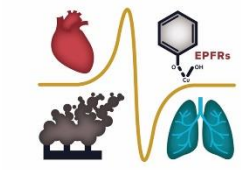
2022 DELLINGER SYMPOSIUM

February 23, 2022

Baton Rouge, Louisiana

LSU College of the Coast & Environment

Dalton Woods Auditorium



LSU | SUPERFUND Research Program

About the Symposium

The Dellinger Symposium is held in honor of Dr. Harold "Barry" Dellinger, founding director of the Louisiana State University Superfund Research Program (LSU SRP). He was recruited to LSU in 1998 where he taught Chemistry and held the Patrick F. Taylor Endowed Chair for Environmental Chemistry for seventeen years. Dr. Dellinger was known for his expertise on how compounds, especially hazardous organic pollutants, degrade as a result of combustion. His work has been recognized by industry, policy makers, the research community, and environmental groups.

The 2022 Dellinger Symposium is a joint effort of the LSU Superfund Research Program's Administrative Core, Community Engagement Core, and Research Experience and Training Coordination Core. It is organized, in part, by LSU SRP trainees. The 2022 Dellinger Symposium includes a community-engaged discussion panel, trainee oral presentations, a poster session, and the Dellinger Distinguished Lecture.

Dr. Harold "Barry Dellinger
(1949 – 2016)

Agenda

Time	Session Details
12:00 – 1:30	**Community-Engaged Discussion Panel – Environmental Justice and Community Engagement in the Classroom** Welcome: Dr. Margaret Reams, LSU Department of Environmental Sciences **Speakers:** Dr. Sharon Petronella Croisant, University of Texas Medical Branch, Department of Preventive Medicine & Population Health ***Community Engagement in Pursuit of Environmental Justice*** Dr. Adrienne Katner, LSU Health Sciences Center New Orleans, School of Public Health ***Research-Academic-Community Partnerships to Inform Stakeholders, Educate and Empower Students, Arouse Media Attention, and Achieve Community Goals*** Dr. Wesley Gray, Southern University Baton Rouge, Environmental Toxicology Program ***Introducing Environmental Justice to STEM Undergraduate Majors*** Dr. Aimée Thomas, Loyola University New Orleans, Department of Biological Sciences ***Addressing Environmental Issues, Racial Inequities, and Injustices in New Orleans***
1:30 – 1:45	**Coffee Break**

Time	Session Details
1:45 – 3:00	**Trainee Oral Presentations**
	Moderator: Dr. Tammy Dugas, LSU Department of Comparative Biological Sciences
	Myron Lard, LSU Department of Chemistry ***Exploring Environmentally Persistent Free Radical (EPFR) Formation and Reactive Oxygen Species Generation Using Metal Loaded Model Clay Systems***
	Prakash Dangal, LSU Department of Environmental Sciences ***Effect of pH on hydroxyl radical formation by EPFRs***
	Dr. Avinash Kumar, LSU Department of Biological Sciences and Pennington Biomedical Research Center ***Exposure to Particulate Matter Containing Environmentally Persistent Free Radical Exacerbates Influenza Infection by Inhibiting IL22 Production***
	Jen Irving, LSU Department of Environmental Sciences ***Cumulative Environmental Health Vulnerability in East Baton Rouge Parish, Louisiana***
	Martine Mathieu, North Carolina State University ***Spatial Associations of Long-term Exposure to Diesel Particulate Matter and Black Race with Seasonal and Annual Mortality Due to COVID-19 in the Contiguous United States***
3:00 – 4:00	**Poster Session and Coffee Break**
4:00 – 5:00	**Dellinger Distinguished Lecture**
	Welcome: Dr. Stephania Cormier, Director, LSU Superfund Research Program
	Speaker Introduction: Prakash Dangal, LSU Department of Environmental Sciences Dr. Staci Simonich, Oregon State University, Departments of Environmental and Molecular Toxicology and Chemistry ***Is Remediation of PAH Contaminated Soils Worth It?***
5:00 – 5:30	**Awards and Closing Remarks**
	Moderator: Dr. Phil Sprunger, Deputy Director, LSU Superfund Research Program
	Sarah Boudreaux and Dr. Albert dela Cruz, City of Baton Rouge-Parish of East Baton Rouge, Department of Environmental Services ***Recognition of LSU SRP Trainees for Community Service***
	Dr. Bill Suk, National Institute of Environmental Health Sciences Superfund Research Program ***Presentation of award and Closing Remarks***

Please take a short evaluation survey on Qualtrics to help us evaluate the Dellinger Symposium.

