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Arranged by Day and Time

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Student Poster Competition

Su-P-01

The Association between Inhibition of Maternal Acetylcholinesterase Activity and Birth Outcomes among Agricultural Farmworkers in Thailand

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Abstract: Although prenatal exposure to organophosphate (OP) and carbamate pesticides was found the association with birth outcomes, there was no report about the association between the intermediate end points such as cholinesterase activity inhibition and birth outcomes. This longitudinal study investigated acetylcholinesterase (AChE), butyrylcholinesterase (BChE) activities in maternal bloods at 3 time points: at enrolment (7-12 weeks), 32 weeks of pregnancy and delivery, and cord blood from pregnant farmworkers receiving antenatal clinic at Fang Hospital, Chiang Mai province from March 2011-February 2012. The mean±SD AChE activity (5.5±1.0 U/mL) at enrolment during a high farming activity period was significantly lower than AChE activities at 32 weeks and delivery (6.1±0.9 and 5.9±1.1 U/mL, respectively). However, no differences were observed in BChE activities in maternal blood collected at these three time points (2.6±0.5, 2.4±0.6 and 2.5±0.6 U/mL, respectively). The activity of AChE enzyme in cord blood was significantly lower than in maternal blood. Mean AChE activity from total maternal blood samples collected during high pesticide-applying season (March-April) was lower than low pesticide-applying season (July-February). Seasonal differences were not observed with BChE. We found that newborn's body weight and length gradually decreased with increasing AChE inhibition level, however, only the decrease of body length was significant ($p<0.05$). To our knowledge, this is the first study that reports the association between %inhibition of AChE which was related to pesticide exposure and birth outcomes. Furthermore, the result also demonstrates a robust trend in AChE with pesticide-applying season supporting its use as a stable biomarker of effect for long-term, acute exposures to anticholinesterase-inhibiting pesticides especially in female farmworkers. The results of this study also support the establishment of cholinesterase monitoring program for health risk assessment in prenatal clinic in Thailand.

Keywords: cholinesterase; birth outcome; pregnant farmworkers; pesticide; Thailand

Su-P-02

Differences in Asbestos Occupational Exposures between Workers of Developed and Developing Countries: The Case of Automotive Mechanics

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Abstract: Background: Asbestos containing brake and transmission products that require manipulation before installation are still common in developing countries. Few studies have analyzed exposures resulting from these manipulations. In higher income countries where manipulation processes of these products were suspended decades ago, several studies have suggested that auto-mechanics are not at excess risk of developing asbestos related diseases. Aims: Compare personal exposure to asbestos of auto mechanics working in developed and developing countries, and determine differences in work practices between both groups. Methods: Since 2010 our research group has studied exposures and working conditions of brake and transmission mechanics in Colombia. This information was complemented by a systematic review of the scientific literature to determine differences in asbestos exposure and work activities of auto mechanics between developed and developing countries. Results: Most of the studies report phase contrast microscopy (PCM) concentrations. For brake mechanics, the 8-hr TWA PCM concentrations ranged from 0.001 to 0.216f/cc in developing countries, and from 0.0001 to 0.140f/cc in developed countries. For transmission mechanics, the 8-hr TWA PCM concentrations ranged from 0.006 to 0.196f/cc in developing countries, and from 0.011 to 0.052f/cc in developed countries. Conclusions: Studies conducted in developing countries report high asbestos exposures, which in many cases are not in compliance with occupational standards. Although similar results are reported in studies conducted in developed countries many decades ago, asbestos exposures have decreased over time in these countries. Current asbestos exposures in developing countries result from the manipulation of asbestos containing auto parts, and the absence of adequate industrial hygiene controls. Asbestos controls and regulatory policies that are commonplace in developed countries need to be expanded to the developing world.

Keywords: D-occupational, C-air, asbestos, personal exposure, asbestos, personal exposure

Su-P-03

The influence of Season and Gers on Urinary1-hydroxypyrene Levels of Children in Ulaanbaatar, Mongolia

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Abstract: Objective: This study is conducted to investigate the influence of season and living environment on children's urinary 1-OHP levels in Ulaanbaatar, Mongolia. Methods: Our study subjects were 320 children aged from 11 to 15 years old living in gers, brick houses and apartments in ger and non-ger areas of Ulaanbaatar. Spot urine samples and questionnaires were collected three times for each subject in three seasons, i.e. September (warm) and December (cold) in 2011and March (moderate) in 2012. Urinary 1-OHP was analyzed by high-performance liquid chromatography with fluorescent detection (HPLC/FLD). Generalized Estimating Equation (GEE) models were applied to estimate seasonal effects on 1-OHP levels, adjusting for demographic and environmental factors. Results: Children's urinary 1-OHP levels showed significant seasonal difference with 0.30±0.57 μmol/mol creatinine in cold season, 0.14±0.12 μmol/mol creatinine in moderate season, and 0.14±0.21 μmol/mol creatinine in warm season. The GEE model showed Urinary 1-OHP levels in cold and moderate seasons were respectively 2.13 and 1.37 higher than the warm season. Urine 1-OHP levels for children living in ger areas were 1.27 higher than those living in non-ger areas. Children who lived in either gers or brick houses had respectively 1.58 and 1.34 higher 1-OHP levels compared with those living in apartments. Children's urinary 1-OHP levels were associated with either NO2 or SO2 concentrations at their home addresses in Ulaanbaatar. Conclusion: Mongolian children's urinary 1-OHP levels were significantly elevated during cold seasons, and for those living in ger areas or in ger or brick houses in Ulaanbaatar. Children's urinary 1-OHP levels were associated with fuel combustion from home heating and transportation.

Keywords: Ger, children, season, 1-hydroxypyrene, Polycyclic aromatic hydrocarbons, Ulaanbaatar, Mongolia

Su-P-04 – Withdrawn

Su-P-05

Assessing the Improvement in Predicting Personal Exposure to Elements in PM2.5 by Including Indoor PM2.5 Measurements and Home Characteristics to Outdoor PM2.5 Measurements

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Abstract: The elemental composition of PM2.5 has been associated with adverse health outcomes. Most epidemiological studies use outdoor PM2.5 concentrations at central monitoring sites as a surrogate of personal exposure. Here, it was tested if the addition of indoor PM2.5 measurements or other home and personal characteristics increased the prediction accuracy of personal PM2.5. The mass concentrations of PM2.5 and 36 elements were measured during 48-hour parallel indoor, outdoor, and personal sampling in nonsmoking households in three urban areas as part of the Relationship of Indoor, Outdoor, and Personal Air (RIOPA) study. Random forests were used to predict personal exposure for elements in PM2.5. A total of three models were developed, differing only with respect to the predictors used. Model 1 included only outdoor elemental measurements. Model 2 included both outdoor and indoor concentrations of elements in PM2.5. Model 3 included indoor and outdoor PM2.5 measurements and also home characteristics. The mean absolute prediction error percentage (MAPE%) for all models were calculated based on bootstrapped cross-validation and then were quantitatively compared. The inclusion of indoor PM2.5 measurements significantly improved the prediction of personal exposure for 17 of the 24 elements (Al, As, Ba, Ca, Cl, Fe, K, Mn, S, Sb, Se, Sn, Sr, Ti, V, Zn, Zr) compared to the model with outdoor PM2.5 data alone. For the remaining elements (Br, Cr, Cu, Ni, Pb, Si), the inclusion of indoor PM2.5 elemental concentrations did not significantly improve the prediction of personal exposure. Inclusion of home characteristics did not significantly improve the prediction of personal exposure for any of the elements. Overall, using outdoor PM2.5 data is not a perfect surrogate for personal PM2.5 exposure. For most elements, supplementing outdoor PM2.5 data with indoor PM2.5 data decreases the MAPE% for personal PM2.5 exposure while the addition of home characteristics does not.

Keywords: A-statistical methods, A-exposure models, random forest

Su-P-06

Notification of Pesticide Applications to Minimize Workplace Exposures: A Feasibility Study

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Abstract: Minimization of workplace exposure to off-target movement of agricultural pesticides during applications is a high priority issue for the Washington State Department of Health. The focus of this project was to evaluate the feasibility of a notification system activated by an orchard applying pesticides that would allow work crew supervisors in adjacent orchards to ensure that workers were not located in areas where off-target movement of pesticides might occur. In theory, users would indicate their intention to spray specific farmland and neighboring property owners would be automatically notified through simple, cost-effective smart phone or similar technology. The specific goals of this project were to: (1) interview tree fruit industry personnel responsible for pesticide applications regarding the desirability of a notification system and barriers to the implementation of such a system, (2) examine existing pesticide spray notification systems to determine their strengths and limitations, as well as their relevance to the Washington tree fruit industry, and (3) evaluate the ability of the Washington State University (WSU) Decision Aid System (DAS) to incorporate neighbor-to-neighbor spray notification. Results from 20 interviews, the framework of existing notification systems, and applicability to DAS are reported. Next steps include engaging a variety of stakeholders such as pesticide applicators, farm owners and managers, farmworker groups, research and education communities, and state agencies to determine how to best develop an agricultural spray notification system in the State of Washington.

Keywords: B-pesticides, D-occupational, Prevention

Su-P-07

The Impacts of Exposure Uncertainty on the Reported Association Between Perfluorooctanoate and Preeclampsia

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Abstract: A recent review concluded that there is a weak to moderate association between perfluorooctanoate (PFOA) exposure and the occurrence of pregnancy-induced hypertension and preeclampsia, with an increased strength of association for studies with higher confidence/accuracy exposure estimates (C8 Science Panel, 2011). This review was heavily influenced by data from cross-sectional studies of over 69,000 people who were environmentally exposed to PFOA near a major U.S. fluoropolymer production facility located in West Virginia. These studies relied on a retrospective PFOA exposure assessment, including a PFOA release assessment, integrated fate and transport modeling, and dose reconstruction to predict the annual exposure dose to each individual in the C8 Health Project from 1951 to 2008; exposure predictions were validated using 2005-2006 serum PFOA measurements (Shin et al., 2011a, b). The fate and transport model used to predict the PFOA water concentration in each of six public water districts (PWD) utilizes a number of uncertain physiochemical and hydrogeological parameters. The aim of the present study is to assess the impact of the uncertain PFOA water concentration predictions on the exposure estimates and subsequently, the epidemiological association between PFOA exposure and preeclampsia (Savitz et al., 2012). Using Monte Carlo simulation, we changed the individual PWD-PFOA water concentration for every year by randomly sampling from lognormal (uncertainty) distributions for the total PFOA release rate, the PWD-specific water concentrations, and auto-correlated annual water concentrations within each PWD using the original predicted concentrations as medians and a range of 2, 5 and 10-fold uncertainty. We find that exposure uncertainty (i.e., coefficient of variation of the log odds ranging from 11.3% to 39.2%) may contribute almost as much as the original sampling variability (47.8%) to overall uncertainty in the association between PFOA and preeclampsia.

Keywords: A-exposure models, Uncertainty Analysis, Monte Carlo simulation, Perfluorooctanoate(PFOA), Preeclampsia, Uncertainty Analysis, Monte Carlo simulation, Perfluorooctanoate(PFOA), Preeclampsia, Uncertainty Analysis, Monte Carlo simulation, Perfluorooctanoate(PFOA), Preeclampsia, Uncertainty Analysis, Monte Carlo simulation, Perfluorooctanoate(PFOA), Preeclampsia

Su-P-08

Effect of Temperature Stratification on Exposure to Non-Buoyant Gaseous Pollutants in Indoor Spaces

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Abstract: In approximately 500 indoor air quality investigations in the past decade, OSHA has found that 52% of indoor air quality problems stem from inadequate ventilation. Inadequate ventilation can be exacerbated by spatial differences in temperature as stratified layers decrease the effective mixing volume. Non-buoyant gaseous pollutants can thus collect in the breathing zone creating concentration spikes much higher than those found near the floor/ceiling. To characterize this effect, 25 controlled experiments were conducted in two indoor spaces in northern California. Cigarette smoke was passed through a smoke actuator which was then cooled to create a non-buoyant fine particulate tracer source. PM2.5 monitors less than 1m away from the source point consisted of 4 sampling points in each cardinal direction so as to account for directionality. There were a total of 10 sampling monitors and 26 sampling points for each experiment. Temperature sensors were placed slightly above and below the floor and ceiling surfaces, respectively to garnish an accurate reading of temperature stratification. Stratification strength ranged from 0 to 10°F (-18 to -12°C). Level of stratification was found to have significant impact on the vertical concentration profile, with concentration levels in the breathing range of stratified spaces reaching roughly 3 times those of unstratified indoor spaces. Vertical mixing levels quantified using the turbulent diffusion coefficient show an increase of up to 75% with a stratification decrease of 3°C. Outdoor factors such as sunlight heating were also recorded and were found to have a significant impact on vertical concentration profiles.

Keywords: A-exposure factors, A-indoor environment, C-air

Su-P-09

Prenatal Exposure to Polybrominated Diphenyl Ethers and Child Language Development

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Abstract: Background: Flame retardants polybrominated diphenyl ethers (PBDEs) can affect children's learning and memory and neurobehavior. This study investigates whether prenatal exposure to PBDEs was associated with adverse language development in children. Methods: We recruited 178 mother-child pairs in Cincinnati, OH between 2003 and 2006, measured maternal serum PBDEs levels at 16 weeks of gestation using gas chromatography/mass spectrometry and assessed children's language skills at age 5 years. We used the Woodcock-Johnson Tests of Achievement to assess children's abilities in basic reading, brief reading (reading concepts and readiness), letter-word identification (word identification skills), passage comprehension, and word attack (pronunciation of nonsense word). We measured Verbal IQ with the Wechsler Preschool and Primary Scale of Intelligence-Revised. We analyzed the association between prenatal PBDEs exposure and children's language abilities after adjusting for maternal age, race, education, household income, parity, marital status, smoking, depression, IQ, child sex, and Home Observation for Measurement of the Environment score for child rearing. Results: The maternal serum median (range) concentration was 32.50 (5.60, 2015.50) ng/g lipid for Sum4PBDEs (BDE-47, -99, -100, -153, with medians of 18.90, 4.30, 3.40, 4.20 ng/g lipid respectively). A ten-fold increase in Sum4PBDEs was associated with a -3.6 (95% confidence interval [CI]: -10.2, 3.0) point change for brief reading (composite score of word identification and passage comprehension) and a -3.3 (95% CI: -8.1, 1.5) point change of Verbal IQ at age 5 years. Of the PBDE congeners, maternal serum BDE-153 level was inversely associated with the brief reading and word attack, with an estimate of -5.2 (95% CI: -10.9, -0.5) and -5.0 (95% CI: -10.2, 0.3) for a ten-fold increase in exposure, respectively. Conclusion: Prenatal PBDEs exposure was negatively related to child language development at age 5 years.

Keywords: B-flame retardants, D-children, D-prenatal, A-epidemiology

Su-P-10

A Modeling Framework for Improved Characterization of Near-Road Exposure at Fine Scale

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Abstract: Traffic-related air pollutants could cause adverse health impact to communities near roadways. To estimate the population risk and locate "hotspots" in the near-road environment, quantifying the exposure at a fine spatial resolution is essential. A new state-of-the-art research line source dispersion model (R-LINE) provides an opportunity to improve the characterization of near-road exposure at fine scales. We modeled concentrations from on-road sources using R-LINE at census block level by using traffic activity data from the FHWA's freight analysis framework (FAF3) in conjunction with pollutant and vehicle-specific Emissions Factors from Mobile Vehicle Emission Simulator (MOVES). An approach called the Annual Stability and Wind Clustering method (ASWIC) was used to select representative meteorological conditions for which we simulated hourly concentrations with R-LINE, which were then scaled based on weights to yield annual average concentrations. We estimated background concentrations using Spatio-Temporal Ordinary Kriging (STOK) technique that uses observations from the AQS network. The total ambient concentration was then calculated by summing up the background and on-road concentrations. We applied this framework over three regions of the U.S. - Portland, Maine, North Carolina's Piedmont region, and evaluated against data from a field study in Detroit near the I-96 highway. The difference between the modeled and observed CO concentration is within a factor of two at four monitoring sites near I-96 in Detroit, MI. The modeled concentration is approximately 25% lower than the observed data within 100 meter from the road. The concentration drops by 40 to 60% after 100 meters from the road in Portland, Maine and 20 to 40% in the North Carolina Piedmont. Background concentration dominates PM2.5 and benzene in most of the areas in the North Carolina Piedmont, but on-road source contributes more than 57% of the total within 50 meters from the interstate roadways.

Keywords: C-air, Traffic air pollution, Fine scale exposure assessment

Su-P-11 - Withdrawn

Su-P-12

Characterization of Fungal Spores and Fragments Released in Various Conditions

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Abstract: Fungal particles released during growth and sporulation contain both intact spores and fragment particles which can cause various health effects in humans. It is unclear if fragment particles originate from fungal culture or from the growth material. The aim of this study was to measure the concentration of fragments and spores released from pure fungal cultures during aerosolization as well as to compare their elemental compositions. Particles from three fungal species (Aspergillus versicolor, Cladosporium cladosporioides and Penicillium brevicompactum), grown on agar and gypsum board for 1, 4 and 18 weeks were aerosolized using the Fungal Spore Source Strength Tester (FSSST) at three different air velocities (5, 16 and 27 m/s). Released spores (da > 0.8 μm) and fragments (da < 0.8 μm) were detected and counted using Optical Particle Size Spectrometer (0.3 - 10 μm) and LAS-X II (0.1 - 1 μm) respectively. The morphology and elemental composition of the particles were analyzed using a transmission electron microscope (TEM) coupled with an energy dispersive spectrometer (EDS). P. brevicompactum and A. versicolor grown on gypsum board produced the highest concentration of spores from 1 month old cultures at an air velocity of 27 m/s while 4 months old C. cladosporioides at an air velocity of 5 m/s and 1 week old P. brevicompactum at 27 m/s produced the highest concentration of fragments. When grown on agar, the highest concentration of spores and fragments were released from 1 week old P. brevicompactum at an air velocity of 27 m/s. Fragments and spores had similar elemental composition showing carbon and oxygen in abundance with minor detection of sodium, potassium, phosphorus, calcium, magnesium and silicon. Preliminary results on elemental composition of fragments and spores indicate that the fragments are of fungal origin. The amount of released fragment particles is influenced by air velocity and fungal species.

Keywords: B-microbial agents, aerosolization, elemental composition, spores, fragments

Su-P-13

A Tool to Reduce Uncertainty in Risk Characterization: Combining Bio-Accessibility of Metals in Soils from Simulated Gastrointestinal Fluids with In Vitro Cell-Based Bioassays for Toxicity

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Abstract: There has been a steady growth in our understanding of risk and concerns related to environmental and occupational toxicants. While exposure to harmful contaminants such as asbestos, lead, and other heavy metals remain of great concern, events such as 9/11 and its subsequent aftermath and human health impacts caused by the explosion debris have taught us that potential contaminants can come in many forms. Some risk assessment tools are limited in their scope, and some, like in vivo animal models are costly, time consuming, and thereby limited in their widespread use. Consequently, simulated human gastrointestinal fluids have emerged as an in-vitro surrogate that has become a well-established tool for bio-accessibility estimates and basis for in vivo bioavailability calculations. A human liver heptocellular carcinoma cell line (HepG2) will be employed to quantitatively asses risk by evaluating the relationship between bio-accessible metal exposure levels, an estimate of bioavailability, and subsequent cell uptake and cytotoxicity. In addition, a quantitative link between metal bio-accessibility extraction and analyses to in vitro toxicological response would further validate and complement results of oral bio-accessibility and bioavailability measurements via sequential extraction. The benefits of quantifying the effects of the bio-accessible fraction of soil by means of in vitro cell culture analysis include: 1) reducing costs; 2) providing a better assessment of the biological link to human exposure and response; and 3) improving risk assessment and intervention strategies. Using simulated human body fluids and human cells, instead of animal model surrogates, to evaluate the transport/transformation of heavy metals in dusts and soils should provide a clearer picture of what happens inside the human body post ingestion.

Keywords: A-risk assessment, B-metals, C-soil, D-children

Su-P-14 - Withdrawn

Su-P-15

Exposure Apportionment by Location in Ibadan, Nigeria: Measuring Personal Exposure to PM2.5

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Abstract: Background: Household air pollution (HAP) is the environmental risk factor responsible for the most life-years lost due to disability globally. Exposure to HAP while pregnant can lead to negative birth outcomes, specifically low birth weight (below 2,500g). HAP is primarily caused by burning biomass, such as wood, for cooking fuel. In addition to HAP, there are many sources of air pollution in urban areas. Objective: An ethanol cookstove intervention in Ibadan, Nigeria followed 300 pregnant women through the course of their second and third trimesters. The aim of this paper is to examine the relative exposure to household and ambient air pollution of the 150 control participants still cooking with traditional cookstoves. Methods: Each participant was outfitted with personal fine particulate matter (PM2.5), carbon monoxide (CO), and GPS monitors for 72 consecutive hours during each trimester of the study. Temporal exposure data for PM2.5 will be linked to the spatial data for each participant using Esri's ArcGIS 10.2 software. Taking the accuracy of +/=10 m into account, data points that fall within 10 m of the house's coordinates will be considered as HAP exposure. Air pollution data collected away from each subject's house can be used to create estimates of ambient air pollution levels. Results: Preliminary analysis indicates that the difference between household and non-household air pollution exposure levels can be determined using this method. Identifying pollution hot spots away from the home will shed more light on exposure patterns. The ratio of ambient to household air pollution exposure will be compared to the Global Burden of Disease (GBD) at the country, regional, and global level.

Keywords: A-cumulative exposure, A-geospatial analysis/GIS, A-indoor environment, C-air, B-particulate matter

Su-P-16

University Students' Exposure Levels to Secondhand Smoke in Various Hospitality Venues: Findings from South Korea

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Abstract: [Background] In South Korea, young adults' smoking prevalence is relatively higher than that of other age groups. Although most hospitality venues are subject to regulations mandating a complete indoor smoking ban pursuant to Article 7 of the Enforcement Rules of the National Health Promotion Act, information is limited on university students' secondhand smoke (SHS) exposure levels in hospitality venues after the implementation of the national smoking ban. This study evaluated indoor secondhand smoke levels in various venues and compared the levels with those measured inside campus buildings. [Methods] Using a portable real-time measurement instrument, Sidepak Model AM510 (TSI Inc.), we measured fine particulate matter (PM2.5) concentrations as an exposure marker of SHS. On weekdays, we performed measurements inside of campus buildings (from 12:00 to 2:00 pm) and in hospitality venues (e.g., PC game rooms, billiard rooms, and pubs) from 6:00 pm to 8:30 pm. On weekends, we performed measurement at clubs and bars, which are recognized as trendy venues among young adults. [Results] The median PM2.5 concentration was 73, 182, 63, and µg/m3 in campus buildings, billiard rooms, and pubs, respectively. The levels at clubs, nightclubs, and hookah bars were as high as 623, 138, and 250.1 µg/m3, indicating that PM2.5 concentrations were 3 to 12-times higher than the exposure guideline for outdoor particulate matter (50 µg/m3) that will be implemented on January 1, 2015 in South Korea. [Conclusion] Our study provides evidence for the introduction of more rigorous policy initiatives aimed at encouraging a complete smoking ban in venues, particularly clubs and periodic monitoring the impact of the national smoking ban.

Keywords: A-second-hand smoke

Su-P-17

Physiologically Based Pharmacokinetic Modeling of Cerium Oxide Nanoparticles by Inhalation Exposure in Rats

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Abstract: *In vitro* studies have reported toxic effects of cerium oxide nanoparticles (CeO_2 NPs) which can be used as a diesel fuel additive and released to the ambient air and then biodistribute in the body via inhalation exposure. Freshly generated CeO_2 NPs could also undergo an aging process with chemicals under sunlight, resulting in different characteristics that may influence their biodistribution. The aim of this study is to measure this biodistribution and to develop a physiologically based pharmacokinetic model of CeO_2 NPs, both fresh and aged, in rats. Our model has 10 compartments (blood, lungs, gastrointestinal tract, liver, kidneys, lungs, heart, brain, spleen, and rest of the body) interconnected via the blood circulation. Each compartment includes phagocytizing cells which may take up NPs in a saturable manner. We therefore exposed Sprague-Dawley rats by nose-only exposure to 12.9 mg/m^3 fresh CeO_2 NPs and 2.0 mg/m^3 aged CeO_2 NPs for 5 hours and measured concentrations in different organs over 14 days. In both experiments, lungs contained the highest amount of CeO_2 NPs while the amounts in other organs were three to four orders of magnitude lower. High concentrations of CeO_2 NPs were also found in feces after one day of exposure (7.3 mg/kg in the feces against 1.9 mg/kg in the lungs for aged CeO_2 NPs), but sharply decreased afterwards (0.18 mg/kg after 4 days for aged CeO_2 NPs). Without any major modifications to the model, the simulated time courses of NPs biodistribution agreed reasonably well with experimental data, yielding R^2 of 0.80 for the fresh CeO_2 NPs experiment and 0.58 for the aged CeO_2 NPs experiment. Further investigations are ongoing to study the sensitivity of the model parameters and to characterize phagocytizing cells dynamics based on *in vitro* experiments.

Keywords: A-exposure models, B-nanoparticles

Su-P-18

Development and Application of a Markov Chain Model for Predicting Influenza Exposure in Indoor Environments

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Abstract: Exposure to airborne pathogens such as influenza remains a significant threat to public health. However, influenza transmission and control in indoor environments remains poorly understood, as it is not clear which routes of transmission (fomite, inhalation, or direct spray) are dominant. The transmission risk associated with each route in indoor environments is a function of many variables, including, ventilation rates, the number of infector individuals and their cough and breath frequency, the concentration and distribution of pathogens in exhaled air, human activities, deposition, and removal by HVAC filters. To improve our knowledge of predominate pathways of influenza transmission, we developed and applied a Markov chain model to estimate the intake dose of influenza viruses in the respiratory tract and mucous membrane of 24 susceptible individuals in a 500m2 hypothetical office environment assuming one infector and 8 hours exposure time. We explore the sensitivity of intake dose to each variable using existing ranges from the literature. Most importantly, we predict the dominant infection transmission pathways by separating the portions of intake dose for each pathway. The results show the direct spray is likely the dominant transmission pathway of influenza viruses in the hypothetical office space. Therefore, human activity patterns and the number concentrations and distribution of infectious particles in exhaled breath and cough have the largest impact on influenza infection risk. The median infection risk was estimated to be ~11.5%, which interestingly, yielded an equivalent quanta generation rate in a transient Wells-Riley model of 125 per hour, which is generally in line with assumptions from the literature. Overall, the model can be used to further explore dominant pathways for influenza transmission in indoor environments under a variety of assumptions and to investigate the effectiveness of control strategies such as filtration, ventilation, and UVGI.

