PBC Focus Meeting: *Pandemic Planning and Lessons Learned from COVID-19*

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Abstract booklet

22 - PROTECTING PREGNANT WOMEN AND NEWBORNS FROM THE HEALTH EFFECTS OF EXTREME HEAT: A CONTENT ANALYSIS OF HEAT HEALTH ACTION PLANS ON MATERNAL AND NEWBORN HEALTH PERSPECTIVE

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Background: The growing evidence of heat-related adverse maternal and newborn outcomes emphasizes the urgent need to implement heat health action plans (HHAPs) focusing on maternal and newborn health.

Purpose: This study reviews heat action plans worldwide and (i) identifies to what extent the heat health action plans incorporated pregnant women and newborns as vulnerable group to heat-related health issues, (ii) identifies preventive strategies to protect pregnant women and their newborn babies from excessive heat (iii) provide recommendations to improve the heat action plans from maternal health perspective.

Method: We conducted a gray literature search between November 2022 and February 2023 to identify publicly available HHAPs focusing on maternal and newborn heat preventive strategies and interventions. We reviewed, extracted, coded, and analysed HHAPs based on the following areas: governance, accurate and timely alert system, heat-health information plan; indoor heat reduction strategies; care for vulnerable populations, care for pregnant women and newborns, available social services for vulnerable people, pregnant women, and newborns; long-term heat reduction planning and policies for maternal and newborn population.

Results: We analysed 42 HHAPs that identified vulnerable population groups to heat. Older people, children, and people with existing medical conditions are the most common vulnerable groups identified. Among all HHAPs analysed, 24 acknowledged pregnant women as vulnerable to heat. Among them, only 20% provided communication strategies targeting pregnant women, and less than 10% indicated available social services for the maternal population. None of the HHAPs reviewed provided long-term plans and policy interventions for heat preventive strategies for the maternal populations.

Conclusion: Despite known links between heat and adverse maternal and newborn outcomes, current HHAPs largely ignore pregnant women and their babies. To address this gap, we recommended that HHAPs include targeted advice and strategies to disseminate heat-health information to pregnant women to protect themselves and their babies from extreme heat. Further, HHAPs should provide clear guidelines to identify and assist pregnant women during the heat and post-heat wave periods. Moreover, clear guidelines and policies for building heat-resilient antenatal and childbirth facilities and indoor temperature monitoring systems are recommended to protect pregnant women and newborns from extreme heat.

Institution

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21 - CALIBRATION OF LOW-COST PARTICULATE MATTER SENSORS PURPLEAIR: MODEL DEVELOPMENT FOR AIR QUALITY UNDER HIGH RELATIVE HUMIDITY CONDITIONS

Martine Mathieu-Campbell[1], Chuqi Guo[1], Andrew Grieshop[1], Jennifer Richmond-Bryant[1]

[1]North Carolina State University

The PurpleAir PM sensor is one of the most widely used low-cost PM sensors (LCS). Its dense monitoring network has the potential to capture PM concentrations at a high spatial and temporal resolution and thus predict community exposure risks. Although good correlations to the reference instrument have generally been identified, bias and low precision have been reported in several cases. Humidity has been documented to reduce the performance of LCSs. Barkjohn et al. (2020) developed a nationwide PurpleAir data correction model, however, very few sites were included in the Southeastern US. In a high humidity environment, accurate detection of particle size and concentration may be affected by coagulation, condensation, and hygroscopic growth. Water vapor may also damage the circuitry. The Southeast region, which includes the most humid states, is characterized by a humid subtropical climate with an annual average humidity varying between 78.6 and 88.7%. The objective of this research is to develop a PurpleAir data calibration model for the Southeastern US (warm humid climate zone) and evaluate the performance of the existing Barkjohn model under high relative humidity conditions. The study used PurpleAir data and $PM_{2.5}$ monitoring data from the EPA Air Quality System from January 2021 to August 2023. We selected PurpleAir sensors within a radius of 20, 10, 5, and 2.5 km of each regulatory monitor. For quality assurance, data were excluded if the two Plantower sensors varied by more than 5% or 20 ug/m^3. For each radius, our study tested six multilinear regression models including the model proposed by Barkjohn et al. (2020), and a semi-supervised clustering model based on a Gaussian model regression approach. Each model was evaluated using R^2,root mean squared error and mean absolute error. Preliminary results suggest that including dew point temperature in the model improves fit.

Institution

North Carolina State University

20 - ENVIRONMENTALLY PERSISTENT FREE RADICALS IN HOUSEHOLD DUST: LONGITUDINAL AND SEASONAL TRENDS

Dwan Vilcins[1], Prakash Dangal[2], Slawo Lominicki[2], Stephania Cormier [2], Wen Ray Lee[1], Peter D Sly[1]

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Objective

Epidemiological links between air pollution and adverse health outcomes are strong, but the mechanism(s) remain obscure. A newly recognised combustion by-product, environmentally persistent free radicals (EPFRs), may be the missing link. EPFRs persist for extended periods of time in the environment, however very little is known about the presence of EPFRs inside homes where prolonged exposure is likely to occur. The objective of this study is to explore the presence of EPFRs in household dust and ascertain if EPFR concentration is stable across time and season.

Material and methods

The ORChID/ELLF cohort is a longitudinal birth cohort (n=158) with dust samples collected from the family vacuum cleaner at multiple time points. EPFR characteristics were assessed with electron paramagnetic resonance. Our team developed an algorithm to estimate oxygen-weighted concentration and impact score for risk of adverse health outcomes. Kruskal-Wallis rank sum test and Fisher's exact tests were used to assess seasonal differences. A mixed-effects linear regression, with random intercepts on participant ID and season and ambient $PM_{2.5}$ as covariates, was employed for longitudinal analysis of EPFR concentration in households that did not move.