The Dellinger Distinguished Lecture

Dr. Staci Simonich, PH.D.

Executive Associate Dean; College of Agricultural Sciences

Professor, Departments of Chemistry and Environmental and Molecular Toxicology

Oregon State University

Is Remediation of Polycyclic Aromatic Hydrocarbon Contaminated Soils Worth it?

Polycyclic aromatic hydrocarbons (PAHs) are ubiquitous contaminants formed through the incomplete combustion of organic matter. Their hydrophobic nature and persistence can ultimately lead to their accumulation in soils, particularly at industrial sites where direct contamination occurs. Many PAHs are known or suspected human carcinogens and, as a result, 16 parent (unsubstituted) PAHs have been classified as 'priority' pollutants. There are many PAH contaminated sites throughout the world and the clean-up process is complex, from preliminary assessment and site investigation to site reuse and redevelopment and can use any number of remediation strategies (or combinations of strategies), depending on the level of contamination, the compounds involved, and site characteristics. Our laboratory has focused on predicting the formation, measuring the presence, and determining the toxicity of PAH transformation products during bioremediation and thermal treatment of PAH contaminated U.S. Superfund site soils. The goal of our research is to provide guidance to site managers regarding the use of appropriate remediation strategies to minimize the formation of these hazardous breakdown products. Our research addresses the question, "Is remediation of PAH contaminate soils worth it?"

Environmental Justice and Community Engagement in the Classroom

A growing body of literature describes investigations of disparate impacts of pollution exposure on communities of color or communities living in poverty. However, facets of environmental justice – namely equitable distribution of environmental costs and benefits, self-determination of communities' acceptance or rejection of environmental costs and benefits, recognition of communities' values and identities in the establishment of environmental policies, and practices of socioeconomic analysis and community engagement – are rarely taught in a formalized manner. This panel discussion brings together scientists of different disciplines to identify existing programs offering classroom training and experiential learning related to community engagement and environmental justice. Topics may include engagement with K-12 teachers and students, informal science education activities, service-learning projects, and incorporation of environmental justice in undergraduate and graduate education.

Dr. Sharon Petronella Croisant,
University of Texas Medical Branch, Department of Preventive Medicine & Population Health
Community Engagement in Pursuit of Environmental Justice

Dr. Adrienne Katner,
LSU Health Sciences Center New Orleans, School of Public Health
Research-Academic-Community Partnerships to Inform Stakeholders, Educate and Empower Students, Arouse Media Attention, and Achieve Community Goals

Dr. Wesley Gray
Southern University Baton Rouge, Environmental Toxicology Program
Introducing Environmental Justice to STEM Undergraduate Majors

Dr. Aimée Thomas
Loyola University New Orleans, Department of Biological Sciences
Addressing Environmental Issues, Racial Inequities, and Injustices in New Orleans

Summary of Abstracts

Oral Presentations

1. Exploring Environmentally Persistent Free Radical (EPFR) Formation and Reactive Oxygen Species Generation Using Metal Loaded Model Clay Systems, **Myron Lard**
2. Effect of pH on hydroxyl radical formation by EPFRs, **Prakash Dangal**, Louisiana State University
3. Exposure to Particulate Matter Containing Environmentally Persistent Free Radical Exacerbates Influenza Infection by Inhibiting IL22 Production, **Avinash Kumar**, Louisiana State University
4. Cumulative Environmental Health Vulnerability in East Baton Rouge Parish, Louisiana**, Jennifer K. Irving**, Louisiana State University
5. Spatial Associations of Long-term Exposure to Diesel Particulate Matter and Black Race with Seasonal and Annual Mortality Due to COVID-19 in the Contiguous United States, **Martine Elisabeth Mathieu**, North Carolina State University