Keywords: A-Infectious disease, A-exposure models, A-risk assessment, transmission pathways, control strategies

Su-P-19 - Withdrawn

Su-P-20

Modeling Variability in Air Pollution-Related Health Damages from Individual Airport Emissions

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Abstract: Aircraft emissions impact human health by increasing ambient concentrations of combustion-related air pollutants. Determining contributions of aircraft and other airport sources to pollutant exposures and related health risks is challenging due to complex aircraft exhaust dynamics and existing background concentrations from other sources. "One atmosphere" chemistry-transport models capture all relevant aspects of emitted pollutant fate and transport, but extracting the influence of many individual sources and their emitted pollutants is infeasible using standard model implementation. The goal of this study is to model regional concentrations of PM2.5 and ozone attributable to emissions of precursor species from numerous individual airports, to develop airport-specific intake fraction estimates and health damage functions per ton of emitted species, and to develop regression models to explain variability in these functions to allow for extrapolation to unmodeled airports. A subset of airports from across the United States were selected, including the largest airports as characterized by annual fuel burn, at least one airport from each state, and other selected airports. We applied the Community Multiscale Air Quality model (CMAQ) using the direct decoupled method (DDM) - a sophisticated sensitivity analysis technique to isolate O3 and PM2.5 related contributions from individual airport-related precursor pollutants in a computationally efficient manner. We linked airport-specific and pollutant-specific concentration estimates with population data and literature-based concentration-response functions to create health damage functions for mortality and morbidity per ton of emissions for both PM2.5 and ozone precursors. These emissions-normalized airport-specific functions were well explained by regional population patterns and meteorological conditions, indicating the viability of developing rapid exposure and health risk estimates for policy analyses.

Keywords: A-exposure models, A-risk assessment, B-particulate matter, C-air

Su-P-21

PAHs Exposure Assessment for Community Elderly (PEACE) Through Personal Particulate Sampling and Urinary Biomonitoring in Tianjin, China

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Abstract: Elderly expouse levels to polycyclic aromatic hydrocarbons (PAHs) has been analyzed through personal particulate sampling and urinary biomonitoring in summer and winter of 2011 in Tianjin, China. 101 subjects from two adjacent communities were recruited in this present study. Personal particulate samples were collected continuously from the subjects for 24 h, while first morning urine samples of elderly were collected when particulate measurements finished. In personal particulate samples, 18 PAHs were measured, and in urine samples 12 mono-hydroxylated metabolites (OH-PAHs) from 5 parent PAHs (naphthalene, fluorene, phenanthrene, pyrene and chrysene) were analyzed. The exposure levels of elderly population were much higher than other countries, while in winter were even higher than some occupationally exposed population reports, suggesting serious health risks exist in cold season. Comparison of personal particulate sampling and urinary biomonitoring results suggests that inhalation is the major route for NaP exposure, whereas ingestion may be a more important route for 3-ringed or larger PAHs. The correlation between 1-OHP and other metabolites support the use of 1-OHP as a useful surrogate representing total PAH exposure.

Keywords: A-biomonitoring, B-particulate matter, D-community, A-risk assessment

Su-P-22

Using Community-Based Participatory Research (CBPR) to Identify Areas of Concern Regarding Neighborhood Children's Exposures to Air Pollution Using Tree Leaves as Biomonitors

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Abstract: Background: Disproportionate exposure to air pollution leads to environmental justice concerns in urban areas, and existing regulatory monitoring networks may insufficiently identify intra-neighborhood variability. CBPR provides knowledge needed to explore any disparities in intra-neighborhood air pollution exposures; using it to engage neighborhood youth in sample collection and analysis using a novel method of tree leaves as biomonitors, they have an opportunity to experience research related to air pollution exposures. Aims: We partnered with a community organization to 1) identify neighborhood-perceived areas of concern related to children's exposures to outdoor air pollution, 2) validate a method of obtaining spatially-resolved, intra-neighborhood air pollution measurements using tree leaves and 3) educate youth and involve them in a novel monitoring technique. Methods:Areas of concern-where children are most likely to spend time outdoors-were identified by Homewood Children's Village (HCV), Pittsburgh, PA. Sampling locations (n=22) near areas of concern were chosen based on proximity of candidate trees and telephone poles to hang air monitors. Neighborhood youth assisted with air monitor deployment and collection of leaf samples, and will be assisting with leaf sample analysis. Results: Neighborhood youth were educated on health effects of air pollution and air pollution monitoring techniques. They will participate in leaf sample analysis and dissemination of results to HCV. Conclusion: Utilizing knowledge unique to this neighborhood was instrumental in identifying perceived air pollution areas of concern related to where children spend time outdoors. Analysis is ongoing to characterize intra-neighborhood air pollution-related exposures. This study increased youth awareness about local air quality and related health effects. Results will be used to inform a multi-level intervention to address childhood asthma challenges in the neighborhood of Homewood.

Keywords: D-community, A-biomonitoring, B-particulate matter, C-air

Su-P-23 - Withdrawn

Su-P-24

Indoor-Outdoor Relationships and Source Apportionment of Fine Particulate Matter (PM2.5) in Retirement Communities of the Los Angeles Basin

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Abstract: Concurrent indoor and outdoor measurements of PM2.5 were conducted at three retirement homes in the Los Angeles Basin during two separate seasons between 2005 and 2006. Indoor-to-outdoor (I/O) mass ratios and correlation coefficients of PM2.5 chemical constituents were calculated to determine the influence of outdoor and indoor sources on PM2.5 levels inside the retirement homes. Elemental carbon (EC), a tracer of diesel emissions, displayed very high I/O ratios accompanied by strong I/O correlations, indicating the significant impact of outdoor sources on indoor levels of EC. Likewise, indoor concentrations of metals and trace elements were found to be significantly affected by outdoor sources. Indoor levels of PAHs, hopanes and steranes were generally strongly correlated with their outdoor components and displayed I/O ratios close to unity. On the other hand, concentrations of n-alkanes and organic acids inside the retirement communities were dominated by indoor sources, as indicated by their I/O ratios, which exceeded unity. Source apportionment analysis, which was conducted by means of a molecular-marker chemical mass balance model, revealed that vehicular sources were the major contributor to both indoor and outdoor PM2.5, respectively accounting for 39 and 46% of total mass. Moreover, the contribution of vehicular sources to indoor levels was generally comparable to their corresponding outdoor estimates, illustrating the strong influence of these sources on indoor PM2.5. "Other water-insoluble organic matter", which accounts for the emissions from uncharacterized primary biogenic sources, displayed a wide range of contribution from 2 to 73% of PM2.5, across all sites. Lastly, higher indoor than outdoor contribution of "other water-soluble organic matter" was evident at some of the sites, suggesting the production of secondary aerosols as well as emissions from primary sources, including cleaning or other consumer products, at indoor environments.

Keywords: A-indoor environment, B-metals, B-particulate matter, Source apportionment

Su-P-25

A Novel Transportable Neutron Activation Analysis System to Quantify Manganese in Bone *In vivo*: System Setup and Validation

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Abstract: Overexposure to manganese (Mn) can lead to various neurological disorders including "manganism", a devastating neurological disorder with symptoms closely resembling Parkinson's disease. The progressive and irreversible characteristics of chronic Mn neurotoxicity make early diagnosis of body Mn burden an urgent issue. Data in literature have suggested that the amount of Mn in bone accounts for ~40% of total body burden and the half-life of Mn in bone is much longer than other organs. We hypothesize that bone Mn (MnBn) may serve as a valuable biomarker for long-term cumulative Mn exposure. To test this hypothesis, we have constructed a neutron activation analysis system and validated its usefulness for non-invasive quantification of MnBn. Thermal neutrons have a high cross section to interact with ^{55}Mn; the resulting 847 keV characteristic γ-rays can then be captured. By measuring the 847 keV γ counts from the irradiated bone, MnBn concentration can be calculated. Our lab has a DD neutron generator with a flux up to $3 * 10^9$ neutrons/sec. Optimized settings including moderator, reflector, shielding and their thicknesses were selected based on MCNP5 simulations. Hand phantoms with different Mn concentrations were irradiated using the optimized DD neutron generator irradiation system. The Mn characteristic γ-rays were collected by a HPGe detector system with 100% relative efficiency. Calibration line between μg Mn/g dry bone (ppm) and Mn/calcium (Ca) counts ratio was obtained, which showed a significant linear relationship. The detection limit was calculated to be about 0.85 ppm with an irradiation dose of 50 mSv to the hand. The whole body effective dose was about 31 μSv. The current effort is devoted to reduce the detection limit to 0.6 ppm with a combination of two 100% HPGe detectors. Given the average normal MnBn concentration of 1 ppm in general population, this system is promising in MnBn quantification in humans.

Keywords: A-biomarkers, A-cumulative exposure, B-metals, D-occupational

Su-P-26
Urinary Biomarkers of Household Air Pollution: Findings from Nepal
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Abstract: Background: Approximately 50% of the global population relies upon biomass fuels (wood, charcoal, crop residue, dung) for cooking and/or heating purposes. Household air pollution (HAP) resulting from the use of these solid fuels is of particular concern, given the range of known adverse human health outcomes resulting in an estimated 4 million deaths annually. While a vast majority of epidemiological studies have relied exclusively on questionnaire as well as environmental monitoring for the quantification of HAP exposure, a more robust exposure assessment method, such as biomarker based approaches are needed to quantify the individual level measure of exposures. Objective: To evaluate urinary metabolites of 1,3 butadiene as a biomarker of exposure to HAP in Nepal. Methods: We analyzed urine samples from 606 cytologically/histologically confirmed lung cancer cases and 606 age and gender matched controls collected from B.P. Koirala Memorial Cancer Hospital between 2009 and 2012, using liquid chromatography tandem mass spectrometry (LC-MS/MS) based methods. The urinary metabolite of 1.3 butadiene (monohydroxybutyl mercapturic acid or MHBMA) was detected in multiple reaction monitoring (MRM) mode and quantified using isotope labeled internal standard (MHBMA-d6). We used multiple linear regression to quantify the relationship between questionnaire based measure of exposure to HAP and the urinary metabolites of 1,3 butadiene adjusting for known confounders (age, ethnicity, tobacco use, SES status, and geographic residence). Results/Conclusion: LC-MS/MS analysis is being currently conducted to quantify the level of MHBMA in urine samples. Our results will show the usefulness of MHBMA as a biomarker of exposure to HAP in large scale studies. This study is the first of its kind investigating biomarkers of HAP focusing on a population in Nepal.

Keywords: A-biomarkers, A-indoor environment, A-global health

Su-P-27
Comparison of Traffic-Related Ultrafine Particle Number Concentrations on Roads and at Nearby Residential Locations in Boston, Massachusetts (USA)
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Abstract: Background: Exposure to traffic-related ultrafine particles (UFP; <100 nm diameter) may be associated with cardiovascular disease. Epidemiologic studies often use mobile monitors and stationary fixed sites to characterize UFP. Relatively little work has been done to compare UFP concentrations on roadways to nearby residential sites and to determine how the difference could impact individual exposure estimates. Aims: The aim of this work was to monitor particle number concentration (PNC; a proxy for UFP) on roads and at nearby residential locations in an effort to generate individual estimates of exposure for the Puerto Rican Health Study in Boston. Methods: A study area covering ~45 km2 was selected based on residences of the cohort. Between May 2012 and November 2013 PNC was measured by mobile monitoring along the same route on 59 days (2-4 hours per day), and during this same period PNC was measured immediately outside of 14 participant homes continuously for six weeks per residence. Results: Median on-road PNC was up to 2-fold higher than PNC measured immediately outside participant homes <100 m from roads. Ambient PNC in residential areas within 100 m of major roads (>20,000 vehicles/day) were higher than residential areas >100 m from major roads (25,000 particles/cm3 versus 20,000 particles/cm3). A slight exponential decrease in mean annual PNC occurred with increasing distance from major roads. PNC within 50 m of major roads were ~45% higher than areas 400-800 m from major roads. Median annual PNC varied significantly between seasons with the highest median concentration in winter (37,000 particles/cm3) and the lowest in summer (18,000 particles/cm3). Conclusions: Residential areas closest to major roadways have the highest ambient PNC levels as compared to those further away, but are still at levels up to 2-fold lower than those measured on the road. These results could have implications for reducing exposure misclassification in epidemiological studies.

Keywords: B-particulate matter, C-air, A-epidemiology, A-exposure models

Su-P-28 – Withdrawn

Su-P-29

The Influence of Temperature, Ventilation and Humidity on the Fate and Transport of Indoor Phthalates: A Case Study

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Abstract: INTRODUCTION: Indoor environments contain a wide range of products that can emit a variety of pollutants. Among these chemicals, phthalate esters are particularly important, because they are used extensively as additives in consumer products and are associated with serious health concerns. As semi-volatile organic compounds (SVOCs), they partition strongly to all interior surfaces, including airborne particles, dust, and skin. The objectives of this field study are to: 1) examine equilibrium partitioning of phthalates (benzyl butyl phthalate [BBzP] and di-2-ethylhexyl phthalate [DEHP]) among indoor compartments, including air, dust, and various interior surfaces; 2) evaluate kinetic constraints on the sorptive partitioning; and 3) determine the influence of temperature and ventilation on emission, partition, and sorption kinetics of BBzP and DEHP. Field measurements were conducted in a residential test house (UTestHouse) located at Austin, Texas. This study suggests that temperature and ventilation have important influence on the concentrations of phthalates in indoor environments. The results enable environmental intervention designs to reduce indoor exposures by developing a clear understanding of the factors that govern emissions and sorption of phthalates and their indoor fate and transport.

Keywords: Emission, Adsorption kinetics, Temperature, Ventilation, Phthalates, Field measurements

Su-P-30

Calibration and Improvements of a Portable XRF Technology to Quantify Lead in Bone In vivo

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Abstract: Lead is a ubiquitous toxin, which has been shown to have adverse health effects on many systems in the body. Bone serves as a valuable biomarker for long-term lead exposure. With recent advancements in portable XRF technology and calibration methods, we have developed a system to measure lead in bone in vivo. The main goals in this study were to improve the sensitivity of the system, determine the best calibration method, and validate the system for in vivo measurement. We investigated four calibration methods, namely background subtraction, bone calibration, bone adjustment calibration, and traditional peak fitting. System calibration is important, as with larger soft tissue thickness the detected lead x-ray signals can be low and difficult to quantify. The device was calibrated using phantoms of known lead concentrations for background subtraction and traditional peak fitting methods, bone of known lead concentrations for bone calibration method, and bone and phantom comparisons for bone adjustment method. Using these calibration methods we measured the bare cadaver bone and goat bone samples with Lucite used to replicate soft tissue, and cadaver bone with and without intact soft tissue. There was strong correlation between the K x-ray fluorescence (KXRF) and portable XRF bone lead results for bare cadaver and goat bones. There was also strong correlation between KXRF and portable XRF results for goat bone with Lucite, however, the results for cadaver bone with Lucite did not show the same correlation. As a final assessment the device was used on cadaver bone with intact soft tissue, and the results of these experiments showed a good correlation with previous KXRF data. Our results suggest that the portable XRF bone lead measurement has a detection limit of 3.4 ppm with 2 mm soft tissue thickness, the best calibration method for use with in vivo data is the background subtraction method, and that the technology needs to be validated in a larger human population.

Keywords: A-risk assessment, A-epidemiology, A-biomarkers, A-biomonitoring

Su-P-31

Residential Indoor and Personal PM10 Exposure of Ambient Origin Based on Chemical Components

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Abstract: Lots of studies have focused on the relationships of particulate matter between indoor, outdoor and personal exposure; there still remain considerable uncertainties about the portion of indoor particles and personal exposure of ambient origin. As part of the Particle Exposure Assessment for Community Elderly (PEACE) study in Tianjin, China, we have further interpreted the relationships between personal, residential indoor, outdoor and community PM10. Comparisons of the chemical composition of PM10 samples were performed using the coefficient of divergence (COD). A robust regression method, least-trimmed squared (LTS) regression, was used to estimate the infiltration factors of PM10 from residential outdoor to indoor environments, based on particle component concentrations. Personal exposures of ambient origin were also estimated. A relatively good correspondence of chemical composition was found between personal and indoor PM10 samples. The infiltration factors (Finf) of residential indoor-outdoor PM10 were 0.74±0.31 (mean±SD) in summer and 0.44±0.22 in winter, with medians of 0.98 and 0.48, respectively. Residential outdoor contributions to indoor environments were 87±55 µg m-3 in summer and 80±54 µg m-3 in winter, with medians of 75 and 61 µg m-3, respectively. The personal exposures of ambient origin were 92±44 µg m-3 in summer and 89±47 µg m-3 in winter, with medians of 81 and 80 µg m-3, respectively. This study indicated that infiltrations in an urbanized area in North China had seasonal difference that residential outdoor contributions to residential indoor environments were larger in summer due to more natural ventilations. The personal exposures of ambient origin were comparable during different seasons, while those of non-ambient origin were higher in summer than in winter.

Keywords: A-cumulative exposure, A-indoor environment, D-community, ambient contribution

Su-P-32

Modeling the Impact of Deep Energy Retrofits on Indoor Air Quality in Low-Income Multi-Family Housing

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Abstract: Elevated rates of asthma morbidity among low-income urban children may be related in part to exposure to indoor pollutants, such as PM2.5, NO2, and allergens. Retrofits implemented to reduce energy consumption can affect indoor air quality by modifying airflow patterns, ventilation, and pollution source characteristics. These impacts are challenging to quantify in multi-family housing given complex airflow dynamics as well as variable and uncertain pollution source characteristics and resident behavior. Simulation modeling can be a useful tool to study these interactions. In this study, we simulated the indoor environmental conditions of a low-income housing complex in Boston, MA that underwent a deep energy retrofit targeting a 70% reduction in energy consumption. We modeled low-rise and mid-rise buildings using CONTAM, a multi-zone airflow and contaminant transport analysis program developed by the National Institute of Standards and Technology. Detailed architectural and mechanical plans were used to assign building design characteristics and ventilation patterns. Occupant activity variables (e.g., cooking frequency, window opening, and smoking) were based on population-specific information collected from a self-administered resident survey on pre- and post-retrofit conditions. Leakiness levels were based on building conditions before and after retrofits, and results from blower door tests were used to validate modeled ventilation rates. Pollutant emission rates were parameterized using published literature values, and were evaluated with monitoring data from a concurrent field study in the same building complex. We ran CONTAM across multiple occupant and building conditions using a factorial design, and constructed regression models to explain variability in indoor humidity, PM2.5, and NO2. Our study characterized the key drivers for indoor pollutant concentrations in pre- and post-retrofit conditions of a multi-family apartment complex in Boston.

Keywords: A-built environment, A-exposure models, C-air, A-indoor environment, D-susceptible

Su-P-33
Spatial Toxicology: In vitro Inflammatory Assessment of Intra-urban Spatially Varying Particulate Matter

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Abstract: Ambient fine particulate matter(PM2.5) concentrations have been associated with various health outcomes related to respiratory and cardiovascular inflammation.PM2.5 varies spatially in both concentration and composition in intra-urban environments due in part to variation in sources. Determining the impact of spatially varying PM2.5 on inflammatory responses may identify causal constituents and sources most relevant to PM2.5-associated health effects. Cell lines allow for an in vitro assessment of variation in inflammatory responses related to intra-urban spatially varying PM2.5 . PM2.5 samples were collected at intra-urban locations(n=5) with previously observed contrasts in PM2.5 composition and concentration's-located samples were used for ambient characterization or extracted and re-suspended in a set volume of Dulbecco's Modified Eagle Medium(DMEM) for inflammatory research. Mouse alveolar macrophage cells(AMJ2-C11) were treated with extracted PM2.5 samples from each location for 3, 24 or 48h.Total macrophage cell counts and IL-6 levels were measured for all treatment and controls to assess inflammation. Characterization of ambient PM2.5 confirmed differences in concentration as well as composition(metals and organic constituents) across an intra-urban environment. Inflammatory research indicated a positive association between total macrophage counts and time points in all treatments and controls. IL-6 differences are hypothesized to be both time and location dependent. Spatial differences in PM2.5 are apparent in concentration and composition in an intra-urban environment and these differences are reflected in inflammatory marker variation. Researching inflammatory makers aside from IL-6 will elucidate pathways activated following exposure to PM2.5.Developing large-scale in vitro and in vivo studies that address the impact spatially varying PM2.5 has on inflammation can help identify suites of causal components that are key to PM2.5 -associated health effects.

Keywords: B-particulate matter, A-sampling methods

Su-P-34
Comparing Approaches for Summarizing Exposure to Multiple, Correlated Pollutants and Resulting Risk Estimates

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Abstract: In air pollution epidemiology, researchers often encounter the issue of having to analyze the effect of multiple correlated co-exposures. Approaches regularly seen in the literature include adding co-exposures to the model with main exposure of interest, treating them as simple confounders; using dimension reduction methods, such as Principal Component Analysis, whose weight vectors can lack interpretability; and exploiting the correlation structure among the pollutants to aggregate them into clusters. In addition to the above approaches, we explored an alternative machine-learning method, supervised clustering, which incorporates outcome information directly into the dimension reduction process. Supervised clustering is a machine-learning method that analyzes the data to produce small, potentially overlapping clusters that best predict risk. We applied this approach to a breast cancer risk analysis of 112,379 female teachers in California exposed to a set of 24 mammary gland carcinogens. There were 5,361 cases of invasive breast cancer diagnosed in the study population between 1996 and 2010. The Spearman correlation coefficient among these 24 compounds ranged between 0.96 and -0.86. Supervised clustering identified four sets of clusters composed of six overlapping compounds. These clusters were then used in the risk analysis of breast cancer. The resulting risk estimates were different from, but complementary to, the estimates provided by traditional methods. This exercise demonstrates that supervised clustering can be a useful tool in air pollution studies examining the effects of multiple, correlated pollutant exposures.

Keywords: A-analytical methods, A-epidemiology, C-air, A-aggregate exposure

Su-P-35

Microbial and Inorganic Contamination in Private Wells along the Santa Cruz River, Arizona

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Abstract: Previous studies have shown that the Santa Cruz River downstream of a wastewater treatment plant that serves both the U.S and Mexico has levels of several microbial and chemical contaminants that are of public health concern. The goal of this study was to investigate the quality of drinking water from private wells within 1-mile of the Santa Cruz River, and to determine whether there were differences in microbial and chemical concentrations between dry and wet seasons. Samples (22 in each season) were collected during a dry season (June 20th-July 9th 2013) and a wet season (July 29th-August 7th) in 1 liter propylene bottles and analyzed for total coliforms, Escherichia coli, arsenic, cadmium, chromium, copper, lead, mercury, and nitrate. Arsenic was above the Environmental Protection Agency's Maximum Contaminant Level (MCL) in 6/22 wells, and 5/22 wells during the dry and wet season, respectively. In the dry season, nitrate was in exceedance of the MCL in 8/22 wells, and in 6/22 wells in the wet season. During the dry season, total coliforms were detected in 19/22 wells with a median concentration of 67 Colony Forming Units (CFU)/100ml, and no E. coli detected. However, in the wet season, total coliforms were detected in 18/22 wells with a median concentration of 211 CFU/100ml, and E.coli was detected in 9/22 wells with a range of 1 to 25 CFU/100ml for detectable samples. Cadmium (p-value=0.048) and chromium concentrations (p-value<0.0001) were significantly higher in the dry season. Drinking water from these wells may result in exposure to E.coli, nitrate and arsenic exceeding municipal drinking water standards. Interventions are needed to ensure well users get their water tested on a regular basis, and be made aware of the possible health effects resulting from exposure to these contaminants.

Keywords: B-microbial agents, C-water, B-metals, A-environmental justice, D-community

Su-P-36

Assessment of Ambient air formaldehyde impact on the respiratory system

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Abstract: Background/Aims: To derive the dependency between respiratory diseases morbidity increase among children aged 4-7 years and chronic inhalation exposure of ambient air formaldehyde. Methods: We examined 92 children aged 4-7 years who were chronically exposed to environmental air formaldehyde. The Monitoring Group - 94 children aged 4-7 years with environmental air formaldehyde chronic inhalation level less than 0.003 mg/m3. For exposure assessment the results of instrumental and calculating ambient air quality data conjugation were used. Incidence estimation was carried out by using children medical aid appealability and primary medical records. Diseases of the respiratory system (Chapter X of ICD-10) were chosen as a response to formaldehyde exposure in accordance with the health risk assessment methodology. Results: A significant cause-effect relation between ambient air formaldehyde inhalation exposure and respiratory diseases (OR=1.14; 95%CI 1.02-1.27), including tonsillar hypertrophy (OR = 15.76; 95%CI 8.2-27.2), acute laryngitis and tracheitis (OR = 14.99; 95%CI 7.8-25.9), acute nasopharyngitis (OR = 1.20; 95%CI 1.03-1.27) were determined. Conclusion: Chronic ambient air formaldehyde exposure exceeding the concentration of 0.003 mg/m3 causes significant increase of respiratory diseases proved by critical organs and systems.

Keywords: A-ecological exposure, C-air, D-children

Su-P-37

Evaluation of the association between urinary 3-phenoxybenzoic acid levels and self-perceived depression symptoms among the rural elderly population in Asan, South Korea

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Abstract: [Background] Recently, a large number of studies reported an increase in the incidence or prevalence of depression among the aged population in South Korea as well as other countries. Several studies have also reported that the occurrence of depression among the rural population is associated with exposure to environmental risk factors such as pesticides. This study aimed to evaluate the association of self-perceived depression symptoms with exposure to insecticides using 3-phenoxybenzoic acid (3-PBA) as a biomarker after controlling for socioeconomic confounding factors among persons aged 60 years and older in rural areas of

South Korea. [Methods] Under a cross-sectional study design, the participants of this study (161 men and 239 women) were randomly recruited from rural areas of Asan. Exposure to environmental risk factors was assessed using a questionnaire and analysis of 3-PBA levels in urine. Logistic regression analysis was used to assess the association between pesticide exposure and self-perceived depression symptoms. [Results] The adjusted odds ratio for self-perceived symptoms of depression was higher in women with considerable farming experience (10 years or longer) than that in those with little (3 years or fewer) or no farming experience. Our study showed that among female participants, the unit increase in 3-PBA levels was likely positively associated (OR: 1.13 95% CI: 1.01-1.26) with an increased risk of depression after adjusting for socioeconomic confounding factors including insurance type, daily physical condition, marital status, and age. [Conclusion] Further studies, including an intervention study, are needed to elucidate the association of exposure level to pesticide and degree of depression symptoms

Keywords: B-pesticides

Su-P-38
Associations between Airborne Concentrations of Black Carbon and Fine Particulate Matter (PM2.5) in Urban Hotspots of South Korea

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Abstract: Black carbon (BC) is an important constituent of fine particulate matter (PM2.5) because of its known effects on human health. In this study, we present the BC and corresponding PM2.5 concentrations measured in urban hotspots of South Korea. PM2.5 and BC concentrations were measured using the SidePak AM510 Personal Aerosol Monitor (TSI Inc., St. Paul, MN) and MicroAeth Model AE51 (Magee Scientific, Berkeley, CA). We conducted our measurements between 8:00 a.m. and 10:00 a.m., and between 6:00 p.m. and 8:00 p.m. to capture the morning and afternoon distributions of the pollutants during the daily rush-hour period at hotspots, including bus terminals and roadside curbs, in Seoul and other satellite cities of Seoul in summer 2013. The median concentrations of PM2.5 and BC ranged from 6.3 to 15.6 µg/m3 and from 1.9 to 8.5 µg/m3, respectively. The BC concentration accounts for 20% to 70% of the PM2.5 concentrations. The overall correlation coefficient between the PM2.5 and BC concentrations was 0.63 (p < 0.001), ranging from 0.32 to 0.72 (p < 0.001) depending on the sampling site.