Results

83 participants returned 238 dust samples. EPFRs were measured in all homes, and 96% of samples. There were seasonal differences in the concentration and speciation of EPFRs, largely driven by lower levels in summer. Longitudinal analysis found concentration and oxygen-weighted concentration was stable across timepoints, when controlling for season and ambient $PM_{2.5}$, however g factor was not stable.

Conclusion

Our results indicate that the concentration of EPFRs in household dust are stable across time in households that did not move. These findings suggest that exposure to EPFRs occurs in the home and may be a significant place for exposure to highly biologically reactive EPFRs.

Institution

The University of Queensland

19 - EXPOSURE TO ENDOCRINE-DISRUPTING PLASTICISERS AND LUNG FUNCTION IN CHILDREN AND ADOLESCENTS: A SYSTEMATIC REVIEW AND META-ANALYSIS

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Introduction/Aim: Exposure to endocrine-disrupting plasticisers (EDPs), such as phthalates and bisphenols, has been associated with reduced lung function in children and adolescents. However, the existing literature yields conflicting results. We sought to systematically review the existing literature assessing the epidemiologic evidence on the association between EDP exposure and lung function in this population.

Methods:
A comprehensive search of PubMed, Embase, Scopus, Web of Science and CENTRAL databases was conducted. The risk of bias within each study was assessed with the Office of Health Assessment and Translation risk of bias tool. We performed a random-effects meta-analysis on spirometry measures, using regression coefficients standardised by the outcome standard deviation (SD).

Results: We reviewed 25 studies encompassing 15,123 subjects, of which 17 were included in the meta-analysis. In our meta-analysis, forced expiratory volume at 1 second (FEV_1) was reduced by a two-fold increase in mono-benzyl phthalate (MBzP) (β=-0.025 SD, 95%CI: -0.042, -0.008), mono-ethyl-oxo-hexyl phthalate (MEOHP) (β=-0.035 SD, 95%CI: -0.057, -0.014) and mono-carboxy-nonyl phthalate (MCNP) (β=-0.024 SD, 95%CI: -0.05, -0.003) urinary levels. Forced vital capacity (FVC) was decreased by MBzP (β=-0.022 SD, 95%CI: -0.036, -0.008) and MEOHP (β=-0.035 SD, 95%CI: -0.057, -0.014). Moreover, MCNP was associated with lower FEV_1/FVC (β=-0.023 SD, 95%CI: -0.045, -0.001), while MEOHP reduced forced mid-expiratory flow (FEF_{25-75}) (β=-0.030 SD, 95%CI: -0.055, -0.005) and peak expiratory flow (PEF) (β=-0.056 SD, 95%CI: -0.098, -0.014). Notably, associations were more pronounced in males. However, due to the possibility of reverse causation bias, the association between, the association between childhood exposure to EDPs and lung function remains uncertain.

Conclusion:
Overall, our meta-analysis showed small reductions in lung function with higher postnatal EDP exposure. The existing literature limitations include small sample sizes, potential exposure misclassification, reverse causation, and confounding bias. However, future studies on children under four years of age are warranted. Furthermore, occupational exposure, vulnerable subpopulations, and potential underlying mechanisms should be explored.

Institution

Children Health Environment Program, The University of Queensland, South Brisbane, Australia

18 - HOUSEHOLD CHARACTERISTICS ASSOCIATED WITH ENVIRONMENTALLY PERSISTENT FREE RADICALS IN HOUSE DUST IN TWO AUSTRALIAN LOCATIONS

Wen Lee[1], Prakash Dangal[2], Zhiwei Xu[3], Stephania Cormier [2], Slawo Lomnicki[2], Peter D Sly[1], Dwan Vilcins[1]

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The association between air pollution and adverse health outcomes has been extensively studied for decades, but the mechanism behind this association is still in discovery. There are emerging studies that propose environmentally persistent free radicals (EPFRs) as the missing connection between air pollution and detrimental health impacts. This research is in its infancy, and the studies to date focus on EPFRs present in ambient air with little information available on the presence of EPFRs in homes. Our study aims to assess the presence of environmentally persistent free radicals in household dust and discover which household characteristics are associated with EPFRs.

This study consisted of two cohorts, Early Life Lung Function (ELLF) and Barwon Infant Study (BIS) from two different locations in Australia. Household characteristics were collected through an online self-reported survey and household dust was collected from the vacuum to measure EPFR concentration. The different geographical locations of households were used to assess the consistency of household characteristics associated with EPFR concentration in Australia. Regression random forests were conducted to identify important household characteristics in predicting EPFRs in each location. Consistent household characteristics found between both cohorts were then plotted with Spearman rank coefficient to understand the direction of associations.

Our results found that age of house, type of garage, house outer wall material, heating method used in home, extractor fan practice when cooking, traffic related air pollution, frequency of cleaning and major house renovation were important household characteristics associated with EPFRs in both Australian cohorts. Some consistent trends of associations were found between the two locations, with households made of weatherboard building material, not using extractor fan when cooking and dirty heating method used demonstrating higher EPFR concentration in household dust. Our results also showed that houses located in a low neighbourhood traffic area were associated with lower EPFRs.