Posters

1. Educational intervention in environmental health: Checking the effectiveness of the "Science take-out kit" of risk factors for Breast Cancer in the Puerto Rican community, **Victoria Pellot,** University of Puerto Rico (undergraduate student)
2. Emissions of Volatile Organic Compounds and Particulate Matter from 3D Printer Filaments, **Farhana Hasan**, Louisiana State University (post-doctoral researcher)
3. Lead poisoning prevention among Puerto Ricans: An educational intervention, **Veronica Morales-Rodriguez**, University of Puerto Rico (undergraduate student)
4. Shedding light on the effects of ultraviolet (UV) irradiation on environmentally persistent free radicals (EPFRs), **Fox Foley**, Louisiana State University (graduate student)
5. Effect of Polarity on EPFR Formation on Transition Metal Oxides, **Syed Monjur Ahmed**, Louisiana State University (graduate student)
6. Environmentally Persistent Free Radicals Inhibit the Formation of Complexes between NADPH-Cytochrome P450 Reductase and AhR-inducible P450s., **J. Patrick Connick, Jr**., Louisiana State University Health Science Center, New Orleans (post-doctoral researcher)
7. Specific lung cells express Cyp1a1 after inhalation of simple and complex Environmentally Persistent Free Radicals (EPFRs), **Pratiti Home Chowdhury**, Louisiana State University (post-doctoral researcher)
8. Formation and Stability of Environmentally Persistent Free Radicals in Dual-Metal Loaded Clay Surrogates, **Emmanuel Ampiah**, Louisiana State University (graduate student)
9. Inhalation of Combustion-Derived Environmentally Persistent Free Radicals Causes Vascular Endothelial Injury Mediated Via AHR Activation in Alveolar Type-2 Pneumocytes**, Ankit Aryal**, Louisiana State University
10. An observed increase in cardiovascular and respiratory disease-related mortality in an area surrounding a hazardous waste incinerator, **Liana Baconguis**, Louisiana State University

Exploring Environmentally Persistent Free Radical (EPFR) Formation and Reactive Oxygen Species Generation Using Metal Loaded Model Clay Systems

Authors: Myron Lard, Robert Cook, Phillip Sprunger

Abstract:

Studies have shown that Environmentally Persistent Free Radicals (EPFRs) are formed in high concentrations at a number of Superfund Sites. The formation of these radicals is understood to occur when chemicals generated through industrial waste interact with metal components in the soil. These free radicals are especially concerning due to their ability to mix with particulate matter (PM), generating biologically harmful reactive oxygen species (ROS). ROS associated with EPFRs have been shown to cause oxidative stress to the body, resulting in pulmonary and cardiovascular illness. The objective of this study is to better understand formation mechanisms of both EPFRs and ROS in an attempt to develop remediation techniques. This is done by generating radicals on model clay systems loaded with metals known to be present in Superfund soils. Radical producing clay samples are then used to generate ROS in aqueous media with the intention to move toward generation in model lung fluid to better mimic real world conditions. The results of the ROS generation will be compared to ongoing inhalation studies to attempt to determine a connection between radical identity and potential health effects.

Effect of pH on hydroxyl radical formation by EPFRs.

Prakash Dangal, Dr. Slawomir Lomnicki, Dr. Lavrent Kanchatryan, Dr. Farahana Hasan, Dr. ChuQi Guo

Louisiana State University

The objectives of this study were to elucidate the role of pH on hydroxyl radical formation and kinetics in the aqueous media by Environmental Persistent free radicals (EPFRs). The model EPFR containing particles was prepared using Monochlorophenol (MCP) as an EPFR precursor on 0.25% CuO/silica matrix at 230 ^{o}C. The EPFR were tested in OH radical production using DMPO spin trap at different reaction times (15, 30, 60, 120,180,300 min) and range of pH's (6.6-9). Pure matrix particles were used as a control. The overall rate of the OH radical production dependent on the proton concentration was analyzed and k' values of the reaction rate were found to be 4.57E-06. The results confirm that the overall rate of hydroxyl radical production is dependent on the slowest step i.e. deprotonation of the parent EPFR and pH of the media plays a critical role in EPFR activation. It was found that the pH > 7.8 accelerates the rate of the redox cycling process of EPFRs. Since the typical environmental pH of particles containing EPFRs is less than 5.5 (and most commonly below 3) this observation can explain why EPFRs in the environment do not decay spontaneously but are stable with a long lifetime.