Keywords: B-particulate matter

Su-P-39
Evaluation of Fine Particulate Matter (PM2.5) Concentrations Measured by a Portable Nephelometer in Comparison with the Federal Reference Method Using a Filter Measuring System in the National Urban Air-Quality Monitoring Site of Seoul, South Korea

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Abstract: [Background] Epidemiological studies have recently shown that exposure to fine particulate matter (PM2.5) is associated with adverse short- and long-term respiratory and cardiovascular health effects. For better understanding of individual exposure level to PM2.5, portable monitors have been used to measure PM2.5 concentrations. However, the lack of validation of the usefulness of portable monitors limits its applicability. This study investigated the association between PM2.5 concentrations estimated by a portable monitor and those measured by the federal reference method (FRM) in the national urban air-quality monitoring site of Seoul, South Korea. [Methods] We used the SidePak AM510 Personal Aerosol Monitor (TSI Inc., St. Paul, MN) as our portable monitor for measuring PM2.5 concentrations and compared the values obtained with the FRM equipped with a filter measurements system in the national urban air-quality monitoring site of Seoul. Measurements were conducted every other day in the winter and spring seasons of 2014. [Results] The PM2.5 daily mean concentrations estimated using SidePak ranged from 13.4 to 161.9 µg/m3. The Spearman correlation coefficient was 0.99, and the correction factor suggested was 0.55±0.09. Adjusted SidePak data with the correction factor showed good agreement with the reference values obtained using the FRM.

Keywords: B-particulate matter

Su-P-40 - Withdrawn

Su-P-41 - Withdrawn

Su-P-42
Development of a New Online Method for Measurements of Reactive Oxygen Species Associated with PM$_{2.5}$

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Abstract: Reactive oxygen species is routinely used as a reporter to assess a measure of toxicity from particulate exposure. While this technique has been embraced by a number of investigators, the relative complexity of these approaches, and the variety of different methods employed, has further complicated our understanding of the relevance of ROS assays. A Particle into Liquid Sampler was coupled to a custom-built flow-through optical chamber to support in situ, semi continuous measurements of ambient or laboratory generated ROS. BEAS-2B pulmonary epithelial cells were cultured and loaded with 2', 7'-dichloroflouroscein-diacetate in phosphate buffer solution, and then dosed with media-based aliquots of water soluble particulate matter. This work has shown that repeatable fluorescence measurements are possible in the context of an online instrument, across a number of laboratory-generated standards including metals, salts, and acids. Hydrogen peroxide, as a positive control, induced fluorescence initiated at a much faster rate than dissolved particles (including particles thought to be highly toxic), suggesting that the ROS formation mechanism is likely different. Cell death, and perhaps upregulation of ROS induction, appear to be a concern in this assay, and studies are currently under way to optimize dosing strategies. Data from field deployments will also be presented.

Keywords: A-chemical prioritization, A-analytical methods, B-metals, B-particulate matter

Su-P-43 - Withdrawn

Su-P-44
Comparison of Free and Total Malondialdehyde as a Biomarker of Oxidative Stress

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Abstract: Malondialdehyde (MDA) is generated as a product of lipid peroxidation caused by reactive oxygen species (ROS). MDA has been long recognized as a biomarker of oxidative stress; but controversies remain as to whether MDA can accurately reflect ROS activity. One of the reasons for this stems from its analytical methods. Due to its reactivity, MDA can react with other constituents (e.g., proteins) of the biological media, However, few studies have considered the confounding effect of protein on MDA concentrations. In our preliminary study, we analyzed both "free" MDA and total MDA (the sum of free MDA and MDA-protein adducts) concentrations in bronchoalveolar lavage fluid (BALF) of Brown-Norway rats exposed to polyvinylpyrrolidone and citrate coated silver nanoparticles. On the first day after exposure, the exposure groups were higher than the control group in both total MDA and free MDA: mean percentage changes comparing the exposure group to the control group ranged from 106% to 148% for total MDA and 86% to 355% for free MDA. On the seventh day after exposure, while the mean concentrations of total MDA for the exposure group were still higher than those for the control group (by 92% to 227%), free MDA concentrations were similar for both groups. This was concurrent with a remarkably low level of protein in the control group. It is possible that with low level of protein, little fraction of the free MDA in BALF of the control group was sequestered, thus leaving the level of free MDA 'abnormally' high compared to the exposure groups. The findings support the hypothesis that concentrations of free MDA in biological media are affected by protein concentrations. Additional comparisons of free versus total MDA are under way using other biological specimens (serum and urine). We expect that in biological media where proteins are present, the concentration of total MDA is a more appropriate biomarker than free MDA in reflecting lipid damage caused by oxidative stress.

Keywords: A-biomarkers, B-nanoparticles

Su-P-45 - Withdrawn

Su-P-46 - Withdrawn

Su-P-47

Granular Activated Carbon Filtration Influence on Metal and Persistent Organic Pesticide Levels in Girls in the Greater Cincinnati OH Area

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Abstract: Background: Granular activated carbon (GAC) is a treatment technology that is effective at removing many organic compounds from drinking water. The Greater Cincinnati area is a natural laboratory for testing the efficacy of GAC, since until 2012 two water providers used the same source water, but one did not use GAC. We have previously reported on the efficacy of GAC in removing perfluoroalkyl compounds. Methods: Metals and persistent organic pesticides were measured in the urine and blood, respectively of 357 and 312 girls from the Cincinnati site of the Breast Cancer and the Environment Research Program Puberty Study. Differences in mean metal and pesticide levels and water source, breastfeeding duration, bottled water use, parity and provider education were assessed using ANCOVA analysis for strontium, manganese, tin, molybdenum, hexachlorobenzene, oxychlordane, PP-DDT and trans-nonachlor. Results: No significant differences were found between water providers for any metals or PP-DDT. Hexachlorobenzene levels were significantly lower with increasing time with a water provider who used GAC. Levels of oxychlordane were lower in girls who did not get their water from the Ohio River at sample; there was no difference between utilities that used GAC and those who did not. Levels of trans-nonachlor were significantly higher in girls where the water source was Ohio River and the water provider did not use GAC, compared to those where the water provider did. There were significant associations with duration of breast feeding for all four pesticides. Conclusions: There may be differences in persistent organic pesticide exposure in the Greater Cincinnati area, depending on drinking water source and treatment train technology. Funding from NIH, U01-ES12771, P30-ES006096, T32-ES10957

Keywords: A-biomarkers, C-water, D-children, A-exposure factors

Su-P-48

Exploring the Influence of Household and Housing Characteristics on Transport of Agricultural Pesticides into Farmworkers' Homes

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Abstract: Agricultural pesticides can enter farmworkers' homes via track-in on shoes, clothes, and skin, along with air-infiltration from pesticide spray drift and wind-resuspension of contaminated soil particles from nearby fields. Using predictive analysis techniques, we explored which household and housing characteristics were most strongly associated with agricultural pesticide levels in farmworkers' homes and whether they are more indicative of the track-in or air-infiltration pathway of pesticides into the home. Surveys that included household and housing characteristics questions were administered to 21 farmworker families in Yuma County, Arizona, an agricultural community along the U.S.-Mexico border, and soil, outdoor air, and household dust were collected from each home. Samples were analyzed for the following pesticides: bifenthrin, endosulfan, permethrin, pronamide, trifluralin, carbaryl, and DDT. Spearman's rank correlations and classification and regression tree (CART) analyses were performed for characteristics that could potentially influence the soil-track in pathway, the air-infiltration pathway, as well as both pathways combined. The number of window panes, increased cooling of the home, and distance to the nearest field were found to most highly influence pesticide detection in house dust. In addition, distance to the nearest field was most influential on pesticide detection in air, while total pounds of pesticides applied in Yuma the month prior to sampling was most influential on pesticide detection in soil. These results suggest that pesticides may be largely entering farmworkers' homes via air infiltration through windows and ventilation systems. Future interventions should focus on the air-infiltration pathway to effectively decrease pesticide levels in farmworkers' homes.

Keywords: B-pesticides, D-community, A-built environment, A-indoor environment

Su-P-49

Using Chemical Characteristics to Explain Agricultural Pesticide Transport Pathways from the Field into Homes

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Abstract: In agricultural communities where many pesticides are applied, it is difficult to assess which types of pesticides pose the greatest hazard and the main pathway of pesticide transport from the field into the home. The chemical characteristics of pesticides may be useful to explain the detected pesticides in the community and shed light on the transport pathway(s) of pesticides. We collected soil, outdoor air, and house dust samples from 21 homes in Yuma County, Arizona, an agricultural community located along the US-Mexico border. Samples were analyzed for multiple pesticides with a wide-range of chemical characteristics. Spearman's rank correlations were used to determine whether there was a relationship between measured detection frequency of each pesticide in outdoor air, soil, and house dust with the various chemical characteristics of each pesticide. Vapor pressure, aqueous solubility, octanol-water coefficient, soil half-life, and Henry's Law Constant were considered for this analysis. The chemical characteristics most strongly correlated with air detection frequency were logKow (ρ=0.72) and aqueous solubility (ρ=-0.73), suggesting that pesticides detected in air may be mainly adhered to soil particles, rather than in the vapor phase. Similar correlations exist between house dust detection frequency and logKow (ρ=0.73) and water solubility (ρ=-0.73). Yet, these relationships are not present for soil detection frequency. This suggests that a major pathway of pesticides into the house dust may be through air infiltration of pesticides adhered to soil particles in the air. This idea is further supported by the strong negative correlations between vapor pressure and soil detection frequency (ρ=-0.84) and house dust detection frequency (ρ=-0.73). Therefore, less volatile pesticides may pose a notable hazard in agricultural communities because they are likely to remain in the soil and be transported into the home adhered to soil particles and persist as house dust.

Keywords: B-pesticides, A-chemical prioritization, D-community

Su-P-50

Residential Outdoor Air Pollution and Brain Morphology in the Adult Health and Behavior (AHAB II) Cohort and Pittsburgh

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Abstract: Background: Air pollution exposure is associated with increased inflammatory risk, and may adversely impact brain morphology through systemic inflammation, disruption of the blood-brain barrier, or translocation via olfactory mucosa. Currently, little is known about the relationship between air pollutants (particulate matter ($PM_{2.5}$), black carbon (BC), trace metal constituents) and brain morphology. The AHAB-II cohort is a community-based registry to identify neural and biobehavioral predictors of physical and mental health in midlife. We combine individual brain morphology indicators with fine-scale air pollution exposure estimates to explore their associations. Aims: Geographic information system (GIS) was used to geocode participant addresses and assign individual air pollution exposure estimates. We developed models to examine associations between outdoor air pollution and brain morphology. Methods: Air pollution data were obtained from a monitoring campaign with 36 sites across the Pittsburgh region. Land use regression (LUR) models were developed for $PM_{2.5}$, BC, and lead. We assigned mean pollutant concentrations within a 300 m buffer of each participant's residential location (n=306; mean age = 43 yrs; 45% men). Structural neuroimaging methods were used to determine indicators of brain morphology. Results: Preliminary results suggest that a 1 $\mu g/m^3$ increase in summer $PM_{2.5}$ exposure is associated with a -0.019 mm (p ≤ .05) decrease in cortical thickness after controlling for intracranial volume and age. Future analyses will examine other outcomes, and potentially mediating factors related to inflammation. Conclusions: This is among the first studies to examine associations between residence-specific air pollution exposures and brain morphology. Observed associations may have implications for pollution effects on brain-based functional outcomes (e.g., early cognitive declines).

Keywords: B-particulate matter, A-epidemiology, A-geospatial analysis/GIS

Su-P-51

Transects Modeling from Bisecting Roadways for Particulate Matter 2.5 (PM$_{2.5}$), Elemental Carbon (EC), and Nitrogen Dioxide (NO$_2$) in Homewood, PA

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Abstract: While large scale monitoring can quantify exposure to pollutants for cities or regions, more specific variations in pollutant levels at a community level require more saturated sampling or sampling on a smaller scale. Monitoring directly at points of interest may not fully capture the spatial variability of pollutants, therefore a spatial saturation model using transects may provide a more reliable estimate of for the entire sampling domain. We partnered with the Homewood Children's Village, a community organization concerned with their neighborhood air quality in areas where children spend a significant amount of time outdoors. Using transect modeling across the entire community, we aimed to establish a gradient or exposure map for PM$_{2.5}$, NO$_2$ and EC. Two main roads identified by the heaviest traffic patterns bisect the community lengthwise. Considering only roads within the community, a transect model was developed with 22 sites sampled at varying distances, relative to the main roads. A reference site from within the community was used to adjust for temporal variation. PM$_{2.5}$ was collected via active filters and NO$_2$ via passive badges on stationary monitors for 4, 7-day periods in Oct.-Nov. 2013. PM$_{2.5}$ ranged from 3.1-9.8 µg/m^3 (mean = 7.1) and NO$_2$ ranged from 11.9-16.7 ppb (mean = 13.7) once temporally adjusted to the reference site. Elemental carbon (EC) was also measured from the filters and ranged from 1.7-6.5 absorbance units (mean = 4.0). Considering the main bisecting roads as the source of pollutants for the transect sampling pattern, NO$_2$ showed a significant (α = 0.05) trend and no pattern was observed in PM$_{2.5}$ or EC. While transects from the main roads showed no trends for PM$_{2.5}$ and EC, NO$_2$ demonstrates a trend of decreasing concentration with increasing distance. External bordering roads with higher traffic density did show a pattern of decreasing all measured pollutants concentrations with increased distance.

Keywords: B-particulate matter, C-air, A-exposure models

Su-P-52

Social Costs of Air Pollution in Population Highly Exposed to Industrial Emissions

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Abstract: Introduction. Over the past decade, Ukraine has seen a significant increase in number of cancer patients (15% of all deaths). According to reports, the estimated number of cancer cases is 90,000 annually; of which almost 40% are working-age people. The aim of the study was to assess the social costs of industrial air pollution in terms of probability of additional cancer cases for further preventive health programs' and mitigation measures' development. Methods: Population in 12 Ukrainian cities was described according to demographic analysis methods. Residential exposure was assessed by geocoding over 45,000 residential addresses and using previously developed air pollution maps. Cancer risks and social costs were estimated in accordance with U.S. EPA methodologies. Average value of human life in U.S. dollars was calculated using methods of international comparisons, labor market researches, utility theory and actuarial approach. Results: It was revealed that almost 80% of the population was highly exposed to industrial air pollution. Potential social cost among working-age people was estimated as lifetime risk of additional cancer cases occurrence. Results showed that annually metallurgical industry was responsible for 51.0 newly diagnosed cancer cases. The impact of combined heat and power enterprises, coke and chemical production was substantially lower and equaled 4.0, 1.0 and up to 6.0 newly diagnosed cases respectively. An average value of human life in Ukraine was estimated at about 0.4-0.5 million U.S. dollars, which annually gives 0.5 to 25.5 million U.S. dollars of social costs attributed to air pollution-related additional cancer morbidity. Conclusion: Methodological approach to estimation of average value of human life in Ukraine was worked out. Based on research outcomes, a set of instruments was developed for implementation of air pollution risk management programs aimed at mitigation of health risks in highly exposed groups.

Keywords: C-air, A-risk assessment, A-environmental regulation, A-geospatial analysis/GIS, A-exposure factors

Su-P-53

Human Health Risk Assessment for Improved Access to Health Hazards Information

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Abstract: Introduction. Universal practice shows that community is constantly late with an awareness of the importance of ecological processes and overall burden imposed by urbanization on human health. This proves the need for accurate information regarding environmental health risks that are present in everyday life. Recent studies revealed that air pollution is a major factor of harmful environmental impact in Ukraine resulting in various negative health outcomes (risk indicators at $10\text{-}3 \div 10\text{-}4$). The study objective was to aggregate the information on health risks attributed to air pollution in Ukrainian cities for raising public awareness and development of risk mitigation measures. Methods: Health risks formed by industrial air pollution in 4 cities, were estimated according to HHRA procedure (U.S. EPA). 1-h, 24-h and annual pollutants' concentrations were modeled with dispersion model ISC-AERMOD View. Results: Human health risk levels attributed to emissions of energy production in Kyiv, chemical industry in Cherkassy, metallurgical enterprises in Zaporizhia and machine-building enterprises in Druzhkivka were calculated. In Kyiv, risk indicators were at $ICRtotal = 8.8 \times 10\text{-}6 \div 4.5 \times 10\text{-}4$ and were attributed to benzo(a)pyrene emissions mainly. In Cherkassy health risk were related to high levels of formaldehyde and benzene emissions: $ICRtotal = 2.7 \times 10\text{-}5 \div 4.6 \times 10\text{-}4$. As for Druzhkivka, were formed by chromium(VI) emissions: $ICRtotal = 1.8 \times 10\text{-}6 \div 2.5 \times 10\text{-}4$. In Zaporizhia the total cancer risk was attributed to chromium(VI) and nickel emissions mainly: $ICRtotal = 1.4 \times 10\text{-}4 \div 2.3 \times 10\text{-}2$. Discussion. The results helped to supplement the information on the health risks formed by air pollution within studied cities and to develop environmental health risks information system for enhanced public awareness on environmental impacts. The study outcomes can be further used for ecological control of the air-polluting-enterprises as well as in development of the regional air quality standards.

Keywords: C-air, A-risk assessment, A-exposure models, B-metals

Su-P-54

Exposure to PM2.5, Ultrafine and Black Carbon Particles in Green vs. Non-Green Homes

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Abstract: Environmental concerns for improved energy consumption are driving a green building/remodeling movement. Energy conservation efforts have resulted in tighter buildings, which have led to a reduction in the air exchange rates between indoor and outdoor environments. Poor air exchange rates could lead to an increase in particles that often originate from indoor sources (tobacco smoke, cooking), but decrease particles from outdoor sources (traffic, combustion). We assessed the concentration of particles alongside air exchange rates (AER) in 30 non-green and 27 green homes. Particles ≤ 2.5 µm (PM2.5) were sampled on 37 mm, 2.0 µm pore-size PTFE membrane filters using single-stage Personal Modular Impactors (SKC, Inc.) and analyzed gravimetrically. In addition, real-time number concentrations of ultrafine particles and mass concentrations of black carbon were assessed using a P-Trak condensation nuclei counter (TSI Inc.) and microAeth® monitors (AethLabs), respectively. Capillary adsorption tubes (CAT) and sources were placed in different locations of the homes to determine the AER. Information on home characteristics was collected by questionnaires. At baseline (immediately post renovation) the AER was significantly higher (p=0.02) in non-green homes (median=3.1 h-1) as compared to green homes (median=1.1 h-1). The geometric mean of PM2.5 was 80 µg.m-3 in green homes and 56 µg.m-3 in non-green homes (p=0.1) and the geometric mean of the number concentration of ultrafine particles was 26087 cm-3 in green homes and 32535 cm-3 in non-green homes (p=0.2). Preliminary data show a higher concentration of ultrafine particles in green homes at 6 months (p=0.05) and at 12 months (p=0.3). Black carbon, which was measured only at 12 months, showed an increasing trend (p=0.06) in non-green homes. Further data analysis will tease out the influence of human activity versus the renovation status of homes.

Keywords: A-built environment, A-indoor environment

MONDAY, OCTOBER 13, 2014

Mo-S-A1-01
Novel Databases for Exposure to Cosmetics and Personal Care Products
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Abstract: Exposure of cosmetics and personal care products to the population can only be determined by way of a detailed and robust survey. The frequency and combinations of products used at specific times during the day will allow the calculation of aggregate exposure for an individual consumer, and to the sample population. In the present study, habits and practices of personal care and cosmetic products have been obtained from market research data for 36,446 subjects across European countries and the United States. Each subject logged their product uses, time of day and body application sites in an online diary for seven consecutive days. Each subject's likely amount of product used per occasion was probabilistically estimated based on their demographic and data from the literature. Furthermore, each subject's likely weight and body surface areas could also be approximated using anthropometric modeling also based on demographics. Using known product dermal retention factors, the chemical exposure was estimated based on Monte Carlo simulations. Statistical analyses of the habits and practices and chemical exposure are presented, which show the robustness of the data and the ability to estimate aggregate exposure. Consequently, the data and models method presented show potential as a means of performing safety assessments on personal and cosmetics products.

Keywords: A-aggregate exposure, A-exposure models, A-statistical methods, C-consumer products, C-personal care products

Mo-S-A1-02
Consumer Exposure Assessment Resources from the (U.S.) National Library of Medicine
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Abstract: Many exposure assessors and toxicologists do not realize how much free online information relevant to chemicals in consumer products is available. The (U.S.) National Library of Medicine (NLM) provides a variety of databases to help meet the needs of these users. One example is NLM's TOXNET® "one stop access" set of numerous databases (TOXicology Data NETwork, toxnet.nlm.nih.gov). TOXNET's TOXLINE® provides bibliographic information covering the toxicological and other effects of chemicals, and incorporates content from NLM's widely used PubMed®/MEDLINE®. TOXNET also includes:1) the Hazardous Substances Data Bank (HSDB®), 2) the Household Products Database (HPD), 3) Haz-Map®, and 4) ChemIDplus®. NLM has been enhancing the HSDB in recent years to include new materials (e.g., nanomaterials) and state-of-the-science toxicology, exposure, and risk assessment information. In addition, NLM offers the Enviro-Health Links (EHLs), Web bibliographies of links to authoritative and trustworthy online resources in toxicology, environmental health, exposures, risk assessment, and risk management. An example is the EHLs page on "Indoor Air." The resources noted in the EHLs are selected from government agencies and non-governmental organizations, and are judged to meet the NLM selection criteria for inclusion. Many EHLs include sets of pre-formulated searches of all relevant SIS and NLM databases, allowing users to search for the most recent citations on a topic of interest.

Keywords: C-personal care products, C-consumer products, A-indoor environment, Databases, Web Portals

Mo-S-A1-03
Cheminformatic Exploration of the Chemical Landscape of Consumer Products
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Abstract: Although Consumer products are a primary source of chemical exposures, little information is available on the chemical ingredients of these products and the concentrations at which they are present. To address this data gap, we have created a database of chemicals in consumer products using product Material Safety Data Sheets (MSDSs) publicly provided by a large retailer. The resulting database represents 1797 unique chemicals mapped to 8921 consumer products and a hierarchy of 353 consumer product "use categories" within a total of 15 top-level categories. We examine the utility of this database for the purpose of prioritizing chemicals, and discuss ways in which it will support (i) exposure screening and prioritization, (ii)

identification of generic or framework formulations for several indoor/consumer product exposure modeling initiatives, (iii) candidate chemical selection for monitoring near field exposure from proximal sources, and (iv) as activity tracers or ubiquitous exposure sources using "chemical space" map analyses; Chemicals present at high concentrations and across multiple consumer products and use categories that hold high exposure potential are identified. In this presentation the audience will familiarize themselves with consumer product ingredient signatures, rationale for developing generic or framework formulations, novel visualization and analysis of the entire consumer product ingredient landscape. We will also discuss areas for improvement such as fragrances/flavor ingredients, packaging and manufacturing residues, and under-reported ingredients to carve out a path for full disclosure of chemical ingredient profiles of consumer products. [Disclaimer: The views expressed in this abstract are those of the authors and do not necessarily reflect the views or policies of the U.S. Environmental Protection Agency]

Keywords: A-activity patterns, A-aggregate exposure, C-consumer products, A-chemical prioritization, A-indoor environment

Mo-O-B1: Advances in Pesticide Exposure Assessment- I

Mo-O-B1-01
The German Environmental Specimen Bank (ESB): Monitoring Phased-out and Emerging Pesticides

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Abstract: Introduction and methods: The ESB regularly collects human samples which are analyzed for various substances before being cryo-archived. Every year i. a. 24 h-urine and blood samples from 480 young adults (20-29 years of age) from four German cities are acquired. To document time trends in human exposure to pesticides samples have been regularly analyzed for Hexachlorobenzene (HCB) and Pentachlorophenol (PCP) since the 1980s. As initial retrospective analysis 40 urine samples acquired in 1996 and 2012 have been analyzed for N-(phosphonomethyl)glycine (Glyphosate). Results: ESB data reveal a major decrease in average internal exposures to HCB (1985: 2.7 µg/L vs. 2010: 0.09 µg/L blood plasma) and PCP (1985: 26.7 µg/L vs. 2010: 0.54 µg/L blood plasma). Until the 1990s, HCB tends to be higher in females. No substantial gender difference for this period was observed for PCP. The internal Glyphosate exposure increased significantly between 1996 and 2012. The fraction of quantifiable levels increased from 40% to 70%. On average the concentration increased from below LOD (0.15 µg/L) to 0.21 µg/L urine. The highest Glyphosate value measured in 2012 resulted in 0.65 µg/L urine. Against expectation the concentration of Glyphosate's main metabolite Aminomethylphosphonic acid (AMPA) did not increase in time. Also no significant correlation was observed between Glyphosate and AMPA levels. Conclusions and Outlook: ESB data document the effect of banning PCP and HCB in Germany in the 1980s. Concerning Glyphosate ESB measurements are in line with the increasing application of this pesticide resulting in an increasing exposure of the population. Levels measured in 2012 are well below toxicologically relevant concentrations. However, due to the ongoing discussion on health effects of Glyphosate further monitoring is warranted. Acknowledgements: The ESB is funded by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB).