These findings are important in understanding which household factors are linked to harmful air pollutant by-products in Australian homes. With such understanding, changes in household behaviours and home ventilation standards in Australia can be made to improve air quality in homes, ultimately protecting vulnerable population from adverse respiratory health outcomes.

Institution

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17 - Long-term stability of Orthobunyaviruses in sera and whole blood at relevant temperature profiles

Erik Turner[1], Rebecca Christofferson[1]

[1]Louisiana State University School of Veterinary Medicine

Orthobunyaviruses represent an understudied group of viruses of One Health importance. Previously, we described the phenomenon whereby BUNV and related Batai (BATV) were retained infectiousness at 37°C for up to 30 days *in vitro*, and we identified Bunyamwera (BUNV) in cattle suspected of having Rift Valley Fever virus (RVFV) in 2018. In this follow-up, we investigated long-term infectiousness in sera and whole blood as a way to determine whether there was a possibility of risk to animal workers from these Orthobunyaviruses as with RVFV. This was done at a temperature profile based on Rwanda climate during peak transmission season.

Sera and whole blood were inoculated with either BUNV or BATV, incubated in environmental chambers, and sampled at 7, 21, and 28 days. Infectiousness was determined by then inoculating these samples onto Vero cells and testing for growth

Interestingly, in serum, infectivity was retained from the samples taken at 7 days for BUNV while samples incubated in whole blood retained infectiousness out to 28 days reaching an average titer of 1.98×10^6 pfu/mL. BATV similarly retained infectivity in both whole blood and sera up to 28 days reaching moderately high titers (~2.9×10^6 pfu/mL). These results suggest that these Orthobunyaviruses are stable in serum and whole blood for relatively long periods of time at environmental temperatures in at-risk regions. This has implications for biosafety and biosecurity of these viruses and preliminarily suggests a novel transmission modality through contaminated animal tissues and fluids.

Institution

Louisiana State University, SVM

16 - Modeling the Prevalence of Asymptomatic COVID-19 Infections: Lesson from the Large-scale Screening in China

Bin Wang[1], Guofeng SHEN[1]

[1]Peking University

Considerable efforts have been focused on intensifying the Screening process for asymptomatic COVID-19 cases in the Chinese Mainland during the early outbreak period, especially for up to 10 million citizens living in Wuhan City by nucleic acid testing. However, a high percentage of domestic asymptomatic cases did not develop into symptomatic ones, which is abnormal and has drawn considerable public attention. Here, we aimed to investigate the prevalence of COVID-19 infections in the Chinese Mainland from a statistical perspective, as it is of referential significance for other regions. By conservatively assuming a development time lag from pre-symptomatic (i.e., referring to the infected cases that were screened before the COVID-19 symptom onset) to symptomatic as an incubation time of 5.2 days, our results indicated that 92.5%of those tested in Wuhan City, China, and 95.1% of those tested in the Chinese Mainland should have COVID-19 syndrome onset, which was extremely higher than their corresponding practical percentages of 0.8% and 3.3%, respectively. We propose that a certain false positive rate may exist if large-scale nucleic acid screening tests for asymptomatic cases are conducted in common communities with a low incidence rate. Despite adopting relatively high-sensitivity, high-specificity detection kits, we estimated a very low prevalence of COVID-19 infections, ranging from 10^{-6} to 10^{-4} in both Wuhan City and the Chinese Mainland. Thus, the prevalence rate of asymptomatic infections in China had been at a very low level during that period. Furthermore, given the lower prevalence of the infection, close examination of the data for false positive results is necessary to minimize social and economic impacts.

Institution

Peking University

15 - A COMMUNITY-ENGAGED STUDY OF TOXIC PARTICULATE MATTER NEAR AN OPEN-BURN/OPEN-DETONATION HAZARDOUS WASTE THERMAL TREATMENT FACILITY

Chuqi Guo[1], Martine Mathieu[1], Matilda Odera[1], Jennifer Richmond-Bryant[1]

[1]North Carolina State University

Colfax, LA, hosts the only commercial open-burn/open-detonation hazardous waste thermal treatment facility in the country. It treats military waste, fireworks, propellants, and soils excavated from Superfund sites. Colfax has a median individual income of approximately $16,000, and 71% of Colfax residents are Black or African American. We describe a community-engaged study of particulate matter (PM) concentration and composition. Based on community member interviews and review of public comments submitted to the Louisiana Department of Environmental Quality, sampling sites and targets for chemical analysis were identified. PM smaller than 2.5 mm ($PM_{2.5}$) samples are collected by two high-volume air samplers. At ten sites varying in distance from the facility, two types of passive samplers collect fine and total PM, and PM at several size cuts is measured by low-cost sensors. The bias-corrected low-cost $PM_{2.5}$ sensor readings from the first three quarters of our sampling campaign, which occurred from March to September, 2022, showed that only 46.2% of readings fell into the “good” category of EPA’s Air Quality Index for 24-hour $PM_{2.5}$, while 0.06% of the readings were considered “unhealthy”, “very unhealthy”, or “hazardous”. Soot-type EPFRs have been detected from the high-volume air samples 1.2 miles and 9 miles away from the facility. Aluminum, barium, chromium, copper, iron, magnesium, manganese, and zinc were detected in fine particles, and cobalt has also been detected in coarse particles. Through this study, we aim to provide the community with information about their exposures and promote community empowerment and engagement to reduce their exposure risks.