Exposure to Particulate Matter Containing Environmentally Persistent Free Radical Exacerbates Influenza Infection by Inhibiting IL22 Production

Dr. Avinash Kumar[1], Dr. Vivek Patel[1], Dr. Jeffrey Harding[1], Dr. Dahui You[2], Dr. Stephania Cormier[1]

Louisiana State University[1], University of Tennessee Health Sciences Center[2]

Combustion-derived particulate matter (PM) containing environmentally persistent free radicals (EPFRs) are one of the major pollutants contributing to ambient air pollution. These are emitted during combustion and thermal processing of hazardous waste and organic materials. Inhalation of atmospheric PM is associated with increased respiratory diseases severity in infants. We previously reported that early-life exposure to PM containing EPFRs damages the lung epithelium and suppresses immune responses to influenza virus (Flu) infection, thereby enhancing Flu severity. Maintenance of lung epithelial layer during influenza virus infection is of critical importance to limit lung damage and pathogen dissemination. Interleukin 22 (IL22) is a member of IL10 family of cytokines and predominantly produced by innate and adaptive T cells, which help in resolving lung injury following Flu infection. In the current study, we determined the effects of EPFR exposure on pulmonary IL22 responses using our neonatal mouse model of Flu infection. Exposure to PM containing EPFRs resulted in an immediate (0.5-1-day post-exposure) increase in IL22 expression in the lungs of C57BL/6 neonatal mice; however, this IL22 expression was not maintained and failed to increase with either continued exposure to PM or subsequent Flu infection of PM-exposed mice. This contrasts with increased IL22 expression in age-matched mice exposed to vehicle and Flu infected. Activation of the aryl hydrocarbon receptor (AhR), which mediates the induction and release of IL22 from immune cells, was also transiently increased with PM exposure. The microbiome plays a major role in maintaining epithelial integrity and immune responses by producing various metabolites that act as ligands for AhR. Exposure to PM induced lung microbiota dysbiosis and altered the levels of indole, a microbial metabolite. Treatment with recombinant IL22 or indole-3-carboxaldehyde (I3A) prevented PM associated lung injury. In addition, I3A treatment also protected against increased mortality in Flu-infected mice exposed to PMs. Taken together, these data suggest that exposure to PM containing EPFRs results in failure to maintain IL22 levels and an inability to induce IL22 upon Flu infection. Insufficient levels of IL22 may be responsible for aberrant epithelial repair and immune responses, leading to increased Flu severity in areas of high PM.

Cumulative Environmental Health Vulnerability in East Baton Rouge Parish, Louisiana

Jennifer K. Irving[1], Dr. Thomas Douthat[1], Dr. Tammy Dugas[2], Dr. Margaret Reams[1], and Dr. Nina Lam[1]

Louisiana State University, Department of Environmental Sciences[1]; Louisiana State University School of Veterinary Medicine, Department of Comparative Biological Sciences[2]

Communities that experience environmental justice (EJ) issues also often experience health disparities and unequal access to health-promoting infrastructure compared to communities without EJ issues. Cumulative risk assessment (CRA) and EJ screening tools can integrate information about environmental exposures, social vulnerability, and characteristics of the built environment to provide a more complete picture of environmental health vulnerability. However, despite being home to several high-profile environmental justice communities and well-documented health disparities, Louisiana does not have a CRA or EJ screening tool. EJ screening tools developed by other states typically include an overall EJ index as well as overall scores data in the domains of Environmental Exposure, Environmental Effects, Baseline Health, and Social Vulnerability. The objective of this project is to integrate existing environmental health data at the census tract level to create a cumulative environmental health vulnerability index (CEHVI) for Louisiana.

Spatial Associations of Long-term Exposure to Diesel Particulate Matter and Black Race with Seasonal and Annual Mortality Due to COVID-19 in the Contiguous United States

Martine Elisabeth Mathieu, Joshua Gray, Jennifer Richmond-Bryant

Center for Geospatial Analytics, Department of Forestry and Environmental Resources, North Carolina State University

Studies have observed a disproportionate share of COVID-19 incidence and mortality among predominantly Black U.S. communities, which may be attributable in part to social and economic inequalities and underlying respiratory and cardiovascular conditions. Diesel Particulate Matter (DPM) exposure may affect the pulmonary and cardiovascular systems. A greater concentration of DPM is accumulated in socioeconomically disadvantaged communities. The objective of the study is to assess if long-term DPM exposure, while accounting for potentially socio-economic confounding effects, was spatially associated with COVID-19 mortality across three consecutive waves (January-May, June-September, October-December) of the disease and throughout 2020. We tested a series of association models, starting with an ordinary least square model. After observing spatial dependence in the residuals, a spatial lag model and a spatial error model, and a geographically weighted regression (GWR) model were run to analyze spatial patterns and seasonal relationships between COVID-19 mortality and long-term exposure to DPM. Positive associations were observed for the January-May and June-September waves with all three global models. Among all confounding covariates incorporated in the models, fraction Black race and fraction American Indian ethnicity were statistically significant in all models. The local GWR model found that associations between COVID-19 deaths and fraction Black race may increase up to 540, 414, 1268, and 1378 deaths per 100,000 people in some US counties for every fraction unit increase in Black race for the January-May, June-September, October-December, and yearlong models.