Keywords: A-biomonitoring, B-pesticides, C-food, A-risk assessment, A-environmental regulation

Mo-O-B1-02
Trends in Exposure to Chlorpyrifos and Pyrethroid Insecticides in the US Population

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Abstract: Background: Organophosphates (OPs) and synthetic pyrethroids compose a significant portion of the insecticides used in U.S. commercial and residential settings. OPs were used as an alternative to the more toxic and persistent chlorinated pesticides, but toxicity of OPs was also well documented. Chlorpyrifos is still one of the most common OP insecticides in the United States even though chlorpyrifos was phased out of most home uses and some agricultural applications in the early 2000s. As a result, pyrethroids, labeled as generally harmless to humans at low doses, now constitute the majority of commercial and household insecticides used. Aims: To examine temporal trends in the United States in biomarker concentrations of chlorpyrifos and commonly used pyrethroid insecticides and evaluate whether trends vary by demographic variables. Methods: We measured the urinary concentrations of biomarkers of exposure to chlorpyrifos (i.e., 3,5,6-trichloro-2-pyridinol) and pyrethroid (i.e., 3-phenoxybenzoic acid) insecticides in the general U.S. population to determine

whether differences exist by age, sex, race, and year. Results: We observed demographic differences in urinary concentrations of 3,5,6-trichloro-2-pyridinol and 3-phenoxybenzoic acid. Also, we observed that while urinary concentrations of 3,5,6-trichloro-2-pyridinol follow a downward trend, urinary concentrations of 3-phenoxybenzoic acid appear to be increasing. Conclusions: These results suggest a downward trend in exposure to chlorpyrifos and a reciprocal upward trend in exposure to its alternatives, synthetic pyrethroids, in the United States since the early 2000s. Furthermore, these findings stress the usefulness of biomonitoring as a tool to assess the extent of human exposure to these commonly used insecticides and to track the public health effectiveness of legislative actions to reduce exposure to OP pesticides after phasing out the use of chlorpyrifos.

Keywords: B-pesticides, A-biomarkers, A-biomonitoring

Mo-O-B1-03
What, if It Is All Safe? The Need for Pesticide Risk Minimization

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Abstract: Pesticides authorized in US and EU are considered safe for humans, i.e. below thresholds of acceptable risk. However, pesticides nonetheless contribute to global human disease burden via different effects, some of which are not even included in authorization procedures, e.g. neurodevelopmental disabilities (Lancet Neurol 13: 330). Comparative substitution scenarios combining crop-specific amount applied with pesticide-specific toxicity potential can help to characterize and minimize disease burden from pesticide exposure. We identified intake via food crop consumption as main exposure pathway to pesticides. For this pathway, we quantified health impacts in a dynamic crop uptake model, detailing how pesticides contribute to average burden of 2.6 hours lost per person over lifetime across Europe. Findings show that only 10% of all pesticides applied to grapes/vines, fruit trees, and vegetables account for 90% of total annual health impacts of around 2000 disability-adjusted life years. Main aspect driving crop residue dynamics and parameter uncertainty is thereby pesticide dissipation from crops. To reduce uncertainties in our assessment, we built an inventory of 811 existing experimental studies providing 4500 dissipation half-lives in crops. Realizing that this inventory still covers only a small fraction of possible pesticide-crop combinations, we developed models to estimate dissipation in crops from collected data. We provide reference half-lives for 333 pesticides with reported temperatures applied at 20°C under field conditions and propose a predictive model for pesticides without measured data to estimate half-lives from substance properties at the level of pesticide class. Combining improved dissipation data with quantitative assessments, we demonstrate that health impacts can be reduced up to 99% by defining adequate substitution scenarios. We recommend that future work focuses on pesticides dominating human disease burden, which has policy implications.

Keywords: B-pesticides, C-food, human exposure, health impacts, substitution scenarios, human exposure, health impacts, substitution scenarios, human exposure, health impacts, substitution scenarios

Mo-O-C1: Exposure to Recreational Water Contaminants

Mo-O-C1-01
Rapid Phycocyanin Fluorometry Predicts Elevated Microcystin Levels in Eutrophic Ohio Lakes

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Abstract: Current approaches for assessing human health risks associated with cyanotoxins often rely on the quantification of microcystin. Significant limitations of current approaches are cost and time to obtain a result. To address these challenges, a numerical index for screening microcystin risks above the World Health Organization's (WHO) low-risk threshold for microcystin was developed for eutrophic Midwestern U.S. lakes based on water quality results from 182 beach water samples collected from seven Ohio lakes. In 48 (26.4%) samples we observed microcystin concentrations as measured by ELISA that exceeded the 4 µg/L microcystin threshold. A multivariable logistic regression model using practical real-time measures of in vivo phycocyanin (by fluorometry) and secchi depth was constructed to estimate the probability of a beach sample exceeding 4 µg/L microcystin. The final model achieved statistical significance ($p = 0.030$) as well as good calibration and discrimination. These results demonstrate two rapid and practical measures of recreational water quality are

effective in identifying "at risk" lake conditions warranting additional management (e.g., advisory and/or advanced testing).

Keywords: A-sensor technology, A-risk assessment, C-water, A-ecological exposure, A-exposure models

Mo-O-C1-02
Fish Intake and Blood Cadmium in a Cohort of Adult Avid Seafood Consumers

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Abstract: Benefits of fish consumption are widely recognized, yet eating fish may also carry important risks that include exposure to heavy metals such as cadmium (Cd). It is well documented that cadmium levels are elevated in seafood, but bioavailability and potential for toxicity after consumption is less clear. Blood cadmium is an established biomarker of cadmium exposure reflecting both recent and decade-long exposure. This study investigates the relationship between seafood consumption and blood Cd levels in a 252 person cohort in the Long Island Study of Seafood Consumption (New York). Data on the amounts and frequency of eating various types of seafood were self-reported by avid seafood consumers recruited in 2011-2012. Blood Cd was measured using ICP-MS by the Trace Inorganics Laboratory at RTI International (RTP, NC), with a detection limit of 0.02 µg/L, and a range from below detection limit to 2.02 µg/L, mean= 0.46 µg/L. After adjusting for age, BMI, sex, current smoking status, and income in a linear regression model, we found no association between total seafood intake (β=-0.01; p=0.19) but did identify an association between salmon intake in cups/week (ln transformed) (β=0.20; p=0.001) and blood Cd. Adding salmon to the multiple regression model increased the R^2 from 0.29 to 0.35. Including rice intake, blood zinc, or dietary iron or calcium in the model did not impact the results. After accounting for salmon, no other types of seafood were meaningfully associated with blood Cd. Treating salmon categorically based on consumption frequency did not produce a significant association with Cd although there was a suggestive trend. Results suggest that seafood is not a major source of Cd exposure, but that salmon intake does marginally increase blood Cd levels. Given that Cd levels in salmon are not higher than those in many other seafood species, the mild association with salmon intake is likely attributed to higher intake of salmon.

Keywords: B-metals, C-food, A-biomarkers, D-community

Mo-O-C1-03 – Withdrawn

Mo-S-D1: Advances in Integrated Ecological Exposure Modeling to Support Chemical Registration Decisions

Mo-S-D1-01
Integrated Models of Exposure with Application to Stream Fishes

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Abstract: Risk managers are in need of tools that inform the spatial extent and context of ecological exposures in natural ecosystems. Species distribution modeling (SDM) approaches utilize readily available empirical data to produce spatial predictions of ecological conditions along with measures of certainty. Here, we demonstrate a modeling framework that combines SDM methods with a pesticide spatial prediction model to map risk of exposure for an aquatic species across a Midwestern watershed dominated by agricultural land use. In this example, we used data from surface water monitoring of pesticides, nutrients, and general chemistry parameters from the Little Miami River watershed near Cincinnati, OH in combination with GIS-derived land use data, to develop predictive models of black redhorse (Moxostoma duquesni) exposure to the herbicide atrazine at toxicologically relevant exposure levels. The black redhorse was modeled because it is an endemic stream fish that requires relatively undegraded habitat, as is the case for many threatened and endangered species. We discuss expected benefits of and strategies for integrating this modeling method with genomic measurement data, including (1) the use of exogenous environmental DNA to improve the efficiency of spatial and temporal monitoring of species distribution patterns, with special relevance to threatened and endangered species, and (2) the use of transcriptomic biomarkers for evaluating field exposures and validating exposure predictions. In the end, we suggest that integration of these research avenues will result in an efficient, spatially informed modeling-monitoring approach for stream organisms that is amenable to adaptive risk management.

Mo-S-D1-02
Integrated Modeling Systems to Assess Exposure and Toxicity of Chemicals in Support of Aquatic Ecological Risk Assessment of Methodologically Challenging Chemicals
M. Barber, K. Sullivan, C. Stevens; USEPA/ORD/NERL, Athens, GA

Abstract: From an exposure perspective, persistent, bioaccumulative and toxic chemicals (PBTs) are some of the most challenging chemicals facing environmental decision makers today. Due to their physico-chemical properties [e.g., high octanol-water partition coefficients (Kow), low aqueous solubilities and slow transformation rates], PBT exposure assessment is generally methodologically challenging either because reliable empirical data concerning their fate, transport and bioaccumulation is unavailable, or because the available data is so limited that extrapolations to other environments and release scenarios cannot be made confidently. In either case, integrated environmental modeling (IEM) offers an objective and scientifically defensible approach to PBT assessments. Importantly, such IEM approaches should be tiered in ways that allow decision makers to evaluate expected environmental exposures and hazards posed by PBTs with a realistic understanding of environmental and biological variability. Within each tier, users need to predict synchronous expected environmental concentrations (EECs) and expected biological concentrations (EBCs); these EECs and EBCs are then used to assess the dermal, dietary and drinking exposures to humans and wildlife. Here, we present a two-tier IEM system for assessing the fate, transport and bioaccumulation of PBTs in rivers. Whereas the Tier I system links a steady-state fate and transport model to a steady-state bioaccumulation model, the Tier II system links a dynamic fate and transport model to a dynamic bioaccumulation model. For this demonstration, we used the USEPA's EXAMS, KABAM and BASS models. Nine environments were constructed to simulate EECs and EBCs of PBTs in rivers of different sizes and physiographic provinces. Seventy-four PBTs having Kow > 1000 were chosen for analysis. We then forecasted regional trends for the EECs and EBCs of these PBTs and enumerated the parameter sensitivity and variability of these forecasts.

Mo-S-D1-03
Integrated Ecological Exposure Modeling to Support Chemical Registration Decisions
A. Gillespie; US EPA, Durham, NC

Abstract: The US Environmental Protection Agency (EPA) has the responsibility for conducting human health and ecological risk assessments for informing decisions about registration and re-registration applications for hundreds of chemicals and pesticides annually. Risk assessments consider both the hazard of the chemicals as well as potential exposures of the chemicals in question. In the case of ecological risk, because ecosystems consist of many species and therefore many potential receptors, risk assessment generally starts with developing a conceptual model of the stressors (direct and indirect) as well as potential pathways to multiple receptors and responses which may be inherent in the way a chemical is proposed to be used. EPA currently has several different approaches for considering ecological exposure in chemical registration decisions, depending on the planned use of the chemical (pesticide or not) and on the availability of existing data. In cases where data are lacking, a variety of modeling and prediction tools can be applied to screen chemicals and to identify the chemicals which are the most likely to cause adverse environmental outcomes. EPA is currently moving to improve integration of ecological exposure modeling approaches with existing data-based analysis approaches. This is expected to increase speed and flexibility and improve the scientific rigor and internal consistency of results and therefore help improve chemical registration decisions. Initially the research involves linking existing modeling and chemical prediction tools. In the long term we will develop a next generation of integrated modeling tools which will automatically gather or data, build representative exposure scenarios, and provide probabilistic assessments of ecological exposures and impacts.

Mo-O-E1: Indoor / Outdoor Air Pollution - I

Mo-O-E1-01
A Hybrid Land Use Regression/AERMOD Model for Predicting PM$_{2.5}$

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Abstract: Land use regression (LUR) models describe empirical relationships between measured pollutant concentrations and geographic information systems (GIS)-based indicators of source contribution. As most LUR models include little physical, chemical, or meteorological information, incorporating this information through Gaussian dispersion estimation should better capture and represent spatiotemporal pollutant variability. AERMOD model predictions should improve the accuracy, reliability and interpretability of the LUR surface by incorporating: (1) deterministic pollutant dispersion from sources based on emission volumes and physical proximity, and (2) planetary boundary layer forcing (hourly meteorological data + digital elevation model). We collected PM$_{2.5}$ measurements from thirty-six sites using Harvard Impactors, in a 500km^2 domain over two seasons across the city of greater Pittsburgh, PA. Sites were selected using stratified randomized sampling, capturing variability in traffic density, proximity to industry (weighted emissions), and elevation (a source-concentration modifier). Thirty-one source groups equaling 231 unique PM$_{2.5}$ and SO$_2$ point and volume sources were modeled in AERMOD, predicting concentrations at the 36 sampling locations. Predictions from AERMOD were included as independent covariates in seasonal LUR models predicting PM$_{2.5}$. The inclusion of AERMOD predictions improved final LUR R^2 values by 10 and 11% for the summer and winter models, respectively. Incorporating predictions from emissions-source dispersion modeling improved LUR model estimations for predicting PM$_{2.5}$. Furthermore, AERMOD within the LUR framework provides a means for improving conceptualization of PM$_{2.5}$ exposure estimates for epidemiology research.

Keywords: A-exposure models, A-geospatial analysis/GIS, C-air, B-particulate matter, Land use regression

Mo-O-E1-02
Estimation of PM2.5 Concentrations in the Southeastern U.S. Using a Two-Stage Model by Incorporating Fire Count Data

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Abstract: Previous studies showed that fires are significant contributors to PM2.5 levels. To date, fire data, however, have not been used as a predictor in AOD-based models for PM2.5 concentration prediction. In this paper, we developed a two-stage model by incorporating a new aerosol product with 1 km spatial resolution derived by the Multiangle Implementation of Atmospheric Correction (MAIAC) algorithm and fire count data in order to evaluate whether fire count data can improve prediction accuracy, particularly in areas with high fire occurrence. The study area is in the southeastern U.S., and the data of year 2007 was collected from various sources. Fire data were linked to each PM2.5 monitoring site by calculating the fire counts within a 75 km buffer centered at each site. Model fitting generated R2 of 0.75, MPE of 2.47 µg/m3, and RMSPE of 3.83 µg/m3, while cross validation (CV) generated R2 of 0.69, MPE of 2.75 µg/m3, and RMSPE of 4.29 µg/m3, indicating a good fit between the dependent variable and predictor variables. A comparison between models with and without the fire predictor showed that the prediction accuracy was improved from the model with the fire predictor to the one without as fire counts increased. The decrease of CV RMSPE was up to 1.5 µg/m3, representing a 13.4% improvement in prediction accuracy, and fire count data have better performance in southern Georgia and spring season due to high fire occurrence in this region and season. The results indicate that fire count data are essential in PM2.5 concentration estimation, especially in areas where fires constantly occur.

Keywords: B-particulate matter, A-exposure models, A-statistical methods, A-geospatial analysis/GIS, C-air

Mo-O-E1-03

Development of a New Online Method for Measurements of Reactive Oxygen Species Associated with PM2.5

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Abstract: Reactive oxygen species is routinely used as a reporter to assess a measure of toxicity from particulate exposure. While this technique has been embraced by a number of investigators, the relative complexity of these approaches, and the variety of different methods employed, has further complicated our understanding of the relevance of ROS assays. A Particle into Liquid Sampler was coupled to a custom-built flow-through optical chamber to support in situ, semi continuous measurements of ambient or laboratory generated ROS. BEAS-2B pulmonary epithelial cells were cultured and loaded with 2', 7'-dichloroflouroscein-diacetate in phosphate buffer solution, and then dosed with media-based aliquots of water soluble particulate matter. This work has shown that repeatable fluorescence measurements are possible in the context of an online instrument, across a number of laboratory-generated standards including metals, salts, and acids. Hydrogen peroxide, as a positive control, induced fluorescence initiated at a much faster rate than dissolved particles (including particles thought to be highly toxic), suggesting that the ROS formation mechanism is likely different. Cell death, and perhaps upregulation of ROS induction, appear to be a concern in this assay, and studies are currently under way to optimize dosing strategies. Data from field deployments will also be presented.

Keywords: A-chemical prioritization, A-analytical methods, B-metals, B-particulate matter

Mo-O-F1: Air Pollution Epidemiology - I

Mo-O-F1-01

Modeling the Health Consequences of Deep Energy Retrofits: A Case Study in Boston Low-income Multi-family Housing

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Abstract: Residents of low-income multi-family housing may have elevated exposures to multiple environmental pollutants known to influence asthma. Energy retrofits - implemented to reduce energy consumption - can affect asthma outcomes by changing indoor concentrations of environmental pollutants through changing air flow, or modifying indoor source characteristics or utilization. However, these impacts are challenging to quantify given complex airflows, variable and uncertain pollution source characteristics, and unknown resident behavior. Simulation modeling can be a useful tool to study these interactions, but models must be parameterized with locally relevant data to provide meaningful outputs. In this study we modeled the changes in lung function and asthma outcomes in children living in a Boston affordable rental housing development which recently underwent a deep energy retrofit. We parameterized our previously developed discrete event simulation model (DEM) of pediatric asthma to simulate the impact of the deep energy retrofit, seasonality, and resident cooking, smoking, and window opening behavior on indoor pollutants, lung function and asthma outcomes (symptom days, severe events, and medication use). Indoor pollutant concentrations were estimated in prototypical mid-rise and low-rise buildings, which were modeled using CONTAM, a multi-zone airflow and contaminant transport analysis program. Information on resident behavior before and after the deep energy retrofit was collected using a self-administered resident survey. Modeled results highlight the tradeoffs between energy retrofits, indoor pollutant concentrations and asthma outcomes in multi-family housing. Results also highlight how individual resident behavior (e.g., window opening) can alter the effect of designed building retrofits. Results from the study illustrate the utility of our DEM as a tool to evaluate the impact of building changes and resident behavior on asthmatic health and cost.

Keywords: A-built environment, simulation models, asthma, A-exposure models, A-indoor environment, simulation models, asthma

Mo-O-F1-02
Modeling Variability in Air Pollution-related Health Damages from Individual Airport Emissions

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Abstract: Aircraft emissions impact human health by increasing ambient concentrations of combustion-related air pollutants. Determining contributions of aircraft and other airport sources to pollutant exposures and related health risks is challenging due to complex aircraft exhaust dynamics and existing background concentrations from other sources. "One atmosphere" chemistry-transport models capture all relevant aspects of emitted pollutant fate and transport, but extracting the influence of many individual sources and their emitted pollutants is infeasible using standard model implementation. The goal of this study is to model regional concentrations of PM2.5 and ozone attributable to emissions of precursor species from numerous individual airports, to develop airport-specific intake fraction estimates and health damage functions per ton of emitted species, and to develop regression models to explain variability in these functions to allow for extrapolation to unmodeled airports. A subset of airports from across the United States were selected, including the largest airports as characterized by annual fuel burn, at least one airport from each state, and other selected airports. We applied the Community Multiscale Air Quality model (CMAQ) using the direct decoupled method (DDM) - a sophisticated sensitivity analysis technique to isolate O3 and PM2.5 related contributions from individual airport-related precursor pollutants in a computationally efficient manner. We linked airport-specific and pollutant-specific concentration estimates with population data and literature-based concentration-response functions to create health damage functions for mortality and morbidity per ton of emissions for both PM2.5 and ozone precursors. These emissions-normalized airport-specific functions were well explained by regional population patterns and meteorological conditions, indicating the viability of developing rapid exposure and health risk estimates for policy analyses.

Keywords: A-exposure models, A-risk assessment, B-particulate matter, C-air

Mo-O-F1-03 - Withdrawn

Mo-S-G1: Exposure in Commercial Aircraft Cabins - I

Mo-S-G1-01
Exposure to Ozone Reaction By-Products in Aircraft Cabins and Other Occupied Environments
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Abstract: Over the last decade human exposure to ozone reaction by-products has been investigated in simulated and actual aircraft cabins as well as in other simulated and actual indoor environments. Such studies began in a mockup of a B-767 at the Technical University of Denmark. Volatile organic compounds were continuously monitored (PTR-MS) with and without ozone in the cabin and with and without the presence of soiled T-shirts - surrogates for passengers. The identified by-products were dominated by carbonyls, dicarbonyls and hydroxy carbonyls generated during ozone's reaction with squalene and unsaturated fatty acids found in skin oil and sorbed on the T-shirts. The next set of experiments substituted human subjects for soiled T-shirts. Once again the oxidation products included compounds indicative of ozone reactions with constituents of skin oil. Analogous experiments were conducted in a simulated office setting, and the same characteristic by-products were identified. Examples of oxidation products identified in all three sets of experiments include 6-methyl-5-heptene-2-one (6-MHO), decanal, geranyl acetone, and 4-oxopentanal (4-OPA). Following these studies in simulated environments, ozone, aldehydes and ketones were measured in the cabins of 52 commercial aircraft, ozone in real time and the carbonyls via sorbent sampling and subsequent thermal desorption/GC-MS. As anticipated, 6-MHO and decanal were identified in the cabin air. Linear regression analysis indicated that the levels of 6-MHO depended in a statistically significant manner on ozone levels and percent occupancy. During this past year products of ozone/skin oil chemistry have been identified in the air of a soccer stadium during a match in Mainz, Germany and in a classroom in southwestern Sweden. Together these studies demonstrate the ubiquity of human exposure to ozone/skin oil reaction products. The potential implications of such exposures are the subject of current study.

Keywords: A-exposure factors, C-air, B-VOCs, A-indoor environment, A-built environment

Mo-S-G1-02
A Controlled Exposure Study of Self-report Symptoms in Response to Organic Compound Mixtures Typical of Aircraft Cabin Environments"
N. L. Fiedler[1], C. P. Weisel[1], D. R. Space[2], K. Mohan[1], K. K. McNeil[1]; [1]Rutgers Biomedical and Health Sciences: Robert Wood Johnson Medical School, Piscataway, NJ, [2]The Boeing Company, Seattle, WA

Abstract: Numerous organic compounds have been identified within passenger cabins of commercial aircraft. Surveys of crew and passengers flying on planes and in simulated flights have identified symptoms to include ocular and respiratory irritation, headaches, fatigue and dizziness, and decreased comfort within the cabin environment. Conditions within the cabin environment may contribute to these symptoms such as low relative humidity, cabin pressurization equivalent to 8,000' altitude, spending extended time in an enclosed environment, and mixtures of organic compounds arising from the passengers and products within the cabin. Prior to the development of purification systems to improve cabin air quality, the organic compounds contributing to reported symptoms must be identified. Therefore in a within subjects repeated measures study, 44 healthy, female subjects, age 18 - 35, rated symptoms and environmental qualities at baseline prior to exposure, 10 minutes after exposure onset and at 1,3,5 and 7 hours during exposure in a "simulated aircraft environment". Subjects were exposed once to each of the following chemical mixtures over a 4-week period: long chain carbonyls, compounds associated with bioeffluents, short chain carbonyls/organic acids, and filtered air. Controlling for baseline differences, subjects reported significantly greater severity of symptoms (e.g., eye/nose irritation, dryness), greater odor intensity, and worse air quality at 5 and 7 hours during the bioeffluent and short chain carbonyls/organic acids conditions relative to the filtered air condition. Few symptom or environmental quality differences were observed for the long chain carbonyls relative to filtered air conditions. The design of this study allowed differentiation of immediate symptoms that declined over time from symptoms that persisted throughout the exposure period. The implications of these findings for the aircraft cabin environment will be discussed.

Keywords: A-indoor environment, B-VOCs, A-behavior

Mo-S-G1-03 - Withdrawn

Mo-S-A2: Assessing Exposures to Chemicals in Consumer Products: Databases, Models and Case Studies - II

Mo-S-A2-01
A Multi tier Approach to Characterizing Exposures to Cleaning Product Ingredients

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Abstract: Tiered approaches to the question of exposure begin with product-use-specific deterministic estimates for several scenarios, using previous studies of habits and practices, publicly-available concentration ranges or estimates thereof, and other previously-established parameters. This information was also used to populate distributions for probabilistic exposure analysis. These results were compared to those derived from multiple software packages (ECETOC TRA, EUSES, CONSEXPO), with sensitivity toward overlapping model parameters. Critical data gaps and uncertainties exist, and the impact of these uncertainties on safety assessment has been considered.

Keywords: A-exposure models, C-consumer products, A-exposure factors, A-risk assessment, A-activity patterns

Mo-S-A2-02
Direct Exposure of Consumers to Personal Care Products

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Abstract: Every consumer product has the potential to expose humans to chemical ingredients during use and via subsequent environmental emissions. To quantify these exposures to consumer products, several challenges need to be first addressed: What are the most suitable starting bases and metrics, how should limited data on chemical content in products be handled, and how should exposure be combined with ToxCast toxicity data? Production volumes are available for many chemicals but only a small and highly variable fraction of the chemicals produced are indeed incorporated into multiple products and ultimately reach consumers. Emissions can constitute another starting point, but the emission-based intake fraction concept needs to be adapted to enable a consistent application, for example direct dermal application of personal care products (PCPs). We propose to determine exposure as the mass of chemical in a product multiplied by the product intake fraction (PiF), defined as the fraction of the chemical in a product that is taken in by the human population. We demonstrate the use of this new metric, applying the dermal uptake model of Ten Berge to 25 chemicals found in PCPs, taking body lotion as a sentinel leave-on product potentially leading to PiFs between 2% and 100%, depending on chemical properties. Two alternatives are presented to inform risk assessment: a) Combining fractions of chemicals in PCPs with PCP usage and PiF, we forward calculate the exposure dose in mg/kg/day and compare it to the Oral Equivalency Dose (OED) calculated from ToxCast high throughput toxicity tests. b) We use the PiFs to back calculate maximum fractions in PCPs corresponding to the ToxCast OEDs and then compare them to measured or plausible ranges of chemical fractions in products. For about one third of the considered chemicals, their actual fraction in PCPs is higher than the fraction corresponding to the OEDs.

Keywords: A-exposure models, A-risk assessment, C-personal care products, C-consumer products, C-multimedia

Mo-S-A2-03
Specific Consumer Exposure Determinants (SCEDs): Refining Default Values in Screening Level REACH Assessments

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Abstract: The EU Registration, Evaluation and Authorization of Chemicals (REACH) regulation requires that conditions of safe use be specified for all uses EU classified substances are sold into. Meeting this regulation required a significant expansion of traditional hazard based approaches to incorporate exposure and risk elements. Key factors that enabled developing an approach and information to meet the REACH requirements on-time included stakeholder dialogue, common and consistent terminology, and implementation of a tiered and targeted approach to exposure and risk assessment. Within this approach, the European Center for Ecotoxicology and Toxicology of Chemicals Targeted Risk Assessment tool (ECETOC TRA) is a preferred

exposure tool for conducting screening level exposure assessments (lower tier) under REACH. Based upon the experiences in developing the initial wave of registrations in 2010, it has been recognized that there are cases where refining default values for consumer exposure scenarios can be an effective way to extend TRA utility. The concept of Specific Consumer Exposure Determinants (SCEDs) as a way to realize this enhanced utility was put forth by ECETOC and subsequently expanded upon by the Downstream Users of Chemicals Coordination Group. The SCEDs concept, template, and underlying principles put forth a consistent and transparent way to utilize more realistic values in place of default parameters for specific consumer exposure scenarios. Within the tiered process, they enable an intermediate step in refinement that can utilize the screening level TRA tool without going to a higher tier more resource intensive model. The SCEDs are based upon basic principles which include transparency and use of common elements. This presentation will discuss the basis of SCEDs and current status of the SCEDs library.