Institution

North Carolina State University

14 - Polycyclic aromatic hydrocarbons alter SARS-CoV-2 pathogenesis in a mouse model of COVID-19

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[1]Baylor College of Medicine

Since its emergence in 2020, SARS-CoV-2, the causal agent of COVID-19, remains a significant public health concern. Understanding pathogenesis remains critical, as factors contributing to severe outcomes remain uncharacterized. Polycyclic aromatic hydrocarbons (PAHs) are pollutants present in the environment, such as diesel exhaust and cigarette smoke, and known to cause respiratory distress and lung damage. We aimed to evaluate if the PAH benzo[a]pyrene (BP) exacerbated SARS-CoV-2 pathogenesis in a mouse model of disease. One day following intranasal administration of BP (20mg/kg) or vehicle control, we infected male and female 6-8 week old K18-hACE2 mice with ancestral SARS-CoV-2 and assessed lung viral load, weight change, clinical scores, immune cell recruitment, and survival in the presence and absence of BP exposure. We found that BP-exposed mice had significantly higher clinical scores, greater weight loss, and decreased survival compared to mock-exposed mice. BP exposure also increased neutrophils and dendritic cells, while decreasing natural killer cells and monocyte populations in the lungs of SARS-CoV-2-infected mice. These data indicate that BP exposure worsens clinical outcomes and influences immune infiltrates during SARS-CoV-2 infection. Additionally, we aimed to understand the role of hyperoxia in pathogenesis, as oxygen is used in the treatment of various lung injuries and may be used for COVID-19. Mice with exposures to both hyperoxia (60%) and BP had significantly less weight loss than those exposed to room air alone, regardless of BP exposure, supporting that supplemental oxygen treatment common with COVID-19 hospitalization may protect against negative clinical outcomes associated with BP exposure during SARS-CoV-2 infection. These data support that environmental exposure to PAHs may play a role in COVID-19 pathogenesis and require further study in animal models and human cohorts.

Institution

Baylor College of Medicine

13 - EPFR Toxicity Studied Using Zn-Loaded Montmorillonite Clay Systems

Myron Lard[1], Robert Cook[1]

[1]Louisiana State University

Environmentally persistent free radicals (EPFRs) have emerged as a pollutant of interest in recent years due to their proven contribution to oxidative stress related illness. To begin developing remediation methods for these radicals, more understanding about the mechanistic formation is necessary. The purpose of my research is to advance the understanding of the fundamental chemistry of the environmentally persistent free radical's (EPFRs) formation in soils and to investigate strategies for prevention or remediation of this formation. This research uses cation-exchanged montmorillonite clay as a metal-loaded vehicle for EPFR formation.

With consistent generation of environmentally persistent free radicals (EPFRs) on the metal loaded clay systems, further investigation into their effect on the generation of reactive oxygen species (ROS) has been taking place. Previous research has shown that EPFRs can participate in a radical cascade mechanism resulting in an increase in detected ROS. This influence on ROS generation is notable because these ROS compounds are directly responsible for oxidative-stress related diseases in the body. Through spin trapping experiments using 5,5-Dimethyl-1-Pyrroline-N-Oxide (DMPO), we are able to observe the generation and growth of the typically short-lifetime ROS. Spin trapping experiments have been conducted in a number of media, including simulated lung fluid, to further understand the ability to form under biological conditions.

Additional biological studies are currently underway involving the ROS generation from the metal-loaded clay systems, particularly the zinc loaded samples. These samples display unique characteristics in both EPFR formation and ROS generation, and therefore have been selected for cell impact studies. Working with the LSU Veterinary School, a methodology to observe the toxicity of these clays has been developed with preliminary results from these cell studies suggest that the EPFR containing clay samples are more damaging to cells than non-EPFR clays.

Institution

Louisiana State University

12 - CHANGES IN SOIL MICROBIOME AND ENVIRONMENTALLY PERSISTENT FREE RADICALS (EPFRS) NEAR A HAZARDOUS WASTE THERMAL TREATMENT SITE

Fan Zhang[1], Jennifer Richmond-Bryant[2], Robert Cook[1], Myron Lard[1], Aiyanah Sandifer[1], Nora Villafuerte[1], Stephania Cormier[1]

[1]Louisiana State University, [2]North Carolina State University

The disposal of hazardous materials from Superfund sites often involves thermal treatment (TT), in which combustion of electron-rich aromatic hydrocarbons leads to the formation of environmentally persistent free radicals (EPFRs). These radicals, generated when organic combustion byproducts interact with transition metal-containing particles, form a biologically reactive free radical-particle pollutant system. Researchers from the Louisiana State University Superfund Research Program have demonstrated that EPFRs induce oxidative stress, contributing to cardiopulmonary issues and other health problems. A Colfax, LA TT facility has utilized open-burn and open-detonation methods to process hazardous waste, including but not limited to military munitions, fireworks, and soils from Superfund sites, since the mid-1980s. Our preliminary air sampling data have identified elevated EPFR concentrations within 1 to 3 miles from the facility. Colfax residents in this area have described health conditions including thyroid disease, skin ailments, respiratory effects, and cancer.

In March 2023, we collected soil samples from five residential sites and analyzed those samples for microbial communities. We found a distinct microbial community near the waste treatment facility, characterized by an increased fungal presence, reduced bacterial abundance, and lower diversity in species richness. These patterns correspond to an increase in EPFR concentration with decreasing distance from the facility. Notably, 35 bacterial genera increase significantly near the TT facility; *Acidobacteria*, as well as members of alpha and gamma-*Proteobacteria*, were predominant genera identified. Genomic analysis of the microbiome highlighted enriched genes related to xenobiotic substance biodegradation and antioxidant biosynthesis, shedding light on biodegradation processes. These findings prompted an expanded sampling range at 12 sites distributed over a radius of 20 miles from the TT facility to improve our understanding of the ecological impacts of EPFRs on soil microbiome. Further investigation into molecular mechanisms and bacterial strains is underway to better comprehend and mitigate the impacts of EPFR-induced oxidative stress.