Educational intervention in environmental health: Checking the effectiveness of the "Science take-out kit" of risk factors for Breast Cancer in the Puerto Rican community

Victoria Pellot[1], Alanis Rivera[1], Kerely Lorenzo[1], Tsunami Nuñez[1], Dr. Nancy Cardona Cordero[1,2]

University of Puerto Rico, Aguadilla Campus[1]; University of Puerto Rico, Medical Sciences Campus[2]

Background and Objectives
Breast Cancer is classified as the Cancer with the highest incidence in Puerto Rico, where the mortality rate reached 18.9% in 2015. The main purpose of this study was to verify the effectiveness of the Science take-out kit as a tool to increase knowledge about breast cancer risk factors among the Puerto Rican community and create awareness of alternatives to reduce risk for the factors that we can control.

Methods
The study recruited participants who were residents of Puerto Rico, 18 years or older and have basic knowledge of biology. The "Science take-out kit" titled Breast Cancer Risk Factors was used. A pre- and post-evaluation was developed and implemented as a tool to assess the participants knowledge before and after the educational intervention. This intervention was offered in the form of a presentation and was accompanied by an interactive activity where each participant received a kit. The kit consists of a study case where participants used a DNA simulator test to identify the BRCA1 gene mutation and infographics

Results
A total of 18 participants were recruited. The average of correct premises in the pre-test was 59.4%, while in the post-test, it was 97.1%. The percentage of correct answers increased by 37.7% after the educational intervention.

Conclusion
The "Science take-out kit" as a complementary educational tool was effective demonstrating the information about breast cancer risk factors among this Hispanic group. In future research, the effectiveness of the "kit" could be evaluated in a community with no prior knowledge of health sciences.

Emissions of Volatile Organic Compounds and Particulate Matter from 3D Printer Filaments

Dr. Farhana Hasan[1], Dr. Philip M. Potter[2], Dr. Souhail R. Al-Abed[3], Dr. Slawo Lomnicki[1]

Department of Environmental Sciences, Louisiana State University, Baton Rouge, LA[1]; Oak Ridge Institute for Science and Education (ORISE), EPA, Cincinnati, OH[2]; Center for Environmental Solutions and Emergency Response (CESER), EPA, Cincinnati, OH[3]

Fused deposition modeling (FDM) 3D printers, have been shown to release volatile organic compounds (VOCs) and airborne particles, indicating the potential for consumer inhalation exposure and consequent health risks. Commercially available 3D printer filaments were analyzed with respect to their gas phase emission. Filaments were chosen on the basis of metal particles or carbon nanotubes present. Three polylactic acid (PLA) filaments containing either copper, bronze, or stainless steel particles were studied along with three carbon nanotube (CNT) filaments made from PLA, acrylonitrile-butadiene-styrene (ABS), or polycarbonate (PC). The metal-containing PLA filaments were found to emit primarily lactide, acetaldehyde, and 1-chlorododecane. The polycyclic aromatic hydrocarbon (PAH) naphthalene was also emitted. The CNT-PC filament emitted chlorobenzene, a toxic halogenated aromatic, which was likely formed from unreacted polymerization solvent or reactants. A comparison between certain emitted VOCs and their suggested maximum inhalation limits shows that printing as little as 20 g of certain filaments can subject the user to hazardous concentrations of multiple toxic VOCs with known carcinogenic properties. The presence of additives that are not advertised by the manufacturer and with unknown inhalation toxicity effects leaves users without the ability to make informed choices about their health when selecting a 3D printer filament. Particulate matter (PM), collected during 3D printing showed radicals presence after EPR studies.

Lead poisoning prevention among Puerto Ricans: An educational intervention

Veronica Morales-Rodriguez[1], Deytzalie Rodríguez-Hernandez[1], Paola Rodríguez-Montoyo[1], Sailyn Cordero-Alvarez[1], Dr. Nancy R. Cardona-Cordero[1,2]

University of Puerto Rico, Aguadilla Campus[1]; University of Puerto Rico, Medical Sciences Campus[2]

Background:

Previous research suggests that little is known about lead exposure and its related health effects among the Puerto Rican population. Exposure to lead can easily occur if effective prevention measures are not followed; it can cause irreversible effects to children and serious harm to adults. The purpose of this study is to dynamically disseminate information to interested individuals on how lead poisoning affects daily life and test the effectiveness of the Science-Take-Out kit "Prevention of Lead Poisoning" as an educational tool among this Hispanic population.