Keywords: A-exposure models, A-exposure factors, C-consumer products, A-risk assessment

Mo-S-A2-04
Aggregate exposure modeling on the basis of individual exposure profiles: Translating higher Tier methods for food to personal care products
N. von Goetz, E. Manova, T. Dudzina; ETH - Swiss Federal Institute of Technology, Zurich, Switzerland

Abstract: In order to assess individual-based exposure estimates for ingredients of personal care products (PCPs) detailed data are necessary on the use of PCPs and the concentrations of the target ingredients in the products. Furthermore, approaches have to be developed how to combine this data, how to group products, and how to extrapolate when data are missing. Taking food intake surveys as an example, we conducted a postal questionnaire survey in the German-speaking part of Switzerland to collect data on the use of leave-on PCPs for all age groups including small children. We also asked for the specific product names. In our probabilistic modelling method (one-dimensional Monte Carlo) performed at an individual level, PCP use and co-use data obtained by the questionnaire were linked to UV filter concentration data gained from chemical analyses of PCPs used by the questionnaire respondents. Therefore, PCP users, who however were not exposed to the target UV filter via the specific product they used, could be identified. This approach should be the method of choice in order to obtain accurate exposure levels for substances in PCPs that are not present in all PCPs of a given category, thus avoiding exposure overestimation. A similar approach was followed in exposure modeling for the a cyclic siloxane in the Dutch population. Since siloxanes are widely used in the whole spectrum of PCPs, nearly all categories of PCPs have been included in an online questionnaire. Like in the above study, the questionnaire data together with a screening model on the basis of generic formulations was used to select the most important PCPs, which were then analysed for siloxane content. In the presentation the methodology of this higher Tier modeling will be presented, differences in the two studies will be highlighted, and the quality of data needed for reliable higher Tier exposure modeling will be discussed.

Keywords: A-aggregate exposure, A-exposure models, C-personal care products

Mo-S-A2-05
Aggregate Exposures to Fragrances in Consumer Products
C. O' Mahony, D. Comiskey, E. Daly; Creme Global, Dublin, Ireland

Abstract: Fragrance materials are used in a variety of personal care products and cosmetics, which in turn are used in a variety of combinations and in different amounts by consumers. Consequently exposure to fragrances via the dermal and inhalation routes is a potential risk for consumers, and in particular the question of aggregate exposure due to multiple product use should be addressed. In order to assure the safe use of fragrances in personal care products and cosmetics, a robust methodology is required to that incorporates variability in both fragrance use levels in different products and in consumer habits and practices. In conjunction with the Research Institute of Fragrance Materials (RIFM) and their membership, use level surveys were conducted to develop a database representative of fragrance concentrations in a wide variety of consumer products on the market. This database was linked to a probabilistic exposure model based on a novel database of consumer habits and practices in order to estimate the distribution of aggregate exposure to the fragrances in the US and European markets. The databases and model were also made incorporated into a cloud-based software tool containing the exposure estimates, having the ability to perform new exposure assessments based on different

model assumptions and capable of assessing prospective exposure to new novel fragrance materials being brought to market.

Keywords: A-aggregate exposure, A-exposure models, C-consumer products, A-risk assessment, A-activity patterns

Mo-S-B2: Estimating Recovery Workers' Exposure to Fugitive Chemicals during Cleanup after Hurricane Sandy

Mo-S-B2-01
CBRA Approach to Inform and Utilize Exposure Assessment for Community Plans for Resilience Building and Protection Options
E. Yeampierre, R. Chavez; UPROSE, Brooklyn, NY

Abstract: Exposure assessment science can service community leaders, businesses, and public health officials as they plan for sustainability and resilience in the face of climate change. In the aftermath of Hurricane Sandy, public health efforts have focused on the possible victims of fugitive chemicals and the means by which such risks may be reduced in future scenarios. Collection of information on chemical inventories, source security status, and descriptive evidence on clean-up activities informed modeling of mobility of fugitive chemicals into residential areas and potential exposure/risk of those laboring without protection in the residues of the storm. The research process was monitored and guided by community stakeholders, with an understanding that resilience planning is best achieved locally and at the grassroots. We will discuss the logic of this community led plan along with ideas for utilizing the assessments for community benefit. Also presented will be the challenges and lessons encountered during this community-based data collection process.

Keywords: A-environmental justice, A-climate change, D-community

Mo-S-B2-02
Mapping Flooding and Storm Surge Vulnerability across Sunset Park (Brooklyn, NY) and Documenting Affected Chemical Source Points and Civilian Sector Risks
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Abstract: Vulnerability to coastal storm surges and flooding is greatly influenced by ambient sea levels and storm strength - where climate change projections suggest that hurricanes can begin happening more often, and could take place any time in New York City. Areas endangered under different degrees of flooding and storm surge were modeled yielding maps documenting which chemical source points and civilian sites would be affected by these potential impacts. Considering the security status of chemical sources and the potential vulnerabilities for industrial and civilian sites, the study derived six groups of chemical sources, and multiple sites per chemical. Building on previous research developed by the New York City Environmental Justice Alliance's (NYC-EJA) Waterfront Justice Project, this presentation will describe the methodology designed by the partnership Grassroots Research to Action in Sunset Park (GRASP) along with the maps and diagrams that have resulted from this study. In addition, this presentation will discuss the challenges and lessons learned from the implementation of Geographic Information Systems (GIS) along with community-based participatory research methodologies, the use of "traditional" and "non-traditional" data sources, in an inter-disciplinary collaboration between community organizers, urban planners and public health experts.

Keywords: A-climate change, A-environmental justice, A-geospatial analysis/GIS, Community vulnerability, A-chemical prioritization

Mo-S-B2-03

Utilizing Internet Data, Social Media, and Community Networks to Gather Data for Characterization of Recovery Worker Exposures

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Abstract: Following the devastation caused by Hurricane Sandy, response and recovery for the working-class neighborhoods in New York City's industrial waterfront areas required massive efforts by many different types of recovery workers, including residents, business owners and their employees, paid contractors, and volunteers both from within the affected communities and from other areas. For many, working with little or no training and protective gear, contact (dermal, inhalation and oral) with the debris and muck was inevitable. No systematic monitoring was completed in real-time to understand what types and duration of activities took place or what personal protective equipment was used by the various types of recovery workers. The rise of social media, Internet sharing sites, and mobile digital technologies can retrieve information about recovery worker activities through photos, videos, text narratives and other media, many of which are publicly available. With a unique community-based approach, we have pioneered a systematic collection of these media to understand and characterize exposure-related elements such as behaviors, recovery site tasks, protective equipment, and media comprising the muck and debris. We will discuss a community-based risk assessment approach for gathering and evaluating photographic, digital, and narrative information in order to characterize recovery worker exposures following Hurricane Sandy. The process utilized both a comprehensive media review to collect publicly-available information and a community-led effort to gather private media collections. Successes and challenges in data collection and use and lessons learned will also be presented.

Keywords: A-emergency response, A-activity patterns, D-community

Mo-S-B2-04

Assessing Exposure to Recovery Workers from Fugitive Chemicals after Sandy's flooding

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Abstract: The exposure assessments are calculated using activity profiles constructed from the descriptive information collected by the community and estimates of chemical residue based on analyses of chemical disbursements from the source points in the flooded neighborhoods. These calculations and underlying assumptions are presented. In doing these exposure assessments, we can identify activities and scenarios contributing significantly to exposure. The exposure mitigation achieved by different patterns of protective clothing or changes in activity profiles are also presented. These exposure assessments are useful to community planners and health professionals as they prepare for future disaster responses. This approach could be applied in other communities for disaster planning, and the assessments can be used to prioritize monitoring sites, chemical security plans, and risk mitigation options.

Keywords: A-activity patterns, A-exposure models, D-community, A-aggregate exposure, A-emergency response

Mo-S-B2-05

Panel Discussion: The CBRA Approach for Guiding and Using Exposure Assessments for Community Planning for Disaster Resilience

C. F. Chaisson[1], C. Inserra[2], E. Yeampierre[4], E. Bautista[5], R. Shih[3]; [1]The LifeLine Group, Annandale, VA, [2]NIOSH, Atlanta, GA, [3]RAND, Arlington, VA, [4]UPROSE, Brooklyn, NY, [5]NYC-EJA, Brooklyn, NY

Abstract: The NIOSH project officer will focus the discussion among panelists from RAND, UPROSE, NYC-EJA and The LifeLine Group. Agencies like NIOSH and CDC recognize the challenges introduced by rising sea levels, changing climates and severe weather events. One of those challenges involves potential health threats from chemicals displaced from their storage/use sites during destructive weather events. Approaches used in

this project may be useful for many global sites where rising sea levels and storm threats are forcing communities toward resiliency projects. Estimating the possible concentrations of fugitive chemicals within community zones can focus public health monitoring and protection strategies and inform recovery worker protection practices. CBRA approaches and input strengthen the overall process and increase the likelihood that study results will be accepted and acted upon for community planning. . The sciences of exposure assessment, vector analysis, mapping, modeling, chemical hazard assessment, and activity profiling from visual descriptive materials can inform these difficult community-specific strategies. The scientific approach initiated in this project can be emulated and improved upon when applied to other sites. The panel discussion focuses on the strength and weaknesses of the community-led approach, technical approaches from multiple scientific fields, and social media information sources employed in this project and their utility for public protection options and guidance to health professionals and epidemiologists.

Keywords: A-climate change, A-cumulative exposure, A-emergency response, A-environmental justice, A-environmental policy

Mo-S-C2: Exposure Science in the 21st Century: Activities Across the Federal Government

Mo-S-C2-01
Innovations in Exposure Science at the USEPA
J. Orme-Zavaleta; USEPA, Durham, NC

Abstract: EPA's mission is to protect human health and the environment. Understanding and characterizing exposure is integral to achieving EPA's mission. Exposure is a multidisciplinary science that sets the context for understanding the real world situation and in the context of sustainability, simplifies the problem in a systems context. New innovations in technology are catalyzing advancements in exposure science. EPA is transitioning its exposure research program by emphasizing the use of new tools and technologies. This presentation will focus on innovations in data mining and analysis of big data, use of 'omics, sensors, and computational methods for predicting measurements, integrated systems of predictive models, and high throughput computational exposure analyses. Examples of research in each of these areas will be presented.

Keywords: A-exposure models, A-sustainability, A-exposure factors, Exposure Tools and Technology; innovation

Mo-S-C2-02
Overview of NIEHS Activities in Transforming Exposure Science
D. Balshaw; NIEHS, Morrisville, NC

Abstract: The NIEHS Strategic Plan for 2012-2017 emphasizes a goal on transforming exposure science which places a priority on both enhancing the power and impact of exposure assessment as well as the development and dissemination of the exposome concept. This program builds on nearly a decade of the Exposure Biology Program supporting the development of wearable technologies for monitoring the complexity of the personal environment including chemical exposures and lifestyle factors. The initial focus of the Exposure Biology program included both improving exposure assessment and linking exposure with biological response. Exposure assessment activities include increasing the temporal and spatial resolution of exposure metrics, enabling multi-exposure exposure analysis and decreasing the burden on both the participant and the study investigators. As the program has involved NIEHS has increasingly supported the validation of the tools for use in research and community settings. As we implement the new NIEHS strategic plan we are transitioning our focus from exposure biology to the broader concept of the exposome, the assessment of the totality of exposures across the life-course. Specific near-term goals for the implementation of the exposome include a further expansion of the analytical capacity both at the point of contact and in biomonitoring, the development of computational capabilities for the integration of exposure across scales, the linkage of comprehensive exposure and biological response assessment, and the demonstration of the added scientific value of an exposome analysis.

Keywords: A-sensor technology, A-geospatial analysis/GIS, A-biomonitoring

Mo-S-C2-03
An Overview of NIOSH Activities in Exposure Sciences
G. DeBord; NIOSH/CDC, Cincinnati, OH

Abstract: The National Institute for Occupational Safety and Health (NIOSH) has developed a research program on exposure assessment. The program has two strategic goals: 1) Develop or improve exposure assessment strategies to understand and prevent occupational illnesses and injuries and 2) Develop or improve specific methods and tools to assess worker exposures to occupational agents and stressors. The bulk of NIOSH research in exposure sciences falls under the second strategic goal. NIOSH has identified several emphasis areas within the Exposure Assessment Program to provide tools and guidance to improve occupational exposure studies. These areas include an update to the Occupational Exposure Sampling Strategies Manual, which will provide guidance on how and when to take samples for assessment of exposure and relies on statistical modeling. The NIOSH Manual of Analytical Methods is a compendium of validated analytical and sampling methods for occupationally-related chemicals. Most appropriate for exposure sciences in the 21st century are two initiatives that NIOSH has undertaken. The first initiative is on Direct Reading Exposure Assessment Methods and Monitors (DREAM). Other terms for DREAM include sensors, field portable, real-time. NIOSH has developed an intramural strategy for DREAM to apply to the occupational safety and health field. The goal is to develop a national research agenda for this technology. The second initiative is the Occupational Exposome. NIOSH is exploring how the exposome can be applied to prevent occupational diseases. Progress in these emphasis areas will be discussed.

Keywords: A-analytical methods, D-occupational, A-biomarkers, A-aggregate exposure, A-cumulative exposure

Mo-S-C2-04
Environmental Chemical Mixtures: A Field Approach to Assessing Exposure and Effects
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Abstract: Assessing the human and ecological health risks associated with exposure to complex chemical mixtures is acknowledged as a significant environmental health challenge. A major limitation to addressing this issue is the scant data on actual environmental chemical mixtures. This presentation describes a field-based approach to identifying chemical mixtures and biological activity associated with stream waters affected by a wide range of contaminant sources. The results will (1) document the mixtures and levels of chemicals found in the environment, (2) help identify potential human and ecological exposures, (3) guide prioritization of toxicological studies of chemical mixtures, and (4) provide insight into potential biological interaction of multiple contaminants. Stream sites were selected from environments that are vulnerable to multiple contaminant sources, including industrial and municipal wastewater discharges, crop and animal agriculture, land-applied manures and biosolids, urban runoff, and other point and nonpoint contaminant sources. Data from previous U.S. Geological Survey (USGS) studies of contaminants of emerging environmental concern provide a basis for site selection. The approach combines comprehensive chemical characterization, which includes sensitive and specific direct analysis for over 700 dissolved organic and inorganic chemicals, identification and quantitation of unknown contaminants (environmental diagnostics), and a battery of bioassays to evaluate biological activity and toxicity. Sample collection and analysis, and data interpretation in this study are inherently complex. Therefore, this pilot study also will test the feasibility of future expansion in terms of sites, environmental media, and exposure and effects pathways. The study is a collaborative effort between the USGS, which leads the site selection, sample collection, and chemical characterization, and the U.S. Environmental Protection Agency, which leads the biological testing.

Keywords: A-aggregate exposure, A-ecological exposure, C-streams, A-chemical prioritization, chemical mixtures

Mo-S-C2-05
Occupational Exposures at Electronic Waste Recycling Facilities
D. Ceballos, E. Page; CDC NIOSH, Cincinnati, OH

Abstract: The National Institute for Occupational Safety and Health performed evaluations at eight electronics waste recycling facilities, and conducted a pilot survey on health and safety in the U.S. electronic waste recycling industry. The purpose of this work is to improve understanding of occupational exposures to metals and other contaminants, and to make recommendations to control these exposures. In our health hazard evaluations we found that employees had overexposures to airborne lead and cadmium, there was surface contamination with heavy metals outside the production areas, a lack of or insufficient engineering controls, poor work practices (such as dry sweeping metal containing dusts), and "take-home" metal contamination issues. Some facilities did not have employee showers and only provided uniforms to employees in the areas thought to have more exposure to metals and other contaminants. Our nationwide survey had a low response rate (47/307 facilities or 15%). Among survey respondents, we found that 1) most companies which responded had between 10 to 80 employees, 2) all recycled a wide array of electronics, 3) most performed manual recycling processes, and 4) some facilities had practices that suggested metal dusts were generated while recycling was not well controlled. We have learned that exposures can be dynamic, due to the variety and varying quantities of electronics being recycled. For example, electronic waste recyclers may only monitor for lead, although their employees may be exposed to mercury, cadmium, nickel, beryllium, and other contaminants.

Keywords: A-workplace, B-metals, D-occupational, A-exposure factors, A-biomonitoring

Mo-O-D2: Global Health: Exposures from Cookstoves

Mo-O-D2-01
Comparison of Household Air Pollution (HAP) Levels between Open Fire and Improved Stoves, Rural Western Kenya

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Abstract: Background: Nearly 3 billion people worldwide use solid fuel as their main household fuel source; household air pollution (HAP) from burning biomass fuels is a risk factor for health effects including respiratory and cardiovascular disease. WHO recently concluded that improved combustion stoves, improved ventilation, and reduced solid fuel use can help reduce HAP. As part of a larger evaluation to identify improved stoves that can be made available in Kenya, this study characterized and compared carbon monoxide (CO) and fine particulate matter (PM2.5) concentrations for the traditional open fire cooking method and improved stoves. Methods: Up to six different improved cookstoves were installed during six different 2-week periods in 45 households in two rural Kenyan villages. We conducted a cross-over exposure assessment to measure HAP for the traditional open fire cooking method (baseline) and each improved stove (Ecochula, Ecozoom, Envirofit, Philips, Prakti, and RTI-TECA). In USEPA lab testing, these selected stoves reduced PM2.5 levels by up to 90%. We collected 48-hour PM2.5 and CO samples in the kitchen. We performed descriptive analysis and compared paired measurements between baseline and post-installation of each improved stove. The analytic sample size varied by stove type (n=34-39). Results: The mean baseline 48-hour PM2.5 level (793 μg/m3) measured in this study is elevated compared to the WHO Guideline (35 μg/m3). Mean PM2.5 levels ranged from 476 to 726 μg/m3 by stove type, representing median reductions of 24% to 48%. The mean baseline 48-hour CO level was 9.1 ppm. Mean CO levels ranged from 6.0 to 10.0 ppm by stove type, representing median reductions of 13% to 56%. The Philips stove performed best in reducing both PM2.5 and CO. Conclusions: The data shows that improved stoves reduce HAP, but PM2.5 levels remain 14-21x higher than WHO Guidelines. High PM2.5 levels could be affected by multiple stove use, kerosene lamp usage, and stove acceptability.

Keywords: A-global health, A-indoor environment, B-particulate matter, A-exposure factors, cookstoves

Mo-O-D2-02

Concentration of Indoor Particulate Matter and Carbon Monoxide Among Households Using Biomass Fuels in Sarlahi, Nepal: The Effect of Cooking, Fuel Type, and Season

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Abstract: Purpose: A large (n=3129) cookstove intervention trial is underway in the Sarlahi district of Nepal. The purpose of this paper is to summarize baseline 24-hour indoor particulate matter (PM) and carbon monoxide (CO) concentrations. Methods: 24-hour continuous PM and CO samples were collected in 2871 households (92%) from March 2010 to September 2011. PM was measured passively using the pDR-1000. PM concentration values were humidity corrected and adjusted to PM2.5 equivalents using a subset of co-located gravimetric samples. CO was measured using a LASCAR data-logging CO monitor. Cooking events were identified based on empirical assessment of temporal trends in PM concentration. Regression models were utilized to evaluate the association of PM and CO concentration with cooking, fuel type, season, and household characteristics. Results: The median of daily average PM concentrations was 1334µg/m^3 (IQR, 1279), median 95th percentile of PM concentration was 4625µg/m^3 (IQR, 4878), and mean of time above 500µg/m^3 was 11.04h (95% CI, 10.86—11.22). The median of daily average CO concentrations was 8.2ppm (IQR, 9.2), and median 95th percentile of CO concentration was 36.5ppm (IQR, 56.5). The mean cooking time per day was 5.63h (95% CI, 5.55—5.72), and median difference of average PM concentration between cooking and non-cooking time was 3140µg/m^3 (IQR, 4093). All PM concentration metrics peaked in the dry season and dipped in the rainy season, while no significant seasonal variation was identified in CO concentration. PM concentration and CO concentration were weakly associated, which varied by fuel type and season. Among major biomass fuels used in Nepal, wood generated the lowest PM concentrations, and crop waste generated the lowest CO concentrations. Conclusions: Baseline PM and CO concentrations are extremely high in the Nepal cookstove trial study homes. PM demonstrated significant variability associated with season and fuel type.

Keywords: A-indoor environment, B-particulate matter, carbon monoxide, biomass fuel, Nepal, carbon monoxide, biomass fuel, Nepal, carbon monoxide, biomass fuel, Nepal

Mo-O-D2-03

Relationship of Mosquito Density and Particle Loading from Cooking Fires in Kenya

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Abstract: Background: Growing evidence suggests that improved cook-stoves can reduce indoor air pollution, lower respiratory infections and help mitigate climate change. Yet, as with many public health interventions, the impact of one intervention may affect other disease systems. Our previous research indicated that individuals residing in homes with cooking fires were half as likely to develop malaria. Aims: The objective of our study was to use passive samplers to characterize particle loadings in sleeping chambers that are with and without a cooking fire, and to see if there was a relation with mosquito densities. Methods: We placed 120 mm diameter filters in plastic buckets (h=191 mm) for at least 7 days. Samples were collected in 21 houses with cooking fires in the sleeping quarters and 24 houses with separate sleeping quarters in western Kenya in low and high transmission settings (i.e. highlands and lowlands). Indoor resting mosquitoes were collected using pyrethrum spray catches at one time point and identified to species. Results: The particle loading in sleeping chambers with a cooking fire (GM=0.004 mg/mm2, GSD=1.11) were significantly higher than the particle loading in separate sleeping chambers (GM=0.002 mg/mm2, GSD=1.18) (p<0.0001). There was no difference in particle loadings between the highland and lowland sites. No mosquitos were quantified in highland houses. Among the lowland houses, there was a moderate negative correlation between particle loading and mosquito counts (Spearman rho=-0.37). Conclusions: Passive air samplers may be a simple low-cost method to assess particle loadings from biomass cooking fires. Our results indicate that a broad-scale distribution of cookstoves in malaria endemic areas may inadvertently increase risk of malaria. Future cookstove interventions should integrate well-established mechanisms for malaria control such as distribution of insecticide-treated bednets.

Keywords: B-particulate matter, A-indoor environment, A-global health, A-Infectious disease, cookstoves

Mo-O-D2-04

Objective Assessment of Stove Use with Temperature Sensors in a Multi-Stove Study — Kenya, 2012-2013

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Abstract: Background: Household air pollution (HAP) caused by burning biomass fuel for cooking accounts for 500,000 annual pediatric pneumonia deaths in the developing world. The Global Health Alliance aims to reduce HAP and improve health outcomes by installing 100 million improved cookstoves by 2020. However, limited data are available on stove-type preference and stove acceptability. We analyzed data from data-logging temperature sensors to assess improved cookstove use objectively during a multi-stove intervention study. Methods: Up to six different improved cookstoves (Ecochula, Ecozoom, Envirofit, Philips, Prakti, RTI-TECA) were installed in a cross-over study during six 2-week periods in 45 households in two rural Kenyan villages; traditional stoves remained available for use. Temperature sensors logged traditional and improved cookstove temperatures and ambient temperature every 10 minutes. Recorded stove temperatures were adjusted for ambient temperature and cooking events were identified using a temperature-change algorithm. Preliminary analyses using ANOVA and chi-squared tests were conducted to compare stove use across improved cookstove types. Results: The 1,247 days with complete data were categorized as: improved cookstove only (24%), traditional stove only (27%), both stoves (42%), and neither stove (7%). Days with any improved cookstove use (alone or with traditional stove) ranged from 58% to 72% across stove types ($p<0.05$). When improved cookstoves were used, daily improved cookstove cooking events ranged from 1.8 to 2.8 across stove types ($p<.0001$). Conclusion: Improved stoves were used frequently, but exclusive use was not common. This study identified two improved cookstoves that were used more often, suggesting increased acceptability within study households. Integration of these results with HAP exposure reduction and qualitative data will help determine if one or more improved cookstoves could be used in a longitudinal health study.

Keywords: A-behavior, A-global health, A-indoor environment, A-sensor technology

Mo-O-E2: Indoor / Outdoor Air Pollution - II

Mo-O-E2-01

Coupling Chemical Transport Model Source Attributions with Positive Matrix Factorization

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Abstract: Background: Source based apportionment models use presumed emissions and atmospheric processes to estimate the downwind source contributions. Conversely, receptor-based models leverage speciated concentration data from downwind receptors and apply statistical methods to predict source contributions. Integration of both source-oriented and receptor-oriented models could lead to a better understanding of the implications pollution sources have on the environment and society. Methods: Source contributions to total fine particle carbon predicted by a chemical transport model (CTM) were incorporated into the Environmental Protection Agency's Positive Matrix Factorization (PMF) receptor model to form a receptor-oriented hybrid model. The level of influence of the CTM versus traditional PMF was varied using a weighting parameter. The resulting hybrid model was used to quantify the contributions of total carbon from both wildfires and biogenic sources at two Interagency Monitoring of Protected Visual Environment monitoring sites, Monture and Sula Peak, Montana, from 2006 through 2008. Results: The lowest, cross-validated root mean square error in total carbon was identified at a weighting parameter between the traditional CTM and PMF results, indicating a robust and improved ability to fit total carbon. Traditional PMF modeling at each site did not resolve a biogenic feature, however the CTM constraints of the hybrid model allowed for the separation of biogenic from wildfire. Two additional features were identified at each site, a soil derived feature and a feature enriched in both sulfate and nitrate. Conclusions: By incorporating information which helps tie the EPA PMF model to emissions and meteorological information, an improvement in exposure assessments can be realized.

Keywords: B-particulate matter, C-air, source apportionment

Mo-O-E2-02

Ambient Air Heavy Metals in PM2.5 and Potential Human Health Risk Assessment in an Informal E-waste Recycling Site of China

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Abstract: Worldwide, electronic waste (e-waste) has become one of the most rapidly growing sources of human residues. Guiyu is one of the largest e-waste destinations and recycling areas in the world. Particulate matter with an aerodynamic diameter less than 2.5μm (PM2.5) in the atmosphere is a significant concern for human health. The informal structure of processing and recycling e-waste in Guiyu has led to the release of several carcinogenic and hazardous substances into the air, which may lead to adverse health effects for humans. To estimate the health effects of particulate matter for local residents, we assessed the potential public health risk associated with the heavy metal composition of PM2.5. Daily samples of PM2.5 were collected with Harvard Impactors on the roof of 3-story buildings from March 2012 - April 2013 in Guiyu (n=133) and a reference site, Haojiang (n=33). The mass concentrations of PM2.5 were determined by gravimetric analysis. Filters were digested by microwave and used to determine Pb, Cd, Cr, and Mn by GFAAS. The geometric mean of concentrations of PM2.5, Pb and Cd in Guiyu were higher than in the reference area (PM2.5: 49.91 μg/m3 vs. 37.60 μg/m3, p<0.01; Pb: 164.03 ng/m3 vs. 69.26 ng/m3, p<0.001; Cd: 5.69 ng/m3 vs. 3.39 ng/m3, p<0.01), but Cr and Mn concentrations were not (Cr: 4.51 ng/m3 vs. 3.81 ng/m3, p>0.05; Mn: 16.93 ng/m3 vs. 15.64 ng/m3, p>0.05). The metal concentrations in PM2.5 from Guiyu were also higher when compared to other Asian cities. We observed higher heavy metal concentrations during winter and spring seasons. Human health risk assessments have shown that the carcinogenic and non-carcinogenic elements in PM2.5 might pose more serious public health risk to children than adults. In summary, exposure to ambient air PM2.5 and metals (Pb, Cd) were higher in Guiyu compared with the reference site. Air pollution resulting from informal e-waste recycling activities might be affecting the health of local residents, especially children.

