NORA) Traumatic Injury Prevention (TIP) Council, for which she helped develop a slide deck to introduce students across disciplines to NORA and the TIP Research Agenda. During this period, Dr. Pollack Porter served as the lead expert for the American Heart Association CEO Roundtable's initiative to provide guidance to employers to identify and dismantle practices and policies that contribute to structural racism and inequities, with a focus on health, through the workplace, and she was a presenter at our school's 2021 Juneteenth celebration. Dr. Pollack Porter received our school's 2018-2019 Public Health Practice Award for furthering health equity by promoting health impact assessments and the Health in All Policies approach. She piloted the health note with the Health Impact Project and the Center on Budget and Policy Priorities. The health note provides legislators with objective information on how policies in other sectors, such as housing or education, may impact health.

In January 2021, our former trainee Dr. Mitch Doucette officially joined our faculty and has taken on a core role within the program, including serving as faculty lead for the *Graduate Seminar in Injury Research and Policy* and as an informal mentor for doctoral students interested in advance statistical methods such as comparative interrupted time series and augmented synthetic control modeling. Dr. Doucette received a National Violent Death Reporting System new investigator award jointly funded by the CDC and the American Public Health Association.

Faculty affiliate Dr. Bruce Lippy continued his work with NIOSH, CPWR (Center for Construction Research and Training) and the American Industrial Hygiene Association's working group on nanomaterials and his service on the National Academies of Sciences, Engineering and Medicine's Health and Medicine Division's Committee on Respiratory Protection for the Public and Workers without Respiratory Protection Programs at their Workplaces, and he represented the construction industry on a National Academies of Sciences, Engineering, and Medicine Committee on the Use of Elastomeric Respirators in Health Care. Dr. Lippy is working with several partners, including the NIOSH Nanotechnology Center, NIOSH Office of Construction Safety and Health, and EU Nanotechnology Researchers, on the SCAFFOLD Project, ANSI/ASSE A10 committee on construction safety and health, and ISO TC 229 WG3 working group on nanotechnology.

Faculty affiliate Dr. Maria Bulzacchelli continued to partner with the Northeast Center for Occupational Safety and Health in Agriculture, Forestry, and Fishing (NIOSH 2U54OH007542). She is leading a research project that is examining the acceptance and use of mobile apps for commercial fishing safety. Dr. Bulzacchelli has been conducting research on naloxone training, naloxone availability, and attitudes about substance use in the U.S. commercial fishing industry. Faculty affiliates Drs. Stephen Wegener and Renan Castillo continued leading an evaluation of the Amputee Coalition, a federally funded center that provides information and programs for persons with limb loss. This process and summative evaluation will address the program's impact on major stakeholders. Faculty are collaborating on a project to examine the impact of California's Workplace Violence Prevention in Healthcare Safety Standard on nonfatal violence involving days away from work.

Additional Activities Led by Outreach Program Director Mary Doyle

A core mission of our ERC's Continuing Education and Outreach programs is to promote and support occupational safety and health professional associations, which are struggling across the country to keep up their membership as baby boomers retire, while a shortage exists of younger professionals. During this grant period, this mission was accomplished in part through our sponsorship of webinars, meetings, and local and regional conferences within federal regions III and IV. Outreach Program Director Ms. Mary Doyle's numerous outreach activities include her service on the external advisory boards of the Mountains and Plains ERC, and New York University's occupational health nursing program, and the Public Employees Safety Association of Maryland, for which she was elected as the secretary, and she was also elected as the treasurer of Metropolitan Washington Association of Occupational Health Nurses, Inc. Ms. Doyle was appointed to the NIOSH Board of Scientific Counselors for a three-year term, and she served as a reviewer for the 2019 NIOSH Director's Intramural Awards for Extraordinary Science. This past year, Ms. Doyle compiled stories of interdisciplinary collaboration from Johns Hopkins ERC graduates for NIOSH's fiftieth anniversary celebration. Together with Drs. Ramachandran and Jackie Agnew, Ms. Doyle traveled to the nation's capital and met with congressional legislators including Representative Anthony Brown and Senators Chris Van

Holland and Ben Cardin of Maryland, as well as the staff of Representative Andy Harris of Maryland and Scott Perry of Pennsylvania, to educate them about the importance of NIOSH and the work of the NIOSH ERCs.