Institution

Louisiana State University

11 - Environmentally persistent free radical (EPFR) production on ZnO and the effects of solar-simulated light exposure

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[1]Louisiana State University

EPFRs are long-lasting toxic air pollutants that are typically created during thermal remediation processes. They form through chemisorption of substituted aromatic organic molecules on transition metal oxide particles. EPFRs have been shown to be capable of producing harmful reactive oxygen species (ROS); inhalation of ROS induces oxidative stress in humans which in turn causes a negative impact on health. Different strategies to remediate EPFRs have been explored. Exposure to UV radiation has been found to affect the production and duration of EPFRs. Electron paramagnetic resonance (EPR) and x-ray photoelectron spectroscopy (XPS) studies on ZnO dosed with the organic precursor phenol have shown that, upon solar simulated irradiation, radical production increases. It was also revealed that there is a positive correlation between the duration of irradiation and radical signal intensity. A lifetime study of radical decay done with EPR confirms a long-lasting radical (> 2 weeks) persisting despite irradiation of up to 2 hours. Longer light exposures may be needed to eliminate the EPFRs. Understanding of photoinduced changes is ongoing.

Institution

Louisiana State University

10 - EFFECT OF HALOGENATED AROMATIC PRECURSORS ON EPFR FORMATION ON TRANSITION METAL OXIDES

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Environmentally persistent free radicals (EPFRs) are a group of emerging environmental pollutants. Owing to their resonance structures, EPFRs have significantly higher lifetimes than typical free radicals, and can induce the formation of reactive oxygen species (ROS) known to cause pulmonary and cardiovascular dysfunction. EPFRs form by the adsorption of organic precursors on a transition metal oxide (TMO) surface and exhibit enough stability to cause negative health and environmental effects. While aromatic and substituted aromatic precursors form EPFRs on transition metal oxides at elevated temperatures and numerous substituted organics are ubiquitous in various industrial processes and household products, studies have largely overlooked the significance of the substituents. Due to the occurrence of an electron transfer between the organic precursor and the transition metal oxide during EPFR formation, the influence of electronegativity on EPFR formation has been studied utilizing 1,2-dibromobenzene (DBB), 1,2-dichlorobenzene (DCB), and 1,2-difluorobenzene (DFB). TiO_2 and ZnO nanoparticles (NPs) were chosen as the transition metal oxides based on reports that TiO_2 is reduced and ZnO is oxidized during EPFR formation. Electron paramagnetic resonance (EPR) studies confirmed the formation of organic free radicals for both TiO_2 and ZnO nanoparticles, with the magnitude of radical concentration of 10^{16}-10^{17} spins/g being the highest for DBB and lowest for DFB. X-ray absorption spectroscopy (XAS) studies for both ZnO and TiO_2, dosed with the aforementioned organic precursors, confirmed the reduction of Zn^{2+} and Ti^{4+} metal centers. In concert, these findings illustrate the significance of the polarity of the organic precursor in EPFR formation. The role of the polarity of the organic precursor in determining EPFR stability and bioactivity, via reactive oxygen species (ROS) production, is currently under study.

Institution

Louisiana State University

9 - "EFFECTS OF COVID-19 AND ITS INFLUENCE IN TECHNOLOGICAL UPGRADATION AND PRACTICES IN PROMOTION OF ENVIRONMENTAL PROTECTION AND OCCUPATIONAL HEALTH"

SENGODA GOUNDER RAJAMANI[1]

[1]Board Member - PBC & Chairman, Asian International Union of Environment (AIUE) Commission

During COVID-19 period, animal slaughtering and meat consumption declined due to poor demand from hotel industries, tourism, cancellation of mass religious activities and functions, etc. The leather and agro based industrial operations reduced by 40-60%. As a precautionary measure, there has been major change in the norms and guidelines on the occupational health and safety measures in the polluting industrial operations and wastewater treatment systems. The development and promotion of cleaner production processes such as recovery and reuse of chemicals and water from the waste discharges have become mandatory.

Zero Liquid Discharge (ZLD) system is being enforced in many individual and Common Effluent Treatment Plants (CETPs) in India and other countries. Manual handling of industrial operations and in wastewater treatment plants have been minimized by introducing auto control and monitoring. The treated effluent discharge standards have become more stringent and many new norms such as control of colour, pathogens, etc. resulted in adoption of advance oxidation system using ozone which is first of its kind in Asia probably in the whole world. The operations and economical situations of the polluting industries such as leather industry continue to decline even after COVID-19 mainly due to the avoidance of articles made from animal base and started using synthetic shoes and articles.

During COVID-19 period (2020-22), the positive environment impact was reduction in carbon emission by about 50% due to major reduction in movement of vehicles, industrial operations and overall temperature is also reduced by 2-5^{o}C. However, after COVID-19 period, there is a negative environmental impact due to increase in carbon emission from Pre-Covid-19 levels and average increase in atmospheric temperature by 2-6^{o}C, extended summer, erratic monsoon during 2023.

The technical paper deals with recent technical and environmental developments and future trends in the midst of COVID-19 in India & other countries.