Keywords: C-air, A-risk assessment, B-particulate matter, B-metals, e-waste

Mo-O-E2-03

Nontargeted Analysis of PM2.5 Particulates in Air Samples from a US-Mexico Border City by Comprehensive Two-dimensional Gas Chromatography Coupled to Time-of-Flight Mass Spectrometry

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Abstract: Fine particulate matter in air, or PM2.5, is recognized as a major cause of morbidity and mortality world-wide. However, the individual components of PM2.5 responsible for adverse health effects are still under investigation. Toxicity and human studies have identified polycylic aromatic hydrocarbons (PAHs) as a major class of chemicals associated with adverse health effects such as cancer and effects on fetal growth and development. The EPA has listed many PAHs as Priority pollutants. Recently, attention has turned to related compounds such as oxy- PAH compounds, some of which are much more mutagenic than the parent PAH compounds. Particulate pollution at the US-Mexico border is a concern but has not been well characterized. Here we report on a wide class of PAHs and other compounds found in urban air in the US-Mexico border city of Tijuana, Baja California, Mexico. Samples were collected for 24 hours using a high-volume PM2.5 air sampler operated at 1.13 m3/min, onto pre-baked quartz filters. Microwave assisted extraction in 1:1 of hexane:acetone was followed by clean up with silica based solid phase extraction. Analysis was by nontargeted comprehensive two-dimensional gas chromatography coupled to time-of-flight mass spectrometry. Compounds were identified through searching 2011 NIST EI mass spectral library and were listed if there was a >70% match. A wide range of PAHs and other compounds were detected. Compounds ranged from oxy-PAHs abundant in diesel (e.g. 9,10-anthracenedione) and others (9,10-anthracenedione, 2-methyl-), to organic nitrate species. In air near the maquiladoras (foreign-owned factories operating in the free trade zone), multiple phthalate compounds were abundant. Quantitative analysis is ongoing for additional locations. This is the first nontargeted analysis of PAHs and related compounds in urban air in Tijuana, Mexico. Such analysis may inform studies of sources and health risks of pollution in the US-Mexico border region.

Keywords: A-analytical methods, A-environmental justice, A-global health, B-particulate matter, C-air

Mo-O-E2-04 – Withdrawbn

Mo-O-F2: Air Pollution Epidemiology - II

Mo-O-F2-01
Potential Respiratory Health Effects of Electronic Cigarette Emissions
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Abstract: The emerging trend of electronic cigarettes (e-cig) poses several new issues for regulatory agencies due to limited data characterizing e-cig emissions and toxicity. To help understand potential health effects, we conducted a study to characterize the inhalation dosimetry and cytotoxicity of e-cig emissions. Mainstream e-cig emissions were generated using a commercially available e-cig and two types of liquid (liquid-1 and 2). We simulated smoking events using behavioral pattern data and smoke inhalation parameters, reported for conventional cigarette. Aerosol deposition fractions in the lungs of a 14-year old adolescent and exhalation fraction were calculated using Multiple-Path Particle Dosimetry model with the measured aerosol size and concentration as model inputs. Mainstream emissions of each e-cig liquid and conventional cigarette were separately collected in cell culture media using liquid impingers. Human airway cells (NL20) were inoculated with the culture media at the doses equivalent to smoking 1 and 3 cigarettes, and cytotoxicity was measured by lactate dehydrogenase (LDH) assays after 24 hours. We also inoculated cell cultures with the neat liquids and measured cell viability by trypan blue staining. The dosimetry model indicated that 47% of mass of inhaled emission were deposited in the lung, with 40% in the alveolar region, and 53% was exhaled. Liquid-1 induced a higher LDH activity than conventional cigarettes, and both caused much greater response than liquid-2 and controls. Cells inoculated with the different neat liquids showed similar toxicity between those in a dose-dependent manner. This study showed differential cytotoxicity caused by inhalation exposures to different types and doses of e-cig emissions. There is also a potential concern for second-hand exposure. Understanding the physical, chemical, and toxicological properties of myriad products will require standardized testing approaches so that reliable comparisons can be made.

Keywords: A-sampling methods, C-air, A-exposure models, Emerging tobacco products

Mo-O-F2-02
Exposure to Multiple Sources and Components of Air Pollution and Preterm Birth in California, 2001-2008
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Abstract: Preterm birth (PTB, before 37 gestational weeks) has been associated with exposure to air pollution, but it is still unclear which sources and components of air pollution might be in play. This work examined the relationships between PTB and exposure to multiple components of air pollution, including gas and particles by size fraction, sources and chemical composition in California (USA) over period 2001-2008. Daily averaged primary particulate matter (fine (PM2.5) and ultrafine (PM0.1)) concentrations were modeled at a 4 km*4 km resolution for 2000-2006, by emission source and composition. Secondary particles were modeled for 2000-2008. Monthly ambient ozone (O3), nitrogen dioxide (NO2) and total PM2.5 concentrations from monitoring stations (2000-2008) were spatially interpolated using Bayesian kriging. Birth certificate data were geocoded to the maternal address at delivery. Associations between PTB (N= 394,683) and air pollutants were examined using a case-control approach with 2 controls per case. Conditional logistic regression models were adjusted for maternal age, race/ethnicity, education and neighborhood income. PTB risk increases by 9-10% for interpolated NO2 and O3, and 17% for total PM2.5, per inter-quartile range increase in entire pregnancy exposure (IQR). For primary PM, the strongest associations by source per IQR are for onroad gasoline, followed by onroad diesel, offroad gasoline and commercial meat cooking. Associations are slightly stronger for PM0.1 than for PM2.5. For PM2.5 composition, the strongest positive associations with PTB risk are observed for nitrate, ammonium and secondary organic aerosols (SOA) (8-15% increased risk per IQR), followed by EC, OC and K (3-4% increased risk per IQR), while metals show only weak associations. For PM0.1, 8-11% increased risk is observed per IQR increase in Al, Ti, V, Si and SOA. In conclusion, both secondary pollutants and species in primary PM are associated with increased PTB risk in California.

Mo-O-F2-03
Evaluating Influential Factors for Spatial Variability of the Effect of Air Pollution on Term Birth Weight Using Bayesian Hierarchical Models
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Abstract: Studies suggest that air pollution has adverse effects on pregnancy outcomes. Such effects can be modified by socio-demographic and environmental factors. Few studies have investigated the impact of these factors on spatial variability of the effects of air pollution. We developed a two-stage Bayesian hierarchical model to evaluate spatial variability of the effects of air pollution on the weight of term birth infants (≥37 gestational weeks) across census tracts and the influential factors for such spatial variability. Based on the birth certificate records from 2001 to 2008 in Los Angeles County, California, USA, we developed a two-stage hierarchical non-linear model to evaluate the spatial variability of the effects of air pollution on term birth weight across Census tract and the influence of socio-demographic (including ethnicity and socioeconomic variables) and environmental (including land-use and greenness variables) factors on the variability of the effects. Air pollution exposure was modeled at individual level for nitrogen dioxide (NO_2) and nitrogen oxides (NO_x) using spatiotemporal models. We found adverse effects of air pollutants on term birth weights (-1.47 g per ppb increment in NO_2 and -0.69 g per ppb increment in NO_x). The effects of NO_2 and NO_x were spatially clustered. Spatial variability of such effects was affected by socio-demographic (ethnicity, median family income, maternal education, and commuting means and time to work), and environmental (distance to freeways/highways, proportion of land-use for agriculture, heavy industry and park/recreation, and greenness) factors. This study contributes new findings on influence of socio-demographic and environmental factors on the spatial variability of the effects of air pollution on term birth weight.

Mo-O-G2: Chemicals in Consumer Products - I

Mo-O-G2-01
Original and Replacement Chemicals in Consumer and Personal-Care Products: Tracking Marketplace Evolution and Human Exposure Trends
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Abstract: Background: Synthetic organic chemicals such as phthalates and bisphenol A (BPA, plasticizers), triclosan (antimicrobial agent) and polybrominated biphenyl ethers (PBDEs, flame retardants) can be used in personal care and consumer products both as "active" and "inactive" ingredients. Data on the potential effects of these chemicals on human health are limited and, at times, even contradictory, but because several of these chemicals have demonstrated toxicity in experimental animals, replacement chemicals are entering consumer markets. However, limited information exists on consequent trends in exposures to both the original chemicals and their replacements. Aims: To examine temporal trends in the United States in biomarker concentrations of chemicals used in consumer products and their replacements and whether trends vary by age, sex, race/ethnicity, or income. Methods: We use case studies including phthalates, BPA, PBDEs, and organophosphate insecticides, to show patterns of exposure among the US general population and select population groups to these chemicals and their replacements, including other phthalates and non-phthalate plasticizers, other bisphenols, organophosphate flame retardants and pyrethroid insecticides. Results: We observed clear differences by age, sex, race/ethnicity and income in concentrations of personal-care and consumer products chemicals that likely reflect differences in lifestyle. Furthermore, although exposure to the original personal-care and consumer products chemicals is still prevalent among the general U.S. population, exposures to the replacement chemicals appear to be on the rise. Conclusions: Exposure to chemicals used in personal-care and consumer products has changed in the last decade. Explaining such exposure trends is difficult because of data gaps. Nonetheless, changes in commercial formulations prompted by legislative activity and campaigns by non-governmental advocacy groups may play a role.

Mo-O-G2-02

Relating Aggregate Consumer Exposure Assessment to Baseline Levels of a Biomarker: Challenges and Opportunities for Validation

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Abstract: The risk assessment for chemicals contained in consumer products grounds on exposure assessments, for which the mechanistic models that can predict population exposure are essential tools. Nevertheless, the exposure assessments conducted to assist regulatory or policy decisions are often challenged to demonstrate their validity. The validation becomes particularly challenging for complex exposure scenarios, involving multiple routes of entry into the body, e.g. in the case of modelling aggregate consumer exposure to a volatile ingredient contained in various personal care products (PCPs) when both dermal uptake and inhalation have to be considered. Here, we present a case study for the validation of a probabilistic aggregate exposure model. A computational framework was designed to quantitatively relate human biomonitoring data to the modelled exposure distribution for a common PCP ingredient, decamethylcyclopentasiloxane (D5), that serves as an illustrative example owing to its high volatility and lipophilicity. The framework employs physiologically based kinetic modelling in conjunction with numerical forward and reverse dosimetry. Considering the uncertainties in the probabilistic exposure assessment the modelled results agree well with the baseline end-exhaled air concentrations of D5 measured in a controlled volunteer study. The variation of biomarker concentrations in relation to the time-intervals between the modelled exposure events will be discussed. The analysis presented here provides a starting point for introducing improved designs for further biomonitoring studies, from the perspective of exposure reconstruction and/or validation, identifies limitations in existing methods for the validation of exposure modelling, and suggests approaches for the validation of exposure models with population biomarker data.

Keywords: A-aggregate exposure, A-biomarkers, A-biomonitoring, A-exposure models, model validation

Mo-O-G2-03

Measurement of the Transfer of SVOCs from Consumer Products to House Dust

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Abstract: Background: Several studies suggest that house dust contributes to human exposure to chemical substances contained in various consumer products. However, it is neither known for which compounds the exposure to dust has an important contribution nor for which compounds and products there is an efficient transfer into house dust. Aim: In a small-scale field study, the contribution of the dust pathway to human exposure is investigated for semi volatile organic compounds (SVOCs). The compound transfer rates from consumer products to dust are measured and compared to transfer rates for other exposure pathways that are relevant for consumer products that are not intended for ingestion such as hand-to-mouth contact and inhalation. Methods: Eight deuterium labelled target SVOCs (phthalates and adipates) were synthesized and introduced into artificial plastic consumer products that are used in different use scenarios with several emission processes (e.g. evaporation, mechanical stress etc.). The plastic products were installed in five apartments for the duration of twelve weeks. To study consumer sprays, the participants of the study were supplied with an insecticide spray, which they used for a defined period of time. During the study indoor dust and air samples were collected regularly using different sampling techniques such as wiping and vacuum cleaning. Extraction and clean-up procedures were adjusted to the target compounds and matrix components. Finally, the samples were quantified by GC-MS. Discussion: Key points of the field study will be discussed, including: product preparation, sampling techniques and sample preparation before analysis. The results of the controlled experiment will be presented and the relevance of different dust transfer pathways from product into dust will be compared.

Keywords: A-analytical methods, A-indoor environment, B-phthalates, B-SVOCs, C-air

Mo-O-G2-04
Infant Exposure to Emissions of Volatile Organic Compounds from Crib Mattresses

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Abstract: Infants spend most of their time sleeping and are likely to be exposed to elevated concentrations of chemicals released from their crib mattresses. Small-scale chamber experiments were conducted to determine the area-specific emission rates (SERs) of volatile organic compounds (VOCs) in a collection of twenty new and used crib mattresses. All mattress samples were found to emit VOCs and the mean values of total VOC (TVOC) SERs were 56 µg/m2h at 23°C and 139 µg/m2h at 36°C. TVOC SERs were greater for new mattresses compared to used ones and were influenced by the type of foam material and the presence of mattress cover layer. A variety of VOCs were identified, with polyurethane foam releasing a greater diversity of VOCs compared to polyester foam. Large-scale chamber experiments were conducted with an infant thermal manikin. TVOC concentrations sampled in the breathing zone and interior pore air of the crib mattress foam were found to be greater than the bulk room air by factors in the range of 1.8 to 2.4 and 7.5 to 21, respectively. The results suggest that crib mattresses are an important source of VOCs and infant exposure to VOCs are possibly elevated in their sleep microenvironments. This study should help understand infant exposures to VOCs as well as other contaminants emitted from crib mattresses, such as plasticizers and flame retardants, which may disproportionately affect infants and lead to lifelong illnesses and disabilities.

Keywords: Infant exposure, Volatile Organic Compounds (VOCs), Sleep Microenvironment, Crib mattress

Mo-O-G2-05
Ex Priori: Exposure-based Prioritization across Chemical Space

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Abstract: EPA's Exposure Prioritization (Ex Priori) is a simplified, quantitative visual dashboard that makes use of data from various inputs to provide rank-ordered internalized dose metric. This complements other high throughput screening by viewing exposures within all chemical space simultaneously (not chemical by chemical). Within modern society, exposure to a wide range of chemicals through our daily habits and routines is ubiquitous and largely unavoidable. The initial focus to estimate exposure to chemicals in products used in microenvironments (uE) necessitates a "systems" model to delineate data needs arising from numerous knowledge bases to integrate product formulations, purchasing and use activities, and human activities. This will indicate products likely to be in the uE and how people come into contact with chemicals in these products. Ex Priori will quantitatively extrapolate single-point estimates of both exposure and internal dose for multiple exposure scenarios, factors, products, and pathways in rank order by biological dose. To rank-order internalized dose from everyday consumer product exposures for a given individual profile, the approach uses multiple integrated data streams including (a) everyday product ingredient data; (b) pharmacokinetic factors, (c) consumer product category-specific "exposure factor surrogates" and (d) time/activity estimates (human factors). These different data streams allows us to estimate multi-chemical signatures of exposure, internalized dose (uptake), remaining dose or body burden and elimination. This overview shares lessons learned that translate into how the future of data-driven informatics-based approaches in support of chemical risk assessment can evolve. Disclaimer: The views expressed in presentation are those of the author and do not reflect the views or policies of the United States Environmental Protection Agency.

Keywords: A-exposure models, A-chemical prioritization, A-aggregate exposure, A-indoor environment, C-consumer products

Mo-S-A3: Assessing Exposures to Chemicals in Consumer Products: Databases, Models and Case Studies - III

Mo-S-A3-01

The Role of Consumer Products as a Source of Exposures to Existing Substances Assessed under the Canadian Chemicals Management Plan - A Retrospective Analysis

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Abstract: The Government of Canada "Challenge" for chemical substances that are a high priority for action included screening assessments of approximately 200 chemicals completed since 2006. An analysis of these as well as other recently completed assessments was conducted to determine the predominant routes of exposure for various consumer products (e.g. paints, personal care products, household cleaners, do-it-yourself products) as well as the types of exposure data available (Canadian vs non Canadian, modeled vs measured). The analysis also examined the role of children's exposure when conducting risk assessments and critical factors to consider when estimating both direct and indirect exposure sources for this sub-population. The presentation will highlight the role of various data sources including biomonitoring data, subpopulations with highest exposures, and a comparison of consumer product exposure with other sources of exposure (food, ambient air, indoor air, drinking water, dust). Current issues such as exposure data availability, uncertainty related to the application of human exposure models for chemical risk assessment, and how human exposure assessment and prioritization tools may be advanced in the future will be discussed.

Keywords: C-consumer products, D-children, A-exposure models, A-risk assessment, C-personal care products

Mo-S-A3-02

New Developments in the Assessment of Consumer Exposure under TSCA

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Abstract: The U.S. Environmental Protection Agency's Office of Pollution Prevention and Toxics (OPPT) is responsible for assessing and managing risks to chemicals under the Toxic Substances Control Act (TSCA), including potential risks associated with consumer exposure. Exposure assessors within OPPT develop assessments of consumer exposure for new chemicals which have yet to be commercialized, as well as existing chemicals, which are in commerce. In general, the data with which to assess consumer exposure to chemicals in products reviewed by OPPT is quite limited. For new chemicals, manufacturers or importers must provide the Agency with information 90 days prior to import or manufacture of non-exempt new chemicals. For existing chemicals, OPPT generally uses readily available data in the literature and from other sources when developing the exposure assessment for consumer use of chemicals. Several activities are underway to enhance and update OPPT's data and methods used for assessing consumer exposure for new and existing chemicals. These ongoing activities include development of a comprehensive database of information on consumer products, updating of computerized models used to estimate consumer exposure to ensure that the most current science is utilized in these important assessments, and updating and enhancing generic scenarios used for assessing consumer exposure. These generic scenarios include information on specific types of consumer products, and factors relevant to the potential for exposure while using the consumer product. The views of the authors of this abstract are those of the authors and do not represent Agency policy or endorsement.

Keywords: C-consumer products, A-exposure models, A-exposure factors

Mo-S-A3-03

The Challenge of Measuring Nanomaterials in Consumer Products

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Abstract: Nanomaterials (NMs) are in products either by new manufacturing techniques or by re-labeling of conventional materials through new awareness or regulatory definitions. Hazard studies of some pristine NMs prior to incorporation in products are showing potential for health effects. However, we cannot connect the hazard studies to uses because the NMs that come out of consumer products may not be the same as what is used in toxicity studies. Between 2011 and 2014 task groups of the NanoRelease projects assembled knowledge about release in a series of publications, to inform reliable measurement and "real world" risk evaluations. In life cycle, materials, and methods review the project has focused attention to release scenarios

for commercial uses of NMs. Most importantly though the project could identify no methods to quantitatively measure what is actually released relative to potential measures of toxicity. To begin to fill this void laboratories from US, Canada, France, Germany, and Korea have volunteered resources for inter-laboratory study of abrasion and weathering, focusing on modeling release repeatably, proposing quantitative protocols for detection relative to risk, and thereby laying the groundwork for quantitative exposure methods. While evidence so far does not raise alarm for unrecognized risk, a tremendous amount of work is needed before we can measure exposure from actual uses. The project is also forcing realization that "hazard first" approach to risk assessment based on study of pristine NMs in controlled dispersions in laboratories is failing. There is a pressing need for an "exposure first" approach instead, understanding first whether materials are released of potential concern, and then measuring what actually enters into exposure pathways and what should be measured in toxicity evaluations. We will present findings of what is released and progress in methods development supporting an exposure first approach.

Keywords: B-nanoparticles, A-sampling methods, C-consumer products, D-occupational, A-risk assessment

Mo-S-A3-04

Refined Exposure Estimates Relying on Biomonitoring Data Associated with Consumer Product Use

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Abstract: A volunteer study was conducted to determine the extent of selected target analyte excretion in urine associated with personal care product use. Every urine void over a 6 day period was collected, with the time and volume of void recorded, for eight individuals. Personal care product use diaries were also recorded. The study included a two day "abstention" period in which personal care products with target analytes were replaced with products that did not contain those analystes. Total excreted quantities of product ingredients, total mass of products used, and time course of analyte excretion are presented for several parabens, triclosan, and benzophenone-3. These data can be used to validate and/or refine consumer product exposure models and to provide basic human pharmacokinetic profiles for the included analytes.

Keywords: A-biomonitoring, C-consumer products

Mo-S-B3: Mining - Occupational Exposures and Community Health Impacts

Mo-S-B3-01
Comparison of Diesel and Biodiesel Exhaust: Acute Human Health Effects

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Abstract: Diesel exhaust is a known carcinogen with pulmonary and vascular health effects. Compliance with occupational standards for exposure is problematic in many underground mining settings. As a result, alternative fuels such as biodiesel have been substituted to improve compliance, although it is unknown whether this substitution changes the toxicity of the resulting exhaust. Using a cross-over study design, 22 subjects were exposed for 200 minutes to exhaust from diesel fuel and a 75% biodiesel/25% diesel mixture (B75) in an underground mine. Pre- and post-exposure levels of endothelin-1 (ET-1) and soluble P-selectin (sP-selectin) in blood and myeloperoxidase (MPO), matrix metalloproteinase-9 (MMP-9), and interleukin-6 (IL-6) in sputum were measured. MPO, and MMP-9 increased and sP-Selectin decreased post-exposure with both fuel types and ET-1 increased following diesel exhaust exposure only (Table 1). IL-6 concentrations did not significantly change with either exposure and are not included in the table. Table 1. Biomarker concentrations (mean ± s.d) in blood and sputum at baseline and post-exposure to diesel exhaust and B75 exhaust. Biomarker Baseline Post-Diesel Post-B75 ET-1 (pg/mL in blood) 1.73 ± 0.38 2.41 ± 1.96** 2.2 ± 2.01 sP-Selectin (ng/mL in blood) 44.73 ± 15.4 34.31 ± 11.6*** 31.96 ± 11.6*** MPO (ng/mL in sputum) 596.7 ± 1117.23 902.87 ± 933.6** 697.41 ± 674.78** MMP-9 (ng/mL in sputum) 501.97 ± 587.74 1296.18 ± 1388.55** 1010.70 ± 981.79** * $p < 0.05$ for difference between baseline and post-exposure levels ** $p < 0.01$ for difference between baseline and post-exposure levels *** $p < 0.001$ for difference between baseline and post-exposure levels However, biomarker levels did not differ significantly between diesel and biodiesel exhaust post-exposure measurements. The preliminary results indicate that inhalation of exhaust from both fuels results in acute health effects, with some evidence for reduced toxicity associated with B75 use.

Keywords: D-occupational, A-biomarkers, C-air, diesel exhaust, biodiesel exhaust, diesel exhaust, biodiesel exhaust

Mo-S-B3-02
Size-dependent Characterization of Dusts from Mine Tailings Deposits

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Abstract: Airborne particles originating from mine tailings deposits may contain toxic concentrations of metal and metalloid contaminants. The risks associated with such particles are related to particle size given that finer particulates are more easily transported off-site and may be readily inhaled. Implications to human health should be assessed through a holistic size-resolved characterization comprised of geochemical, bioavailability, and toxicity experiments, which require gram-size samples that are difficult to collect using conventional sampling instruments. To address this limitation, a laboratory dust generator was developed with the goal of producing size-fractionated dust representative of the field to provide a common sample for multidisciplinary studies. In the dust generator setup, a clean air source enters a rotating drum where the source material is mixed and re-suspended. Entrained particles follow the airflow towards a cyclone separator. Fractionated material is then collected in a settling chamber and subjected to characterization. The instrument was optimized for the fractionation of tailings deposits from the arsenic and lead-contaminated Iron King Superfund site in Dewey-Humboldt, AZ. Chemical characterization shows the contaminants are more concentrated in the smaller size fractions, which are also more likely to affect surrounding communities and ecosystems. The equipment and methods developed for this assessment ensure uniformity between physical and chemical characterization, bioavailability and toxicity studies, thus providing a comprehensive representation of the emission source and the associated risks of exposure.

Keywords: A-sampling methods, B-particulate matter, B-metals

Mo-S-B3-03
Effectiveness Evaluation of Noise Controls in Deep Shaft Mining
E. A. Lutz, R. J. Reed, D. Turner, S. Littau; University of Arizona, Tucson, AZ

Abstract: Introduction: Noise exposures and hearing loss in the mining industry continue to be a major problem, with an estimated prevalence of 27% noise-induced hearing loss among all U.S. miners. Deep shaft mining introduces unique challenges for noise control. This study evaluated the effectiveness of engineering, administrative, and personal noise controls in a deep metal mine using both traditional and in-ear dosimetry by job task, work shift, and five types of ear plug. Methods: The noise exposures of 22 miners performing deep shaft-sinking tasks were evaluated during 56 rotating shifts in an underground mine. Miners were earplug-insertion trained, earplug fit-tested, and monitored utilizing traditional and in-ear dosimetry. Results: Overall, the mean noise exposure dose measured by traditional dosimetry (183% [95% CI=112-254%]) was significantly higher (p=0.012) than MSHA standards, while those via in-ear dosimetry (80% dose [95% CI=54-107%]) tended to be lower (p=0.072). Mean noise exposure doses for bench blowing (654 ±85%), jumbo drill operation (610 ±71%), and mucking tasks (457 ±284%) were significantly higher (p<0.05) than other tasks, via traditional dosimetry. For these tasks, as well as jackleg drill operation and pumping water, the mean in-ear dose was greater than 100%. Those working swing shift had a significantly higher (p<0.001) mean noise dose (319 ±272%) than those working day shift; there was no statistical difference compared to night shift. There was no statistically significant difference in noise reduction among types of earplug tested. Conclusion: This study found that engineering and administrative controls were somewhat inadequate in protecting miners' hearing, while the addition of personal hearing protection did protect most miners.