Methods:

Individuals with >21 years were recruited (n=18) and given an information sheet about the study. Then, an informative workshop on the Prevention of Lead Poisoning took place, where the participants completed a pre- and post-test digitally. Each participant was provided with a Science-Take-Out kit for the complementary hands-on activity. Once the pre-test and post-test answers were received, a statistical analysis on the percentage difference was carried out to examine the participant's comprehension.

Results:

On average, participants obtained 62.5% in the pre-test and 87% in the post-test, for a total increase of 24.5% about lead-related questions. According to 94% of the participants, the Science-Take-Out kit is a good educational method.

Conclusions:

The activity does not exceed 60 minutes, representing its ease and efficacy. The Science-Take-Out kit provides an opportunity to learn and reinforce previous knowledge to participants of different ages, levels of education, and interests, relating these to real-life cases and urging each participant to use simple experimentation models.

Shedding light on the effects of ultraviolet (UV) irradiation on environmentally persistent free radicals (EPFRs)

Fox Foley, Dr. Nadra. I. Sakr, Dr. Dr. Robert L. Cook, Dr. Phillip T. Sprunger

Louisiana State University

EPFRs are long-lasting toxic air pollutants. They have been found to form on the surface of metal oxide particles via chemisorption of substituted aromatic organic molecules. EPFRs are capable of producing harmful reactive oxygen species (ROS); inhalation of ROS induces oxidative stress in humans causing a negative impact on health. To decrease the damaging effects of EPFRs, we are searching for strategies to remediate their formation. Exposure to UV radiation has been found to affect the production and duration of EPFRs. Electron paramagnetic resonance (EPR) and Fourier transform infrared spectroscopy – attenuated total reflectance (FTIR-ATR) studies on TiO_2 nanoparticles dosed with the organic precursor phenol has shown that, upon irradiation with light identical to solar spectra, radical production increases. It was also revealed that there is a positive correlation between the duration of irradiation and signal intensity. Although signal intensity increases after UV exposure, we do not know the lifetime nor can we confirm the species of the produced radicals. We are going to more closely examine the changes induced by irradiation by using spin-trapping techniques to discover the type of ROS present. We will also investigate the lifetime of UV-produced radicals. Future experiments will be carried out using different types of metal oxide nanoparticles (such as ZnO) to research effects of surface variations on EPFR formation.

Effect of Polarity on EPFR Formation on Transition Metal Oxides

Syed Monjur Ahmed, Dr. Phillip Sprunger, Dr. Robert Cook

Louisiana State University

Studies have found that environmentally persistent free radicals (EPFRs) form by the adsorption of organic precursors on a metal oxide surface. EPFRs exhibit enough stability to cause negative health and environmental effects. Aromatic and substituted aromatic precursors form EPFRs on transition metal oxides (TMOs) at elevated temperatures; however, the roles of the substituents have largely been overlooked. Due to the occurrence of an electron transfer between organic precursor and TMO during the EPFR formation process, the influence of electronegativity on EPFR formation was studied utilizing Br-, Cl- and F- disubstituted organic aromatic precursors, such as 1,2-dibromobenzene (DBB), 1,2-dichlorobenzene (DCB), and 1,2-difluorobenzene (DFB). TiO_2 and ZnO nanoparticles (NPs) were chosen as the TMOs based on reports that TiO_2 oxidizes and ZnO reduces the organic precursor, respectively, during EPFR formation. Electron paramagnetic resonance (EPR) studies confirmed formation of C-centered organic free radicals adjacent to an O atom. It was also observed that the EPFR concentration for TiO_2 was the highest with DBB and decreased from DBB to DCB to DFB. On the contrary, the EPFR concentration for ZnO was the highest with DFB. X-ray photoelectron spectroscopy (XPS) for TiO_2 with DBB indicated partial reduction of Ti^{4+} to Ti^{3+}, and dehalogenation resulting in semiquinone-type radical formation. Further work will be done with DBB, DCB, DFB, and other substituted aromatic precursors, using such analytical tools as XPS, EELS, FTIR, XANES, and EXAFS to provide a more detailed EPFR formation mechanism.