Institution

Asian International Union of Environment (AIUE) Commission

8 - THE ROLE OF WASTEWATER SURVEILLANCE IN PANDEMIC RESILIENCE

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THE ROLE OF WASTEWATER SURVEILLANCE IN PANDEMIC RESILIENCE

Pandemic threats spread rapidly in cities, but the pace of response is currently limited by the time required for infectious individuals to access and progress through health systems. As a result, the appearance of just a few cases of a pandemic pathogen will likely commit a city to a massive epidemic surge and ignite a chain reaction in other cities connected by travel, leading rapidly to regional or global spread. As the COVID-19 pandemic indicates, these chain reactions are not reversible with current knowledge, technologies and workforce. Recent work demonstrates that feedback loops between monitoring, forecasting, and response can allow cities to reverse the chain reactions that lead to pandemics *if* the feedback is sufficiently localized and rapid. Our proposed systems leverage the social-technological networks that characterize urban environments to create city-level 'immune systems' that (1) gather data through environmental sensing (2) forecast the prevalence and behavior of infectious and susceptible individuals and (3) engineer systemic responses that reduce transmission. Forecast information is used to inform and engage individuals and groups, and passes back information to adapt sampling design, while the forecasts themselves incorporate temporal heterogeneity in behavioral states. Thus, a feedback loop is created between sensing, prediction and response. As public infrastructure, these city-level 'immune systems' will provide a crucial platform for convergence research in pandemic prediction and prevention. Without them, pandemic threats will progress from local to global scales with increasing frequency over the next century as cities continue to grow and become more interconnected. Wastewater surveillance can achieve the goal is to make environmental surveillance data actionable for public health in cities everywhere, through the timely, durable, scalable, data-driven, process-based conversion of raw environmental surveillance data (*e.g.*, gene copies of virus/L of wastewater) to accepted public health metrics (*e.g.*, community prevalence). We have carried out state-wide wastewater surveillance (from over 40 utilities) for SARS-CoV-2 for three years, and for influenza and RSV for two years. The lesson learned from this program as well as the improvements needed to realize a healthy 'immune system' for pandemic resilience will be discussed.

Institution

Oregon State University

7 - EVALUATION OF T-VANT, A NOVEL OUTER MEMBRANE VESICLE ADJUVANT, IN A MUCOSAL SARS-COV-2 SUBUNIT VACCINE

Allyson Hirsch[1], Amy Meyer[1], Frania Ramirez Lopez[1], Jonatan Maldonado[1], Michelle Galeas-Pena[1], Nell Bond[2], John Schieffelin[2], Xuebin Qin[1, 3], James McLachlan[1], Lisa Morici[1]

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FDA-approved Covid-19 vaccines effectively reduce severe disease, hospitalization, and death from SARS-CoV-2 infections, yet breakthrough infections and virus transmission continue in vaccinated individuals. Mucosal vaccination strategies may enhance mucosal immune responses and lead to improved vaccines that prevent SARS-CoV-2 colonization of the respiratory tract.

We evaluated a SARS-CoV-2 spike subunit vaccine adjuvanted with T-vant, an outer membrane vesicle-based adjuvant, that can be delivered mucosally. We hypothesized that intranasal immunization with spike plus T-vant (S + T-vant) would lead to better mucosal immunity and protection compared to intramuscular immunization with spike adjuvanted with Alhydrogel (S + alum). K-18 hACE2 transgenic mice were administered two immunizations, three weeks apart. One month later, humoral and cellular immune responses were measured in the blood, bronchoalveolar lavage (BAL), lung, and spleen. Subsequently, immunized mice were challenged with SARS-CoV-2 WA1 to assess vaccine efficacy by determining survivability, morbidity, and weight loss.

Mice immunized intranasally with S + T-vant displayed more spike-specific IFN-g-, GrzB-, IL-4-, and IL-17-producing $CD4^+$ T cells, including tissue resident T cells, in the lung and spleen compared to all groups. Sera and BAL spike-specific IgG antibodies were significantly higher in S + T-vant-immunized mice compared to non-immunized mice but were not significantly different than S + alum immunized mice. Importantly, spike-specific IgA was significantly greater in the BAL of mice immunized with S + T-vant compared to controls. Spike-specific neutralizing antibodies were observed in the sera of S + T-vant and S +alum immunized mice. Despite enhanced mucosal immune responses, S + T-vant-immunized mice experienced increased morbidity and greater initial weight loss compared to controls despite some improvement in overall survival following challenge.

These results suggest that intranasal immunization of mice with T-vant-adjuvanted spike vaccine induced greater mucosal adaptive immune responses compared to alum-adjuvanted spike vaccines, however the protective efficacy was diminished. This may be attributed to the increased Th17 immune response in the lungs of S + T-vant-immunized mice, which has been shown to be detrimental in intranasal vaccine studies with Influenza. Our work underscores the importance of aligning requirements for effective pathogen clearance with the specific immunity elicited by adjuvanted mucosal vaccines.

Institution

Tulane University

6 - SURVEILLING THE GLOBAL CIRCULATION OF INFECTIOUS AGENTS VIA AIRCRAFT WASTEWATER

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The role of travel in spreading infectious diseases has been recognized since the bubonic plague. In 1348 during an outbreak of “Black Death” the Venetian Republic appointed three guardians of public health to quarantine ships suspected of carrying infected passengers. Nearly 700 years later the air travel networks of our globalized world enable the rapid emergence or re-emergence of infectious diseases among dispersed human populations. In the face of these challenges, wastewater from long haul flights offers an un-intrusive opportunity for public health surveillance. To consider the potential of aircraft wastewater for such surveillance we will examine applications of aircraft wastewater surveillance for SARS-CoV-2 with attention toward the strengths and limitations of the approach for surveilling the global circulation of infectious diseases.