During this period, Ms. Doyle supported the four local chapters of the American Association of Occupational Health Nurses in Maryland to planning chapter meetings and joint regional conferences, and she also served on the conference planning committees for the annual Mid-Atlantic Regional Conference on Occupational and Environmental Medicine, the Southeast Conference on Occupational and Environmental Medicine, the Public Employees Safety Association, the Chesapeake American Industrial Hygiene Association-American Society of Safety Engineers, the Alliance of Hazardous Materials Professionals, and the 2023 International Commission on Occupational Health Scientific Committee on Occupational Health for Health Workers to be held in New York. She is now collaborating with the University of Maryland and the Maryland Department of Health for a symposium on naloxone in Maryland workplaces. Ms. Doyle collaborates with other centers within our institution as well, including the Johns Hopkins POE Total Worker Health Center in Mental Health, and she was on the planning committee for POE's October 2022 Summit on Mental Health.

Ms. Doyle continued to field requests from employers and workers on COVID, including vaccinations, masks, return to work issues, and workplace policies on these issues. Ms. Doyle collaborated with the International Safety Center, Federal Occupational Health Nurses and the National Council for Occupational Safety and Health to offer webinars, and conferences, with Alliance to Prevent Legionnaires' Disease to offer a webinar on the COVID-19 pandemic and Legionella, and with Pennsylvania Occupational and Environmental Medical Society and with the Mid-Atlantic Regional Conference in Occupational and Environmental Medicine for a series of 14 online webinars for occupational safety and health professionals. She is currently working with occupational medicine faculty from the University of Maryland School of Medicine and submitted a grant on online training in motivational interviewing for occupational health providers to address vaccine hesitancy among employees. She is also working with the American Industrial Hygiene Associations' Museum and Cultural Heritage Industry Working Group and with the federal Occupational Safety and Health Administration's on-site consultation on respiratory protection programs for conservation and collection care professionals. This outreach is aimed at small businesses without occupational safety and health resources.

Ms. Doyle worked with the International Safety Center to address sharps injuries in operating room personnel and to develop and record four modules on protection from bloodborne pathogens that operating room personnel and others can easily watch during a work break. She additionally collaborated with ORCHSE Strategies to provide contact hours for nurses who attend their biannual corporate medical directors meetings, for which Ms. Doyle identifies speakers, reviews objectives, obtains continuing nursing education credits from the Washington, D.C., Board of Nursing, and reviews presentations and evaluations. Throughout the grant period, she has collaborated with Abbott Global Occupational Health Services to provide quarterly one-hour virtual nursing education seminars to their worldwide nursing staff. With the Mountains and Plains ERC, she offered the asynchronous 18-module *Online Prep Course for COHN/COHN-S* certification for nurses preparing to sit for the American Board for Occupational Health Nurses exam or needed continuing nursing education credits. Ms. Doyle and the Outreach Program collaborated with Dr. Mary Townsend to develop practicum exercises for our virtual *Spirometry* courses, which were the only pilot spirometry courses approved by NIOSH in 2020. Ms. Doyle also served as a practicum instructor for our virtual *Council for Accreditation in Occupational Hearing Conservation Hearing Certification* courses with new course director Dr. Frank Wartinger.

Ms. Doyle maintains our ERC's social media presence on LinkedIn, Facebook, Instagram, and Twitter, and she routinely advises nurses wanting to enter the field of occupational and environmental health nursing, as well as those seeking certification in occupational and environmental health nursing, and she gives information and advice to prospective students wishing to obtain a graduate certificate or master's degree.