Keywords: D-occupational, A-workplace

Mo-S-B3-04
Environmental Exposures to Children at a Legacy Mine Site
M. Loh, N. Lothrop, A. Sugeng, O. I. Felix, E. Betterton, E. Saez, W. Klimecki, S. Wilkinson, P. Beamer; University of Arizona, Tucson, AZ

Abstract: Objective: The Metals Exposure Study in Homes (MESH) investigated children's exposures near a mine tailings site in Arizona. Lead and arsenic are of particular concern due to the high concentrations found in the tailings (≥1000 ppm). The goal of this analysis was to determine whether wind-blown dust was the main source of contaminants in surface-level soil and whether this significantly contributes to indoor dust levels of contaminants and exposures. Methods: Soil and indoor dust samples were taken from 34 homes, sieved to < 63 micrometers, acid-digested, and analyzed by ICP-MS for metal(loid)s and lead isotopes. Urine and toenail samples were taken from children in these homes and analyzed for metal(loid)s. Results: Arsenic concentrations in soil and dust were more significantly correlated than lead concentrations (Spearman's rho = 0.7 and 0.5, respectively). Homes closer to the mine tailings had more similar Pb isotope ratios to the mine tailings than homes further away, indicating a larger contribution of the tailings to lead in those homes' soil and dust. Arsenic concentrations in urine and toenails were significantly correlated with soil and dust arsenic (Spearman's rho = 0.4 for both). Lead biomarker levels were predominantly below detection limits. Conclusions: Indoor dust arsenic and lead most likely come from outdoor soil. Lead isotopes allowed determination of the impact of aerial transport from the tailings to residential soils and indoor dust. Lead exposures were typical compared to a national sample of children, while arsenic exposures were higher. Additional arsenic sources in residential soil near this site in Arizona include homes' underlying mineralogy or mixed fill, rather than the mine site itself. Given that children may be at greater risk of exposure to metals in house dust and soil, understanding the sources of such metals is imperative for reducing exposures.

Keywords: B-metals, A-risk assessment, D-children

Mo-S-B3-05
Occupational Heat Strain in a Deep Underground Metal Mine
E. A. Lutz, R. Reed, D. Turner, S. Littau; The University of Arizona, Tucson, AZ

Abstract: From 1992-2006, 423 workers died from environmental heat exposures. When comparing the crude incidence rate for heat illness per 1 million person hours, the rate-ratio for heat illnesses in U.S. metal mining (1983-2001), was 61.1 - significantly higher (p<0.001) than any other mine type. This pilot study used core temperatures with additional heat strain measures to elucidate high-risk physiological characteristics and job tasks for heat strain at an active underground mine. Thirty-one miners, who worked rotating day, swing, and

night shifts were evaluated during 98 total shifts. Job tasks were classified into 36 separate task types. Monitoring occurred using continuous core body temperature, heart rate, pre- and post-shift urine specific gravity (USG), and body mass index (BMI). Median, as well as highest 10-, 30-, and 60-consecutive minute averages of core body temperature and heart rate were recorded. BMI data was categorized by the World Health Organization (WHO) BMI classifications. Cutting and welding tasks were associated with significantly ($p<0.05$) increased core body temperature, maximum heart rate, and increased post-shift USG. However during the study, seventy-three percent of job tasks were performed only once, indicating high variability between job tasks and workers performing them. Most (98%) miners' median core body temperatures were measured below the ACGIH TLV for hyperthermia (38°C), with a mean of 37.2 ±0.56°C. However, over half (51%) of the observed highest 10-consecutive minute averages were above the TLV (mean 38.2 ±0.67°C). Average highest 30- and 60-consecutive minute average core body temperatures were 38.0 ±0.62°C and 37.9 ±0.56°C, respectively. Miners had a post-shift USG of 1.030 on 43 occasions (44.3%). Miners in the Obese Level II and III BMI categories, as well as those working night shift, had lower core body temperatures ($p<0.05$). This study confirms that job task, body type, and shift are risk factors for heat strain.

Keywords: D-occupational, A-biomonitoring, A-workplace

Mo-S-C3: Tooth Chemical Biomarkers: Novel Approaches to Study Environmental Determinants of Human Health

Mo-S-C3-01
Building Objective measures of Historical Exposures
D. Balshaw; NIEHS, Morrisville, NC

Abstract: One of the major challenges in assessing the associations between environmental exposures and human disease is the differing response to exposure based on the timing of exposure and the life-stage at which exposures occur. It is well known that many environmental factors exhibit differential effects with chronic as opposed to acute exposures or have differential effects in certain windows of susceptibility. Some environmental factors also exhibit latent effects that manifest only after many years have passed. We, as an exposure science community, have had success in developing technologies that can directly measure acute exposures with very high temporal resolution, and we have long-standing capabilities in measuring integrated exposures over intermediate periods of days to months. Assessing historic exposures, however, remains a critical gap in the field of exposure science. Traditionally, such assessments have relied on modeling and questionnaires based largely on residential and occupational history. More recently, it has become apparent that the use of imaging and other analytical techniques can provide direct measurements of exposures that occurred in the past, often with a degree of temporal resolution. Likewise, certain biological measures such as epigenetic modifications and the resultant lasting changes in gene expression have been shown to be a lasting record specific to environmental exposures which can be used as a surrogate measure of exposure. This talk will highlight NIEHS activities to develop such objective measures of historical exposure and biological indicators as part of our larger efforts in Exposure Science and the Exposome.

Keywords: A-biomonitoring, A-cumulative exposure

Mo-S-C3-02
Reconstructing Prenatal, Early Childhood and Cumulative Life-Time Metal Mixture Exposure using Micro-Spatial Analysis of Teeth
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Abstract: Prenatal exposure assessment is one of the major challenges in environmental epidemiologic studies. This presentation will highlight recent developments in micro-spatial analysis of teeth that permit assessment of chemical mixture exposures over the prenatal and early childhood periods. The conceptual framework of this biomarker will be provided to link the developmental physiology of teeth with their application as a biomarker in environmental epidemiologic studies. Detailed validation of the proposed biomarker has been undertaken in human and animal studies for chemical mixtures that include metal toxicants (e.g. lead) and essential dietary nutrients that may be harmful at higher exposures (e.g. manganese and zinc). In humans, lead and manganese levels in prenatally formed regions of teeth and concentrations of these metals in pregnancy

biomarkers (e.g. maternal blood and urine) and in utero biomarkers (e.g. cord blood) showed significant positive associations (Spearman r >0.6; p<0.05). In rats exposed to controlled doses of manganese, tooth levels were significantly associated to concentrations in brain and blood (Spearman r >0.7; p<0.001) when exposure was concurrent. Beyond providing data on the validation of this biomarker, the presentation will also discuss potential biases in the use of the tooth biomarker, with emphasis on limitations of the analysis of whole teeth to estimate exposure timing. This presentation will conclude by providing conceptual links between the series of following presentations that use data generated from this biomarker and novel statistical methods to study organic toxicant exposure, diet, and neurodevelopmental outcomes.

Keywords: A-biomarkers, D-children, D-prenatal

Mo-S-C3-03
Recent Developments in Reconstructing Exposure to Organic Chemicals and Diet Using the Tooth Chemical Biomarker

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Abstract: Past attempts to use the tooth chemical biomarker to reconstruct exposure to environmental organic chemicals has been limited to the analysis of whole teeth or fragments of teeth. Such methods result in loss of critical information on various aspects of exposure, including exposure timing, which prevents effective use of this biomarker in studies exploring critical windows of susceptibility to childhood and adult health outcomes. Similarly, measurement of diet has been largely restricted to the study of dietary trace elements, with limited information on the developmental timing of dietary transitions. Here, we present the development of analytical methods that address these barriers. We have undertaken analysis on the spatial distribution of a range of organic environmental chemicals (bisphenol A, for example) in dental tissues to elucidate the effect of dental microstructure on uptake and distribution of these chemicals. Results indicate a clear heterogeneity in chemical distribution that is not linked to exposure intensity or timing. Similarly, using macaque and human samples, we have studied dietary transitions from breastfeeding to non-breastmilk foods (e.g. infant formula and solid foods). Barium (and in some cases strontium) signatures allowed identification of the transition from the prenatal period to onset of breastfeeding and the introduction of infant formulas. Breast milk intake imparted higher barium levels than those observed during prenatal development. However, infant formula intake corresponded to the highest barium concentrations of the three transitional periods (p for trend <0.05). Overall, the results of experiments show that use of whole teeth and fragments of teeth results in loss of important information regarding exposure history and may in some cases lead to exposure misclassification.

Keywords: A-analytical methods, A-biomarkers, D-prenatal, B-metals, organic chemicals

Mo-S-C3-04
Novel Statistical Methods to Uncover Time Varying Critical Developmental Windows to Chemical Mixtures

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Abstract: Background: - The tooth chemical biomarker generates complex data structures on multiple chemicals and nutrients over fine-scale developmental windows (weekly to fortnightly exposures) that maybe linked to a range of health outcomes. At present there is a dearth of statistical approaches to study such complex higher-dimensional interactions. - Our work develops cutting-edge statistical techniques that flexibly estimate the health effects of time-varying chemical mixtures. The methods can be applied to the tooth chemical biomarker as well as more broadly to chemical mixture studies. The methods accommodate nonlinear exposure-response curves, as some metals are nutrients at lower doses but toxic at higher doses and likely do not have linear dose-response curves. Methods: - We used time-window specific tooth data from the second trimester to 1 year of age to identify sensitive windows of exposure to each metal. We adapted three approaches to accommodate this feature. - The first approach estimates the association between time-varying exposure and a single cognitive outcome by reversing the role of these two variables in the regression equation, with the longitudinal exposure measures playing the role of the "response" and the cognitive outcome playing the role of the "predictor" in a longitudinal model for exposure, while adjusting for relevant confounders. - Second, to develop a more traditional distributed lag modeling framework for each metal, we take a secondary approach

that fits a smooth curve model to the temporal data, via a nonparametric penalized spline model as implemented in the gam() function in R, for each exposure for each subject. - Third, we consider distributed lag interaction models that allow chemical exposures experienced during different time windows to interact with one another. Results and Conclusion: - The following presentation (by Claus Henn) will detail the results generated from the application of these methods.

Keywords: A-statistical methods, B-metals

Mo-S-C3-05
Critical Windows to Neurodevelopmental Effects of Manganese and Lead Co-exposure: A Case Study Using the Tooth Biomarker

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Abstract: Our current understanding of the health effects of Pb and Mn co-exposure is based largely on metals levels measured in blood. However, there may be substantial exposure misclassification, given the short half-life of Mn in blood. A preferred biomarker would be an integrated exposure measure that reflects specific windows of development. The tooth biomarker is such a measure, which can provide information on exposure timing and can be used to identify critical windows to individual chemicals and mixtures. We collected >100 teeth from Mexican children enrolled in a prospective birth cohort and analyzed teeth for Mn and Pb concentrations, reflecting prenatal through early postnatal exposures. We measured IQ among these children using the Wechsler Intelligence Scale for Children (WISC). Individual and interactive effects of Mn and Pb on IQ were estimated using statistical methods described by the previous presenter (B. Coull). Tooth Mn measurements at multiple prenatal time points were positively associated with IQ (beta range: >0 to 0.10; p<0.05). However, the postnatal time points, no significant association was evident. The Mn-IQ association changed markedly when considering co-exposure to Pb: at high Pb levels (tooth Pb>median), the positive association with IQ during the prenatal period was attenuated; postnatally, Mn was inversely associated with IQ in children who have higher Pb levels (beta range = 0 to -0.10; p<0.05). Associations between Mn exposure, measured in teeth, and IQ varied by exposure timing, supporting the notion of critical developmental windows. The observed effect modification of the Mn-IQ association by Pb is consistent with previously published findings. Our data, however, are able to distinguish specific exposure windows that are important for individual and joint effects of metals on neurodevelopment. Future analyses will address higher-order chemical interactions, including with zinc and iron, and their associations with neurodevelopment.

Keywords: A-biomarkers, A-epidemiology, B-metals

Mo-S-D3: Hydraulic Fracturing: Potential Occupational Safety and Health Issues

Mo-S-D3-01
Use of Hydraulic Fracturing in the Oil and Gas Industry: Introduction to Occupational Exposures Pathways

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Abstract: The use of horizontal drilling technologies and hydraulic fracturing in the oil and gas industry has expanded tremendously in recent years. Hydraulic fracturing involves pumping large volumes of water and sand proppant into a well under pressure, as well as multiple activities involving trucks, pumps, and construction equipment. Inhalation hazards possibly associated with hydraulic fracturing operations are therefore of concern, particularly among the worker population Potential exposures include crystalline silica, diesel particulate, and technically-enhanced naturally occurring radioactive material (TE-NORM). This talk will set the stage for the remainder of the session by introducing the operations that use directional drilling and hydraulic fracturing to access oil and gas, and then summarizing the possible exposure pathways for workers.

Keywords: A-workplace, C-air, Silica

Mo-S-D3-02

Initiatives to Evaluate and Manage Occupational Exposures in Hydraulic Fracturing Operations

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Abstract: There have been various efforts to address the health aspects associated with occupational exposures resulting from hydraulic fracturing. These efforts involve a multi-discipline and multi-stakeholder collaborate approach that has included operators, oilfield service companies, equipment manufacturers, industry associations, professional societies and governmental agencies. Some of the main efforts have included National STEPS Network Hydraulic Fracturing Respirable Crystalline Silica Focus Group, the American Industrial Hygiene Association's Oil and Gas Working Group the American Petroleum Institute's (API) Industrial Hygiene Group, API's E&P Health Issues Group as well as other organizations. The organizations and activities that are addressing the OH issues of hydraulic fracturing as well as other oil and gas OH issues will be reviewed, highlighting the successes and challenges of using a multi-stakeholder approach. The life cycle of the well development process extends beyond hydraulic fracturing. Chemical and physical agent exposures associated with well life cycle process such as noise, oil field chemicals, radiation, DPM and thermal stress will be reviewed. Some of the aspects for managing these exposures include the practical and technical considerations of workplace hazard communications, exposure assessments, and exposure mitigation measures. This presentation will outline the value of using and leveraging existing OH initiatives of others to better manage OH aspects.

Keywords: D-occupational, A-workplace, A-risk assessment, B-particulate matter, B-radiation

Mo-S-D3-03

Development and Field Evaluation of the NIOSH Mini Baghouse Retrofit Assembly for Control of Silica Dust Emissions on Hydraulic Fracturing Sites

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Abstract: The National Institute for Occupational Safety and Health (NIOSH) has had an active program of occupational safety and health research in oil and gas extraction since 2005. The goal of program is reducing occupational diseases and injuries among workers. The program fulfills its mission through partnerships with industry resulting in high quality research leading to practical solutions, and carrying out Research-to-Practice (R-2-P) technology transfer. As part of the NIOSH Field Effort to Assess Chemical Exposures in Oil and Gas Workers NIOSH researchers determined that an occupational exposure hazard exists for exposures to respirable crystalline silica (quartz) for workers involved in hydraulic fracturing. Workers who operated sand moving machinery (i.e., sand movers and sand transfer belts) were at highest risks for exposures. NIOSH identified 8 primary points of dust generation at hydraulic fracturing sites, emissions from sand movers was identified as a primary point for quartz dust emissions and also for control of silica-containing dusts. NIOSH researchers invented and fabricated a local exhaust ventilation control called the NIOSH Mini Baghouse Retrofit Assembly which is designed as a "bolt-on" control that exploits pneumatic energy during sand mover filling operations. This presentation describes results from NIOSH field trial evaluations of the Mini Baghouse Retrofit Assembly and implications for control of silica dust emissions from sand movers and silica dust exposures to workers.

Keywords: A-workplace, A-exposure factors, B-particulate matter, A-sampling methods, unconventional oil and gas extraction, hydraulic fracturing

Mo-S-D3-04

Data Requirements for Epidemiological Assessment of Worker Health Risks Associated with Hydraulic Fracturing

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Abstract: Improvements in horizontal drilling technology have led to substantial increases in the number of workers engaged in hydraulic fracturing over the past 10 years. Although the potential for adverse health effects on workers from hydraulic fracturing operations is generally recognized, epidemiological data quantifying such impacts are absent. Epidemiological approaches are needed to understand health risks in relation to quantified estimates of exposure to chemicals, minerals, and others agents encountered during oil and gas extraction.

Common exposures are hydrogen sulfide, hydrocarbons (e.g., benzene, toluene, xylenes), diesel particulate matter, lead, acids, biocides, and naturally-occurring radioactive materials (NORM). Designing epidemiological studies and/or surveillance programs to address mixed pollutant exposures for workers engaged in hydraulic fracturing is challenging. Some of the challenges involve collecting exposure and basic identifier data to track workers over time, including contractors from small and moderate sized companies engaged in drilling and servicing wells. Quantitative exposure data summarized for similar exposure groups (SEGs) that can be linked to individuals performing similar tasks and work activities are necessary for assessing health risks. In addition, shorter-term and transient workers may differ from longer term workers with respect to factors that affect health and are associated with exposures. Proper study design to optimize existing data is important, especially considering that some diseases (e.g., cancer, chronic lung diseases) have long latencies. In the absence of exposure registries or a surveillance program, it may prove difficult to link future diseases to exposures in the present. Epidemiological studies of oil and gas workers must also consider study design to minimize potential bias stemming from misclassification of exposure and selection bias, and data to address potential confounding.

Keywords: A-epidemiology, A-cumulative exposure, D-occupational

Mo-S-D3-05
Legal and Regulatory Changes Affecting Shale Gas Developments
D. W. Wagner; Reed Smith, Pittsburgh, PA

Abstract: The rapid development of hydraulic fracturing of shale gas is occurring against an unsettled and still developing legal landscape. In the United States, federal, state and regulations and guidance documents addressing hydraulic fracturing are being promulgated and are subject to legal challenges by interest groups both for and against shale development. The industry also faces the prospect of private hydraulic fracturing-related lawsuits, which accuse it of causing harm to others' environmental, human health, real property, and commercial interests. This presentation will address the environmental, safety and public policy issues raised by hydraulic fracturing and discuss federal, state and local regulatory developments in the United States.

Keywords: A-environmental regulation

Mo-O-E3: Indoor / Outdoor Air Pollution - III

Mo-O-E3-01
Effectiveness of Ventilation Interventions at Improving Indoor Air Quality and Ventilation Rates in Canadian Homes with Asthmatic Children
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Abstract: A randomized controlled study was conducted with 83 asthmatic children living in homes with ventilation rates below 0.30 1/h. During year 1 (pre-intervention) and 2 (post-intervention), the ventilation rates and a number of IAQ relevant parameters were measured during two home visits in the heating-season and one visit in the summer. Following year 1, participants were randomized. The ventilation rates were increased in the homes of participants of the intervention group by optimizing the existing mechanical ventilation systems or by the addition of a heat recovery ventilator or an energy recovery ventilator. During the pre-intervention phase a pronounced seasonal variation in the concentration of VOC's was observed where most aliphatic and aromatic hydrocarbons were observed at higher concentrations in winter whereas most oxygenated VOC's, with aldehydes in particular, being observed at higher concentrations in summer. Following the intervention the geometric mean air exchange rate (1/h) increased from 0.17 to 0.34 in the intervention group compared to 0.18 and 0.21 in the control group. A statistically significant reduction in concentrations, of up to 55%, was observed during the heating season for airborne mould spores and most VOC's in the intervention group relative to the control group. The mean heating-season concentration of formaldehyde (µg/m3) decreased from 37.2 to 24.1 in the intervention group compared to 36.5 to 35.4 in control group. Following the intervention all homes in the intervention group were able to meet the formaldehyde guideline of 50 µg/m3 for an 8-hour exposure compared with only two thirds prior to the intervention. This study demonstrates that under-ventilated homes can be corrected through a careful retrofit with ERV or HRV systems and the concentration of potentially health relevant chemical and microbial IAQ parameters can be significantly reduced with increased ventilation.

Keywords: A-exposure factors, D-vulnerable, C-air, B-VOCs, D-children

Mo-O-E3-02

Development and Evaluation of a New Air Exchange Rate Algorithm for the Stochastic Human Exposure and Dose Simulation Model

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Abstract: Previous exposure assessment panel studies have observed considerable seasonal, between-home and between-city variability in residential pollutant infiltration. This is likely a result of differences in home ventilation, or air exchange rates (AER). The Stochastic Human Exposure and Dose Simulation (SHEDS) model is a population exposure model that uses a probabilistic approach to estimate personal exposures for simulated individuals of a defined population, based on ambient concentrations, literature-based distributions of residential AERs and particle infiltration parameters, and time spent in various microenvironments (e.g. home, office, school, vehicle) from a large database of human activity diaries. A new AER algorithm was incorporated into SHEDS based on the Lawrence Berkley National Laboratory Infiltration model, with stochastic sampling of inputs added. However, this model only accounts for the leakiness of a home and does not include natural (opening of windows) or forced (air conditioning use) ventilation that can greatly influence AERs. We therefore developed a methodology to adjust for the opening of windows based on the prevalence of air conditioning and outdoor-indoor temperature differences. To evaluate the algorithm, we compared SHEDS estimated AERs with measured AERs in four different cities: Los Angeles, CA, Detroit, MI, Elizabeth, NJ, and Houston, TX. Using inputs developed from study data for each city, SHEDS underestimated measured AERs for Detroit (0.7 vs. 1.5 1/h, for SHEDS vs. measured averages), LA (0.9 vs. 1.4) and Elizabeth (0.9 vs. 1.4), and overestimated AERs for Houston (0.7 vs. 0.6). Measured AERs were between the median and 95th percentile of the modeled SHEDS AER distributions. The algorithm was also evaluated using nationally available input data. SHEDS AER distributions using national inputs were lower compared to the study-specific inputs, and were also evaluated against other AER distributions used for exposure modeling.

Keywords: A-exposure models, A-activity patterns, A-built environment

Mo-O-E3-03

Environmental Health Inequality: A Geographic Information System-based Platform to Build Exposure Indicators

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Abstract: Analyzing the relationship between environment and health has become à major issue for public health as evidenced by the emergence of the second French national plan for health and environment. These plans have identified the following two priorities: - Identify and manage geographic areas, where hotspot exposures are suspected to generate a potential hazard to human health - reduce exposure inequalities. The purpose of this project is the development of a coordinated integrated environment spatial information system within France, building a GIS-based (Geographic Information System) platform -PLAINE- able to map environmental disparities and detect vulnerable population. A multimedia exposure model (MODUL'ERS) was developed by INERIS to assess the transfer of pollutant from the environment (air, water, soil, food chain) to individual exposure through inhalation and ingestion pathways. This project adds a spatial dimension and linking the PLAINE platform to the model. Spatial data were used to implement the multimedia exposure model at a fine resolution. Tools have been developed, using modeling, spatial analysis and geostatistic methods to build and discretize variables and indicators from different spatial supports within the Nord-Pas-de-Calais region (France). By example, topsoil concentrations have been estimated by developing a kriging method, able to integrate surface and point spatial supports. Eulerian atmospheric dispersion model (CHIMERE) was used to simulate pollutant atmospheric deposition and concentration of the pollutant. The aim of this work is the presentation of the data and model development based on the example of trace metals and polycyclic aromatic hydrocarbons. Results enable to identify pollutant sources, determinants of exposure and vulnerable populations. Environmental and exposure datasets are integrated in the French coordinated integrated environment and health platform to map and analyze environmental inequalities.

Keywords: A-geospatial analysis/GIS, A-exposure models, A-aggregate exposure, C-multimedia, PAH and Metals

Mo-O-E3-04 - Withdrawn

Mo-S-F3: Occupational and Environmental Exposures to Pharmaceuticals

Mo-S-F3-01
NIOSH's Approaches to Reducing Occupational Exposure to Hazardous Drugs
T. H. Connor; NIOSH, Cincinnati, OH

Abstract: Based on growing evidence of contamination of healthcare settings with hazardous drugs and reports of worker exposure to these drugs, NIOSH convened a Working Group on Hazardous Drugs in 2000. Since that time, NIOSH has been actively involved in several endeavors aimed at reducing healthcare workers' exposure to hazardous drugs. NIOSH has successfully partnered with government agencies, professional organizations and academia to achieve these goals. Approaches related to NIOSH's goals have included: method development for sampling and analysis of hazardous drugs; field studies to evaluate worker exposure; and development of several guidance documents related to hazardous drug exposure. These have included an Alert on hazardous drugs, several Workplace Solutions documents on specific safe handling issues, and a guidance document addressing potential adverse reproductive effects of hazardous drugs. As a result of these activities, NIOSH has helped raise awareness of the issues surrounding workplace exposures to hazardous drugs in healthcare settings. This awareness has resulted in several states adopting legislation based entirely or in part on the Alert on hazardous drugs and professional organizations patterning their safe handling recommendations on the NIOSH Alert.

Keywords: A-exposure models, B-pharmaceuticals, D-occupational, healthcare

Mo-S-F3-02
Development of Immunochemical Methods for the Measurement of Drug Surface Contamination
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Abstract: Contamination of workplace surfaces by antineoplastic drugs and drugs of abuse presents an exposure risk for workers. Because traditional instrumental methods to detect contamination are expensive and incapable of producing results in real time, we have developed immunoassay based methods for detection and semi-quantitative measurement of surface contamination by drugs of abuse and antineoplastic drugs. Lateral flow immunoassay based methods for methamphetamine and three antineoplastic drugs (5-fluorouracil, paclitaxel, and doxorubicin) have been developed to detect contamination in the field in near real time. The responses from these lateral flow methods have been evaluated using visual interpretation and using an electronic lateral flow reader. For methamphetamine, 1 ng/100 cm2 can be detected on a spiked tile using the electronic reader with semi-quantitative results over a range of 0-25 ng/100 cm2, and 1 to 2 ng/100 cm2 can be detected with visual interpretation. For 5-fluorouracil, 10 ng/100 cm2 can be detected using the electronic reader with semi-quantitative results over a range of 0-100 ng/100 cm2, and 25 ng/100 cm2 can be detected with visual interpretation. The methamphetamine lateral flow assay has been developed into a commercial product and the 5-fluorouracil assay is also being considered for commercial development. We have also developed fluorescence covalent microbead immunosorbent assays (FCMIA) that can simultaneously measure multiple drugs of abuse (methamphetamine, THC, heroin, and cocaine) or multiple antineoplastic drugs (5-fluorouracil, paclitaxel, and doxorubicin) with detection limits better than 1 ng/cm2 for all drugs. The FCMIA assay for drugs of abuse has been used to evaluate contamination in a number of field studies where methamphetamine, heroin, and cocaine were detected on several surfaces. The immunoassay based methods have the potential to provide lower cost detection methods as well as real-time capabilities.

Keywords: A-workplace, A-analytical methods

Mo-S-F3-03
Evaluation of Hazardous Drugs Exposures: From Hospitals to Veterinary Schools
J. Couch; Centers for Disease Control and Prevention, Cincinnati, OH

Abstract: The NIOSH Health Hazard Evaluation (HHE) program has received numerous requests to evaluate the use of hazardous drugs in a wide variety of occupational environments. We highlight three evaluations that include a hospital oncology unit, a regional oncology clinic, and a state university veterinary school. Despite an array of preventive steps and controls, positive surface wipe samples followed the path of hazardous drugs throughout the workplace from receiving through disposal. We evaluated select hazardous drugs (cyclophosphamide, ifosfamide, doxorubicin, and platinum containing drugs) that were common in the respective workplaces. Hazardous drug migration into non-use areas was common. We will discuss common sampling methodologies, identifying high-risk areas, and potential complications when interpreting sample results, and highlight best practices that can be utilized in all work environments.