Environmentally Persistent Free Radicals Inhibit the Formation of Complexes between NADPH-Cytochrome P450 Reductase and AhR-inducible P450s.

Dr. J. Patrick Connick, Jr., Dr. James Robert Reed, Dr. Wayne L. Backes

Louisiana State University Health Science Center, New Orleans - Dept. of Pharmacology and Experimental Therapeutics

Combustion of industrial waste affects human health by production of ultra-fine particles containing air-stable, environmentally persistent free radicals (EPFRs). EPFR exposure negatively influences pulmonary function. Cytochromes P450 (CYP) are enzymes necessary for the elimination of exogenous pollutants. EPFRs can influence P450 function both by elevating the levels of specific P450s via the Ah receptor (AhR), and by inhibition of P450 activity. One P450, CYP1A2, was inhibited competitively at lower substrate concentrations but non-competitively at higher substrate, raising the possibility that P450 activity is inhibited by disruption of its complex with the redox partner, NADPH-cytochrome P450 reductase (POR). The goal of this study was to determine if EPFRs inhibited AhR-inducible P450s by disrupting physical POR•P450 interaction.

We measured the effect of EPFRs on physical complex formation between POR and either CYP1A1, CYP1A2, or CYP1B1 using bioluminescence resonance energy transfer (BRET). Both CuO-Si particles and MCP230 inhibited POR•P450 complex formation for each P450, with MCP230 causing more potent disruption for the CYP1A1•POR and CYP1A2•POR complexes.

These results support the idea that EPFRs disrupt the redox complex between POR and CYP1A, and this mechanism may lead, at least in part, to inhibition of both exogenous compounds and the endogenous compound 6-formylindolo[3,2-b]carbazole (FICZ). This endogenous compound is an important inducer of the AhR response, and is metabolically inactivated by CYP1. However, when EPFRs are present, CYP1 activity is inhibited by disruption of the protein-protein complex, decreasing the degradation of FICZ and prolonging the AhR response. (Supported by P42 ES013648)

Specific lung cells express Cyp1a1 after inhalation of simple and complex Environmentally Persistent Free Radicals (EPFRs)

Dr. Pratiti Home Chowdhury, Liana Baconguis, Dr. Alexandra Noël, Dr. Ashlyn C. Harmon, Dr. Stephania Cormier

Louisiana State University,

Environmentally persistent free Radicals (EPFRs) are recently identified pollutants, generated during combustion of hazardous wastes, that proved to have an adverse effect on human health. EPFRs are usually associated with particulate matter that damages the respiratory system when inhaled and can disrupt the immune system by ROS orchestrated T helper 17 (Th17) pathways. In this study, we used two laboratory-generated EPFRs, which differ in their chemical complexity. Simple EPFRs are generated from Mono-Chlorophenol (MCP) at 230o C in absence of oxygen. Whereas complex EPFRs (CAM) are generated in presence of oxygen as the combustion generated particle. CAM contains a higher level of Polyaromatic Hydrocarbons (PAHs) and their oxidative derivatives, soot particles, oxygen and carbon-centered molecule, etc. Previously, EPFRs have been studied for their ROS-mediated toxicity through Cyp1a1 (a gene from the Cytochrome P450 family) in lung cells however it is important to understand which cells in the lung are the major contributor of Cyp1a1 expression. Here, C57BL6 mice were exposed to simple or complex EPFRs. After a certain period of exposure, mice were sacrificed, and their lungs were isolated. The single-cell suspension of the lung was then treated with specific antibodies and cyp1a1 expression and cell types were identified by Flow cytometry. We identified club cells and Type II Alveolar cells expressed maximum Cyp1a1 when the mice were exposed to simple and complex EPFRs respectively. As Cyp1a1 is responsible for Aryl hydrocarbon (AhR) inducibility, our next aim is to determine if AhR signaling is necessary for EPFRs induced Th17 cellular response by knocking out the AhR signaling in identified cell.