Institution

Department of Civil & Environmental Engineering, Louisiana State University

5 - DISTINCT PULMONARY EFFECTS IN MICE EXPOSED TO E-CIGARETTE AEROSOLS CONTAINING DIFFERENT CHEMICAL FORMS OF NICOTINE

Alexandra Noel[1], Arthur Penn[1]

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Background: Fourth generation (4th-gen) electronic nicotine delivery systems (ENDS) are extremely popular among youth who vape in the United States. Little, however, is known about the pulmonary effects associated with inhaling nicotine-rich ENDS aerosols during adolescence. Methods: This study was designed to investigate how ENDS aerosols generated by devices of the third generation (3rd-gen) or 4th-gen affect lung responses in juvenile male mice, allowing for comparison of nicotine chemical forms (free base vs. salt) on respiratory health. Starting at 4 weeks of age, mice were exposed to either air, sunrise tobacco-flavored 3rd-gen ENDS aerosols (free base nicotine: 24 mg/mL), or Vuse golden tobacco-flavored 4th-gen ENDS aerosols (nicotine salt: 24 mg/mL), for 1-hr/day for 3 months. Mice were exposed to ENDS aerosols with similar particle size distributions (median size ~274 nm) and at equal concentrations. Results: Although the exposure levels were similar for 3rd- and 4th-gen ENDS aerosols (~0.4 mg/puff), the 4th-gen-exposed mice had significantly higher serum cotinine concentrations compared to 3rd-gen ENDS-exposed mice (54.2 and 25.9 ng/mL, respectively), indicating that nicotine salt has a higher rate of absorption than free base nicotine. Compared to controls, both ENDS aerosols significantly increased the lung tissues mean linear intercept values, showing an impact on lung architecture. While the lung inspiratory capacity was significantly decreased following exposure to both ENDS aerosols, the respiratory system compliance was significantly reduced, and the respiratory system elastance was significantly increased, only in the 3rd-gen exposed mice, suggesting that the use of 3rd-gen ENDS during adolescence results in restrictive pulmonary function testing phenotypes. Although 8-isoprostane, an oxidative stress biomarker, was significantly increased by both ENDS, only the 3rd-gen aerosol induced macrophagic pulmonary inflammation compared to controls. At the molecular level, a higher number of dysregulated genes related to fibrosis and extracellular matrix were observed in the 3rd-gen vs. 4th-gene exposed mice, supporting our lung structural and functional findings. Conclusions: These data show differential pulmonary effects of ENDS aerosols based on nicotine chemical forms. Since adolescence is a critical window of development affecting maximal lung capacities reached in adulthood, our results highlight that youth vaping may alter lung function trajectory.

Institution

Louisiana State University

4 - SPIKE PROTEIN VACCINE TRIGGERS SYSTEMIC TH2 AND TH17 INFLAMMATORY RESPONSES AND PULMONARY IMMUNOPATHOLOGY FOLLOWING SARS-COV-2 BREAKTHROUGH INFECTION

Tianyi Zhang[1], Nicholas Magazine[1], Michael C McGee[1], Mariano Carossino[1], Konstantin G Kousoulas[1], Avery August[2], Weishan Huang[1, 2]

[1]Louisiana State University, [2]Cornell University

Vaccines have shown remarkable protection against COVID-19, but vaccination-enhanced respiratory disease (VAERD) following breakthrough infections poses safety concerns. SARS-CoV-2 Spike (SARS-2 S) protein subunit vaccines induced VAERD in hamsters, where aluminum adjuvant primed a Th2-biased immunization, resulting in elevated type 2 pulmonary inflammation in animals with breakthrough infections. To further understand the potential risks and immunopathogenesis of VAERD, we immunized K18-hACE2 mice with SARS-2 S protein in the presence of aluminum and CpG ODN adjuvants and infected them with a lethal dose of SARS-2. The vaccine induced robust antibody and T cell responses, significantly reducing viral titers and increasing host survival. However, following breakthrough infection, vaccinated animals exhibited severe airway immunopathology, with a dramatic increase of eosinophils and $CD4^+$ T cells, and elevated Th2/Th17 cytokines in the lungs. Intracellular flow cytometric analysis showed a systemic Th2/Th17 inflammatory response, prominently in the lungs. Our data show that the aluminum/ODN adjuvants elicit strong protection against COVID-19 but prime a robust Th2/Th17 inflammatory response that may contribute to rapid onset of T cell-mediated pulmonary immunopathology following breakthrough infection. Our results highlight the need for additional studies to elucidate COVID-19-associated VAERD and to further improve vaccine formulations for broad protection and maximal safety.

Institution

Department of Pathobiological Sciences, Louisiana State University

3 - Inhalation of particulate matter containing environmentally persistent free radicals induces endothelial dysfunction via AhR activation in the air-blood interface.