Formation and Stability of Environmentally Persistent Free Radicals in Dual-Metal Loaded Clay Surrogates

Emmanuel Ampiah, Dr. Philip T. Sprunger, Dr. Robert L. Cook

Louisiana State University

Environmentally persistent free radicals (EPFRs) are highly stable and toxic organo-metallic radical complexes that persist in the environment longer than regular radicals do. EPFRs are concentrated in the clay mineral/humin fraction of Superfund site soils, but the chemistry, formation and stability mechanism have not been fully investigated. We present findings from ICP-OES, EPR, FTIR, and XANES characterization in terms of EPFR formation, stability, redox activity, and potential toxicity of phenol-generated EPFRs generated on dual-metal-loaded synthetic clay (FeCuSYn) surrogates. EPFRs were formed with g-values of ~2.0034, which is characteristic of phenoxyl and semiquinone-type radicals. Phenol exposure of the 50% (v/v)-loaded FeCuSYn surrogates yielded 2.79 ´ 1017 spins per gram of EPFRs, which is 59% of the EPFR yield when 100% (v/v)-loaded FeCuSYn (5.07 ´ 1017 spins/g) surrogates are exposed, with Fe being the major contributor to EPFR formation. Cu and Fe K-edge energy shifts in the XANES spectra of FeCuSYn-phenol-exposed clays suggest EPFR formation involving both Cu and Fe, via a mono-electron transfer and a concerted reduction of the metal center. These EPFRs produce hydroxyl (•OH) and superoxide (O2–•) radicals, both known to act as reactive oxygen species, which is indicative of their potential biotoxicity.

Inhalation of Combustion-Derived Environmentally Persistent Free Radicals Causes Vascular Endothelial Injury Mediated Via AHR Activation in Alveolar Type-2 Pneumocytes

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Particulate matter containing environmentally persistent free radicals (EPFRs) is formed by incomplete combustion of organic pollutants during thermal remediation. Initial studies used laboratory-generated EPFRlo: (1.5e16 radicals/g particles) and EPFRhi: (1.0e18 radicals/g) at 250 µg/m3 to investigate their effects on vascular endothelial and pulmonary oxidative stress in C57BL/6 male mice. These studies demonstrated that EPFRs inhalation results in an increase in endothelin-1 (ET-1) and intracellular adhesion molecule-1 (ICAM-1), at high but not low radical concentrations, and genes associated with AhR activation (Cyp1a1/1b1) were upregulated in the lungs. We also identified that AhR activation was significantly increased in AT-2 pneumocytes after EPFRhi exposure. We hypothesized that inhalation of EPFRs leads to vascular endothelial dysfunction via activation of AhR in AT-2 cells in a radical-dependent manner. To address our hypothesis, AhR was knocked down in AT-2 pneumocytes in male and female mice before exposure to filtered air (FA), EPFRlo, or EPFRhi for 4h/d for one day. Plasma ET-1 remained unchanged between KO and WT mice exposed to FA and EPFRlo; however, ET-1 was significantly decreased in AhR KO mice exposed to EPFRhi versus WT. Over the course of 10d exposure (4hr/d), we identified a decrease in blood pressure in AhR KO mice at 2d and 10d compared to WT mice when exposed to EPFRhi, supporting our hypothesis AhR deficient mice are protected from endothelial injury after EPFRhi exposure. Together, these data suggest that EPFR exposure promotes AhR activation in AT-2 pneumocytes, which results in vascular endothelial dysfunction, likely at the air-blood interface.

An observed increase in cardiovascular and respiratory disease-related mortality in an area surrounding a hazardous waste incinerator

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Clean Harbors, LLC operates a thermal treatment plant near the city of Colfax, LA in Central Louisiana. Its regular open burning of explosives causes consistent smoke plumes and various community disturbances. We hypothesize that particulate matter (PM2.5) and other pollutants produced from this facility increased the disease burden of Colfax compared to surrounding areas. We previously demonstrated that respiratory- and cardiovascular-related hospitalizations, particularly asthma and hypertension, were greater in Colfax than in the surrounding ZIP codes and parish from the years 2000-2017. To further analyze the effects of our previous data, we obtained rates for mortality of the respective diseases and rates for cancer incidence from data owned by the Louisiana Tumor Registry over the same time period. Rate ratios and 95% confidence intervals were used to determine statistical significance between geographic levels. We did not find significant differences across various cancer subtypes at the ZIP code level. However, the estimated mortality rates for any death where a cardiovascular disease was identified as a cause (eg. a heart attack) in Colfax was 76.1% higher than the Louisiana rate and 51.6% higher than the rate in the rest of the parish rate, a pattern observable for specific cardiovascular diseases (eg. hypertension). Mortality for all respiratory tract infections (eg. influenza) in Colfax was 55.4% higher than the state rate and 26.1% higher than the parish rate. These rates are consistent with our previous results and long-term PM2.5 exposure, though further analyses on confounding factors such as race need to be conducted.