Ankit Aryal[1], Ashlyn Harmon[1], Lavrent Khachatryan[1], Alexandra Noël[1], Arthur Penn[1], Stephania Cormier[1], Tammy Dugas[1]

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Particulate matter containing environmentally persistent free radicals (EPFRs) is formed by incomplete combustion of organic pollutants, resulting in the chemisorption of these pollutants to the surface of particulate matter containing redox-active transition metals. In initial studies, we exposed mice by inhalation to laboratory-generated $EPFR_{lo}$: ($1.5e^{16}$ radicals/g particles) and $EPFR_{hi}$: ($1.0e^{18}$ radicals/g) particles at 250 $\mu g/m^3$ and investigated their effects on the vascular endothelium. We observed EPFR-induced impairment in vascular relaxation that was both dose- and endothelium-dependent. We also observed aryl hydrocarbon receptor (AhR) activation in the Alveolar Type 2 (AT-2) cells that form the air-blood interface. AhR modulates a broad spectrum of biological and toxic effects. We thus hypothesized that AhR activation at the air-blood interface induces the release of systemic mediators that induce endothelium dysfunction in vessels peripheral to the lung. To address our hypothesis, we used a Cre/lox recombinase system to knock down AhR in AT-2 cells of male and female mice and exposed these mice to filtered air (FA), $EPFR_{lo,}$ or $EPFR_{hi}$ for 4h/d for one day or five days. Compared to FA-exposed mice, $EPFR_{hi}$ inhalation for 1d caused a significant increase in plasma ET-1 levels. However, EPFR-induced increases in plasma ET-1 were abolished in AT-2-specific AhR KO mice. We observed a similar AhR-dependent response in plasma sVCAM-1 levels after EPFR exposure for 5d. Moreover, impairment in endothelium-dependent vasorelaxation was abolished entirely in AT-2 cell-specific AhR KO mice exposed to $EPFR_{hi}$ and $EPFR_{lo}$. Furthermore, we found that EPFR inhalation decreased the expression of eNOS mRNA levels in the vasculature of littermate control but not AT-2 cell-specific AhR KO mice. Together, these data suggest that AhR activation in AT-2 pneumocytes at the air blood interface regulates nitric oxide signaling, and this, in turn, induces vascular endothelial dysfunction. (Support: R21 ES030062; P42 ES013648)

Institution

Louisiana State University

2 - ENVIRONMENTAL RISK ASSESSMENT OF SELECTED PHARMACEUTICALS IN HOSPITAL WASTEWATERS OF HANOI, VIETNAM

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Pharmaceuticals are considered as emerging environmental contaminants that are extensively and increasingly being used in human and veterinary medicine. This study investigated the occurrence of selected pharmaceuticals in influent and effluent wastewaters of hospital wastewater treatment plants of 13 hospitals in Hanoi and 4 northern cities of Vietnam during dry and rainy seasons. In addition, the environmental risk of pharmaceuticals in both hospital influents and effluents were assessed by risk quotients (RQs). Nine selected pharmaceutical compounds including sulfamethoxazole (SMX), naproxen (NPX), diclofenac (DCF), ibuprofen (IBU), acetaminophen (ACT), carbamazepine (CBM), iopromide (IOP), atenolol (ATN), and caffeine (CAF) were frequently detected in most influent and effluent wastewaters of 12 investigated hospitals. Levels of detected compound varied from 16 ng/L for atenolol to 25,400 ng/L for acetaminophene. Acetaminophen, caffeine, sulfamethoxazole, and iopromide were detected in highest concentrations, at significant levels in the influents and effluents. The investigation also revealed that green algae were the most sensitive species to hospital wastewaters, followed by invertebrates and fish. Among studied pharmaceuticals, sulfamethoxazole in hospital influents showed very high risk for green algae in both wet and dry seasons with RQ values were in range 153 - 234, and median risk to the invertebrate. These results are expected to provide scientific-based evidence for planning hospital waste management and environment management programs in Vietnam.

Institution

Gwangju Institute of Science and Technology (GIST)

1 - DECREASED HEARING LEVELS AT FREQUENCIES FOR UNDERSTANDING SPEECH IN TANNERY WORKERS EXPOSED TO A HIGH LEVEL OF TRIVALENT CHROMIUM IN BANGLADESH

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Hexavalent chromium [Cr(VI)], which has a strong corrosive effect, has been reported to cause perforation of the eardrum. Trivalent chromium [Cr(III)] also has a weak corrosive effect. However, there has been no study on the effects of exposure to Cr, either Cr(VI) or Cr(III), on hearing levels in animals or humans. In this study, the effect of Cr(III) exposure on hearing levels was determined in a human study. Then the reproducibility of the results obtained in the human study and the etiology were investigated in an animal study. The mean levels of total chromium (t-Cr) in hair and toenails from 100 Bangladeshi tannery workers were >20-fold and >360-fold higher, respectively, than those in hair and toenails from 49 Bangladeshi non-tannery workers (office workers). Multivariate analysis revealed decreases of hearing levels (DHLs) at 1 k and 4 k Hz, frequencies that are crucial for understanding language, but not at 8 k and 12 k Hz, in the tannery workers. Since >99.99% of t-Cr in the wastewater that the workers were in direct contact with in the tanneries was Cr(III), the epidemiological results suggest Cr(III)-mediated DHLs in the tannery workers. The results of animal experiments in this study further showed that treatment with eardrops but not intraperitoneal injection with the same amount of Cr(III) that tannery workers might be exposed to resulted in DHL with a damaged eardrum in mice. Previous studies suggested that Cr(III) can directly reach the eardrums of tannery workers via droplets in the air. Cr(III) could also reach the eardrum via picking an ear canal with a finger contaminated with tannery wastewater including Cr(III). Taken together, the results of both human and animal studies suggest the risk of DHLs caused by damage of the eardrum through external exposure to Cr(III) via the ear canal.

Institution

Nagoya University Graduate School of Medicine, Nagoya, Japan

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