Keywords: B-pharmaceuticals, A-workplace, D-occupational

Mo-S-F3-04
Exposures to Pharmaceutical Dust in Pharmacies Using Automatic Dispensing Machines
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Abstract: Automatic dispensing machines concentrate and dispense large volumes of pharmaceuticals, including uncoated tablets that can shed dust. We evaluated 43 employees' exposures to pharmaceutical dust at three pharmacies where these machines were used. Pharmaceutical dust was generated during a variety of tasks like emptying and refilling of machine canisters. We detected 10 active pharmaceutical ingredients in air, including lisinopril, a drug prescribed for high blood pressure, levothyroxine, a drug prescribed for hypothyroidism, and methotrexate, a hazardous drug prescribed for cancer and other disorders. Three air concentrations of lisinopril exceeded the lower bound of the manufacturer's hazard control band. Our findings indicate that pharmacy employees could be exposed to multiple drugs and that measures are needed to control those exposures.

Keywords: B-pharmaceuticals, A-sampling methods, D-occupational, C-air

Mo-S-F3-05
Pharmaceuticals and Other Contaminants of Emerging Concern in Source and Treated Drinking Water
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Abstract: Paired source and treated drinking water samples were collected from 25 drinking water treatment plants (DWTPs) across the United States, and analyzed for 251 chemical and microbial contaminants of emerging concern (CECs), including 111 pharmaceuticals and their metabolites. Fifty-four pharmaceuticals were detected at least once in the source water, 36 were measured at least once in the treated drinking water. This presentation will discuss occurrence and concentration of pharmaceuticals and other CECs, as well as place the concentrations measured in drinking water into context through a margin of exposure risk assessment.

Keywords: C-water, B-pharmaceuticals, A-chemical prioritization, B-microbial agents

Mo-O-G3: Chemicals in Consumer Products - II

Mo-O-G3-01
Passive Exposures of Children to Trihalomethanes during Domestic Cleaning Activities of their Parents
P. Charisiadis, S. Andra, K. C. Makris; Cyprus International Institute for Environmental and Public Health in Association with Harvard School of Public Health, Cyprus University of Technology, Limassol, Cyprus

Abstract: Domestic cleaning has been proposed as a major determinant of trihalomethanes (THM) exposure in women. We hypothesized that parental housekeeping activities could influence children's passive exposures to THM from their mere physical presence at home during cleaning. A cross-sectional study was conducted with 382 residents [41 children (<18y) and 341 adults (≥18y)] from 193 homes in Nicosia (Cyprus) to assess factors influencing personal exposure to trihalomethanes. The inclusion criteria were to provide a questionnaire-survey and two first morning void urine samples in consecutive seasons. We identified 22 and 18 pairs of children with matched-mothers and matched-fathers, respectively. Regression models were applied to understand the association between individual practices influencing ingestion and noningestion exposures to THM, and the two-season average of urinary THM levels. Children were classified into low and high exposure group based on their median urinary THM level to evaluate determinants of passive exposures from their parental activities at home. Among the children-specific variables, age alone was significantly associated with their creatinine-adjusted urinary THM ($rS = -0.59$, $p < 0.001$). The average urinary THM was significantly different not only between high- and low-exposure children group ($p < 0.0001$), but also between their matched-mothers ($p = 0.01$) and matched-fathers ($p = 0.03$). Time daily spent by the matched-mothers' for domestic mopping, toilet and other cleaning activities using chlorine-based products were associated ($p < 0.05$) with their children's urinary THM levels. This trend was not observed between children and their matched-fathers' because of less amount of time spent by the latter performing cleaning. Our findings support the influence of mothers' domestic cleaning activities in enhancing the passive THM exposures of their matched-children. The duration of such activities could be a useful indicator of children THM body burden.

Keywords: A-biomonitoring, A-exposure factors, C-water, D-community, A-biomarkers

Mo-O-G3-02
An Improved Method for Measuring and Characterizing Phthalate Emissions from Building Materials and Its Application to Exposure Assessment
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Abstract: Phthalate emission from baby mattress cover and vinyl floorings was measured in specially-designed stainless steel chambers. Phthalate concentrations increased and reached steady state after 2 to 5 days for all experiments. By having a high ratio of emission surface to sorption surface, avoiding mass loss of phthalates onto sampling pathways, and improving air mixing inside the chamber, the time to reach steady state was significantly reduced, compared to previous studies (1 to 5 months). An innovative approach was developed to determine $y0$, the gas-phase concentration of phthalates in equilibrium with the material phase, which is the key parameter controlling phthalate emissions. Target phthalate material-phase concentration ($C0$) and vapor pressure were explicitly measured and found to have great influences on the $y0$ value. For low phthalate concentrations in materials, a simple partitioning mechanism may linearly relate $y0$ and $C0$, but cannot be evoked for high-weight phthalate percentages. In addition, the sorption kinetics and adsorption isotherm of phthalates on stainless steel chamber surfaces were determined experimentally. Independently measured or calculated parameters were used to validate a semi-volatile organic compounds (SVOCs) emission model, with excellent agreement between model predictions and the observed chamber concentrations in gas and stainless steel phases. With the knowledge of $y0$ and emission mechanisms, human exposure to phthalates from tested floorings was assessed; the levels were comparable to previous studies. This paper developed a rapid, novel method to measure phthalate emissions; emission measurement results can be connected to exposure assessment and help health professionals estimate screening-level exposures associated with SVOCs and conduct risk-based prioritization for SVOC chemicals of concern.

Keywords: B-phthalates, A-indoor environment, A-sampling methods, A-cumulative exposure, B-SVOCs

Mo-O-G3-03

Exposure and Toxicity Modeling of Chemicals in Personal Care Products: Case Study Using Parabens

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Abstract: Chemical prioritization has historically focused on indirect human exposure to chemicals, for example, through the environment, rather than on direct exposure during product use. Furthermore, exposure levels should be combined with toxicity data to more fully understand the risks of chemicals associated with consumer products. Hence, in order to prioritize substances used in consumer products, the entire continuum of usage and emissions, direct and environmental exposure, and toxic effects need to be taken into account. We present a case study on parabens which are used as preservatives in personal care products. We applied the concept of the product intake fraction, PiF (defined as the fraction of chemical taken by the population during product use and disposal) to calculate the exposure to parabens of the U.S. female population via cosmetic products such as shampoo, body lotion, and body wash. The PiF was found to vary between ~1-100% depending on product usage (for example, rinse-off versus leave-on). Exposure during product use was several orders of magnitude higher than exposure through the environment via disposal. Additionally, there can be considerable population variability in exposure factors, such as amount of product used, and uncertainty in factors such as chemical properties. Thus, we used Monte Carlo simulations to take into account population variability and uncertainty. The resulting modeled exposure distributions were within an order of magnitude of urine levels measured in the U.S. female population (NHANES). Furthermore, we used molecular docking models to identify target proteins with which parabens are likely to interact, with particular emphasis on proteins that regulate the endocrine system. Docking studies can be used in conjunction with high throughput toxicity datasets, such as ToxCast from the U.S. EPA, to further inform chemical toxicity. This toxicity information can then combined with the exposure model to identify priority chemicals.

Keywords: A-exposure models, A-chemical prioritization, C-personal care products, C-consumer products, A-aggregate exposure

Mo-O-G3-04

Prenatal Exposure to Triclocarban and Triclosan In Relation to Birth Weight and Size in an Urban Population from Brooklyn, NY

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Abstract: Triclosan (TCS) and triclocarban (TCC) are antimicrobial agents formulated in a wide variety of consumer products that are regulated by the U.S. Food and Drug Administration. According to available National Health and Nutrition Examination Survey (NHANES) data, exposure to TCS is prevalent in the general U.S. population. TCS has been detected previously in urine, blood, serum, plasma, human breast milk, and amniotic fluid. In 2014, the FDA is reviewing the use and effectiveness of these chemicals given their potential contribution to bacterial resistance to antibiotics, and endocrine disruption. TCS is known to interfere with thyroid hormone metabolism and has also been associated with allergy and weakening muscle contractibility. TCC has been shown to enhance androgen action and to elicit anti-inflammatory effects. Little is known about potential human effects of either compound in utero. In this study, we assessed prenatal exposure to TCS and TCC and associated birth outcomes including gestational age, birth weight and birth size. We determined the concentrations of TCS, TCC and metabolites as total concentrations in urine and cord blood plasma from a cohort of 181 expecting mothers in an urban, multiethnic population recruited between 2007-'09 in Brooklyn, NY. Maternal characteristics and birth outcomes were gathered from a technician-administered questionnaire and patient charts. We examined the relationship between concentrations of TCS, TCC and metabolites in maternal urine and cord blood plasma with gestational age, birth weight, and birth size. Correlations with birth outcomes yielded insights into the associations with exposure to TCS and TCC. This study is the first to report human biomonitoring data for TCC exposure in an urban population in the United States, and provides additional data on environmental exposure to TCS in the maternal-fetal unit.

Keywords: A-biomonitoring, D-prenatal, C-personal care products, C-consumer products, A-epidemiology

Mo-O-G3-05
Do Human Exposures to Bisphenol A and Three other Bisphenol Analogs Track Market Changes?
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Abstract: Human exposure to bisphenol A (BPA) is widespread because of the extensive use of this chemical in consumer products. Due to the toxicity of BPA in animal studies and its potential effects on human health, several government entities in different countries have banned its use in certain products. In response to these restrictions and public pressure, the use of BPA may decrease, while the use of some of its analogs, such as bisphenol S (BPS, 4,4'-sulfonyldiphenol), bisphenol F (BPF, 4,4′-dihydroxydiphenylmethane), and bisphenol AF (BPAF, hexafluorobisphenol A), may increase. Limited data suggest that BPS, BPF, and BPAF, similar to BPA, possess slight to moderate acute toxicity and weak estrogenicity. Although the potential environmental and health impacts of BPA analogs are largely unknown, understanding the extent of human exposure to these chemicals is necessary for risk assessment. We measured both total (free plus conjugated) and free urinary concentrations of BPA, BPF, BPS, and BPAF in samples collected between 2009 and 2012 from 100 adult volunteers, using on-line solid-phase extraction-isotope dilution-high-performance liquid chromatography-tandem mass spectrometry. The conjugate species represented more than 95% of the excreted bisphenols. We detected BPA at the highest frequency and median concentrations (95%, 0.72 ng/mL), followed by BPS (78 %, 0.13 ng/mL), BPF (55 %, 0.08 ng/mL), and BPAF (10 %, <limit of detection). The median concentration of BPA, similar to those reported among the general US population in 2011-2012, is lower than concentrations reported in 2003-2004. Together, these data suggest that exposure to BPA analogs may have increased since 2009 while the exposure to BPA is showing a clear downward trend. These changes in human exposure to bisphenols may reflect shifts in commercial formulations, public awareness, and regulations.

Keywords: A-biomonitoring, A-biomarkers

Mo-O-A4: Modeling Sources and Exposures of Air Toxics

Mo-O-A4-01
Proximity to Industrial Facilities Linked to Increased Levels of Polychlorinated Dibenzo-p-dioxins and Polychlorinated Dibenzofurans in Carpet Dust Samples from Four Areas of the United States
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Abstract: Polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/F) are persistent organic pollutants emitted from industrial combustion facilities such as incinerators, coal-fired power plants, and cement kilns. Proximity to municipal solid waste incinerators and cement kilns has been associated with increased risk of non-Hodgkin lymphoma (NHL) in studies in France and the United States, respectively. We evaluated the relationship between proximity to PCDD/F-emitting facilities and concentrations of PCDD/F in carpet dust samples from homes in a population-based case-control study of NHL. Carpet dust samples from 100 homes in Detroit, Los Angeles, Seattle, and Iowa (1998-2000) were analyzed for 17 PCDD/F congeners considered toxic by the Environmental Protection Agency. Relationships between the concentration of each congener and proximity to 6 types of PCDD/F-emitting facilities were evaluated using multiple linear regression models, adjusting for location and home characteristics. Compared to homes located farther away, homes within 3 km (n=25) or 5 km (n=44) of a medical incinerator had 1.3 to 2.0-fold (p<0.05) higher dust concentrations of 6 of the 7 dioxin congeners and 3 of the 10 furan congeners, including the most potent dioxin, TCDD. Homes within 5 km of a solid waste incinerator (n=16) had 1.8 to 3.5-fold (p<0.1) higher dust concentrations of 5 furans, and homes within 5 km of a coal-fired plant (n=31) had 1.5 times (p<0.1) higher levels of 2 furans. No associations were observed with proximity to cement kilns, hazardous waste incinerators, or sewage sludge incinerators. Our results suggest that outdoor sources such as incinerators and coal-fired plants are contributing to indoor environmental exposures of several, specific PCDD/Fs, providing support for studies of NHL among those residing near industrial facilities. These findings may be important for other diseases known or suspected to be associated with exposure to dioxin-like compounds.

Keywords: A-indoor environment, A-geospatial analysis/GIS, persistent organic pollutants, dioxin/furans, dust

Mo-O-A4-02
Population-Weighted Exposure to 174 Air Toxics in a Representative Sample of the United States Population 1999 - 2010

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Abstract: BACKGROUND: The 1990 Clean Air Act regulates air toxics because they are known to or suspected of causing cancer or other serious health problems. US EPA's 2005 National-Scale Air Toxics Assessment (NATA) provides a "snapshot" estimate of chronic inhalation exposure for numerous air toxics at each US census tract. The National Health and Nutrition Examination Survey (NHANES) obtains a complex, multistage probability sample of human subjects representative of the US population. AIMS: Estimate reference exposure concentrations of 174 air toxics, including diesel engine emissions, for a representative sample of the United States population. METHODS: Publicly avaiable US EPA NATA 2005 air toxics exposure concentrations estimated at the census tract were geographically merged with geocoded residences of participants in NHANES 1999 - 2010 (n = 62,160). Population-weighted statistics were estimated for each air toxic. RESULTS: For a selection of air toxics, the population-weighted geometric mean (GM [GSD] in micrograms per cubic meter) of exposure concentration were estimated to be: toluene 1.6 [0.089]; formaldehyde 1.5 [0.036]; acetaldehyde 1.4 [0.027]; benzene 0.75 [0.027]; diesel engine emissions 0.24 [0.019]; acrolein 0.021 [0.0012]; and PAHs 0.0061 [0.00042]. Statistics grouped by metropolitan and non-metropolitan census tracts are also available. CONCLUSIONS: This analysis provides a comprehensive assessment of air toxics exposure for the US population potentially useful for prioritizing pollutants for further evaluation of public health impact.

Keywords: A-exposure models, A-exposure factors, C-air, B-VOCs, B-particulate matter

Mo-O-A4-03

Characterizations, Relationship and Potential Sources of outdoor and indoor particulate matter bound Polycyclic Aromatic Hydrocarbons (PAHs) in a community of Tianjin, Northern China

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Abstract: Polycyclic aromatic hydrocarbons (PAHs) are among the most toxic air pollutants in China. Besides direct personal exposure measurement, residential indoor and outdoor samplings were considered as another pathway to estimate the personal exposure levels. However, due to unsubstantial data on the measurement and relationship analysis of residential indoor and outdoor particulate PAHs, efforts in assessing inhalation exposure of susceptible population to PAHs and its potential risks to lung cancer have been limited. This study measured 12 PAHs individuals simultaneously in residential indoor and outdoor environment at 36 homes in the same community during the non-heating period (August - September) and heating period (November- December) in 2009. Indoor and outdoor PAHs concentrations, profiles and I/O ratio in the two sampling periods were discussed. Indoor PAHs were comparable with outdoor concentrations in non-heating period, but lower in heating period. The average I/O ratio in both sampling periods were lower than 1, while the ratio in non-heating period were higher than those in heating period. Correlation analysis and coefficient of divergence were also applied to verify the difference between indoor and outdoor PAHs concentrations. All these results obtained were consistent, which could be interpreted as the better ventilation in non-heating period. To further support the influence of ventilation, linear regression and robust regression were also used to estimate the infiltration factor outdoor PAHs to indoor PAHs. The calculated infiltration factors obtained by the two models were similar in non-heating period, but vary greatly in heating period, which can be explained as the influence of ventilation. Potential sources were distinguished by using diagnostic ratio and principal component analysis, finding similar sources were influencing both indoor and outdoor particulate PAHs, such as coal combustion, vehicle exhaust and some industrial emissions.

Keywords: B-particulate matter, polycyclic aromatic hydrocarbons, indoor-outdoor relationship,source analysis, polycyclic aromatic hydrocarbons, indoor-outdoor relationship,source analysis, polycyclic aromatic hydrocarbons, indoor-outdoor relationship,source analysis

Mo-O-A4-04
Global Polycyclic Aromatic Hydrocarbons Exposure Risk
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Abstract: Polycyclic aromatic hydrocarbons (PAHs) are among the most concerning organic pollutants in terms of human health. In this study, lung cancer risk induced by inhalation exposure to ambient PAHs was modelled based on a high resolution emission inventory, an atmospheric transport model, and a cancer slope. Globally, incremental lifetime lung cancer risk (ILCR) induced by ambient PAH exposure is 0.000031, which will be underestimated by 60% if the susceptibility is not taken into consideration. The contribution of a given source depends not only on the emission strength but also on the proximity to people. The most important source types are combustion of biomass fuels (40%) and fossil fuels (14%) in the residential/commercial sector, coke (13%) and aluminium (12%) production, and motor vehicles (9%). The effect of a given source is also quantified by specific health effect (ILCRs), defined as ILCR caused by per unit emission. Globally, ILCRs for various source types varies extensively from 0.08 and 0.14 /Pg for shipping and wildfire to 13 and 17 /Pg1 for residential fossil fuel usage and motor vehicles. 1.7% of the population facing high risk (ILCR > 0.0003) is largely because of exposure to emissions from coke and aluminium productions. Emissions from residential solid fuel combustion contribute mainly to the population at risk levels between 0.00000003 and 0.0001. Residential biomass burning causes the largest overall lung cancer risk and should be the top priority in the emission abatement. On the other hand, control of emissions from motor vehicles and residential coal combustion is the most effective way of reducing risk. If the objective is to protect the most vulnerable people, emissions from coke and aluminium productions should be addressed first. Regional risks are predominantly caused by local emissions and the external contributions to local risk are no more than 3%. Interregional transport is relatively active within the Eurasian continent.

Keywords: A-global health, A-exposure models, A-risk assessment, B-SVOCs, C-air

Mo-O-A4-05
Comparative Models for Estimating Personal Exposure to Particulate Matter Associate Polycyclic Aromatic Hydrocarbons for Elderly Men in China
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Abstract: OBJECTIVES: Current understanding on health effects of personal exposure (PE) to polycyclic aromatic hydrocarbons (PAHs) is limited because insufficient data was obtained on PE to PAHs at individual level. In a panel study for elderly men in Tianjin, China, we examined the contribution of temporal, spatial and behavior factors to estimate exposure levels, and developed several models for predicting PAHs exposure METHODS: PE concentrations to PAHs of 80 elderly men were monitored; indoor and outdoor levels of PAHs were measured simultaneously. Multiple linear regression analysis was applied to reveal the associations between exposure and several questionnaire and behavior variables. Moreover, this paper compared three models including linear regression (Model 1-3), time activity weighted model (Model 4) and neural networks (Model 5) for simulation and prediction of PE. RESULTS: Outdoor sources were most important risk factors of PAH exposure for elderly men, while some indoor activities related variables played a weak role. In three predictive models, Model 1 and 2 cannot better estimate PE level, and only five PAHs individuals were found to represent significant correlation (p <0.01). In Model 3, representing a new prediction approach, good or strong correlations were observed. CONCLUSION: Most subjects were exposed to outdoor-originating PAHs within the indoor setting in this study. The neural network model was promising in predicting the PE rather than Model 1 and 2, which gave bad performance with lower correlation coefficients. These results are generalizable to susceptible subpopulation in similar exposure settings and support reduction of exposure to protect human health.

Keywords: personal exposure, polycyclic aromatic hydrocarbons (PAHs), risk factors, predictive model, elderly men, personal exposure, polycyclic aromatic hydrocarbons (PAHs), risk factors, predictive model, elderly men

Mo-S-B4: Land Use Regression Models to Assess Traffic-related Air pollution: Novel Features and Future Directions for Enhancement

Mo-S-B4-01
Using Building Heights and Street Configuration to Enhance Intra-urban Land Use Regression Models
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Abstract: Background Land use regression (LUR) models are increasingly used for air pollution exposure estimation in epidemiological studies. However, models have rarely offered variables that account for the dispersion environment close to source (e.g. street canyons, position and dimensions of buildings, road width). It is computationally impractical to include individual buildings in dispersion models for large geographical areas but it is feasible with LUR. Methods This study used recently available data on building heights and geometry to enhance the representation of land use and the dispersion field in LUR. Models were developed for PM10, NOX and NO2 for 2008-2011 for London. A separate set of models using 'traditional' land use and traffic indicators (e.g. distance from road, area of housing within circular buffers) were also developed and their performance compared with 'enhanced' models. In a further step, we also developed 'hybrid' LUR models where information on road geography and traffic flows were substituted with output from a dispersion model (ADMS-Urban) used to model emissions from road sources. Results Models were evaluated using grouped (n-25%) cross validation (GCV). GCV R2 values were 0.71, 0.53, 0.64 and 0.68, 0.77, 0.77 for traditional and enhanced PM10, NOX and N02 models, respectively. Data on building volume within the area common to a 20 m road buffer within a 25 m circular buffer substantially improved the performance (R2 > 13%) of NOX and NO2 LUR models. Performance of 'hybrid' models (with output from the dispersion model) was similar to the LUR models with information on traffic volume and road length. Conclusions Data on building heights and street configuration could have utility in improving the performance of LUR models, but may not improve performance of models for some pollutants (e.g. PM10), and may perform less well in areas where building height and density is less variable.

Keywords: A-exposure models, A-geospatial analysis/GIS, C-air

Mo-S-B4-02
Use of LUR Models to Cover a Large Spatial Scale: Integration with Satellite Data
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Abstract: Background: Land use regression (LUR) is a common approach for estimating intra-urban variability in air pollution, typically at the urban scale. Recent improvements in data quality, including satellite-based air pollution measurements, have allowed for LUR models to be extended to national and continental scales. Satellite-based measurements account for regional and background pollutant concentrations, including emissions from sources not explicitly included in typical land use variables. LUR models incorporating satellite-based measurements offer the fine-scale spatial resolution typical of LUR (~100 m) but cover very large study areas. Methods: We will focus on an overview of studies that have incorporated satellite-based measurements into large-scale LUR models. **Results:** We will compare the spatial and temporal resolution; geographic range; and performance of the most recent models. We will also discuss issues with large scale LUR models incorporating satellite-based measurements, including (1) employing measurements from large regulatory monitoring networks, (2) relating satellite column measurements to surface concentrations, and (3) working with missing satellite data. **Conclusions:** We will provide our thoughts on future directions and challenges for large-scale LUR.

Keywords: A-geospatial analysis/GIS, C-air

Mo-S-B4-03
LUR Models Beyond the Traditional Pollutants NO2 and PM
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Abstract: Land use regression (LUR) methods have generally been applied successfully to model concentrations of NO2, NOx, PM2.5, the soot content of PM2.5 and VOCs. However, there is an interest to estimate exposure for other pollutants as well, such as ultrafine particles and the elemental composition of particulate matter using similar methods. Although ultrafine particles have a higher spatial and temporal variability than larger particles, three studies have recently shown that LUR modeling for ultrafine particles is feasible. Model performance (R2) was somewhat lower (40-70%) than for previously reported LUR models for

the pollutants NO2, PM2.5, and soot. Recently, the first LUR models for the elemental composition of particulate matter have been developed. As part of the multi-center European ESCAPE project, elemental composition in both PM10 and PM2.5 at 20 sites in 20 study areas across Europe were measured. LUR models for eight a priori selected elements (copper (Cu), iron (Fe), potassium (K), nickel (Ni), sulfur (S), silicon (Si), vanadium (V), and zinc (Zn)) were developed. Good models were developed for Cu, Fe, and Zn in both size fractions (average R^2 between 67 and 79%). Traffic variables were the dominant predictors, reflecting nontailpipe emissions. Models for V and S in the PM10 and PM2.5 fractions and Si, Ni, and K in the PM10 fraction performed moderately with R^2 ranging from 50 to 61%. Si, Ni, and K models for PM2.5 performed poorest with R^2 under 50%. A limitation for the elemental composition models is that some specific predictors are not yet available in Geographic Information Systems, such as data from wood smoke, specific industry data and specific port data. LUR models beyond the traditional pollutants NO2 and particulate matter are thus possible, but require specific challenges such as temporal adjustment and more specific predictor variables. Within the symposium we will discuss these challenges and limitations in more detail.

Keywords: A-exposure models, B-particulate matter, A-epidemiology

Mo-S-B4-04
Transferability of Land Use Regression Models Across Time and Space
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Abstract: Land use regression (LUR) models have increasingly been used to estimate chronic and sub-chronic exposure to air pollution for individual study subjects in epidemiologic studies. A core assumption of these applications is that the spatial patterns described by the LUR model are stable over time such that a model developed based on measurements and predictors from a specific time period can be reliably applied forwards or backwards in time to match requirements for epidemiologic analysis. Further, given the need for site-specific measurement campaigns in LUR modelling there is interest in the extent to which a model developed in one location may be applied to others, and in whether the LUR methodology is equally applicable to urban areas of rapidly developing countries where geographic predictor data may be limited and where source contributions may be more varied and complex. We review such temporal and spatial transferability with emphasis on studies we have conducted in western Canada and in the development of a LUR model for New Delhi. Our findings indicate the plausibility of transferring LUR models between geographically similar locations, but model performance depends upon consistency in available geographic input data. For example, spatial factors that typically predict a high proportion of variation in North American and European contexts were not strong predictors in New Delhi. Calibration with local measurement data can improve transferred models in similar locations to a point where they are nearly as predictive as the initial source model. Several studies in which measurements have spanned periods as long as 18 years indicate stability in spatial patterns and support the validity of applying LUR models developed at one time point to earlier or future periods, especially if temporally adjusted with routinely collected network monitoring data and when area-wide concentrations are not changing dramatically.

Keywords: A-exposure models, A-epidemiology, A-geospatial analysis/GIS, C-air

Mo-S-B4-05
Integrating LUR models with Time-activity Data to Better Estimate Personal Exposures
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Abstract: Land use regression (LUR) modeling is common within air pollution epidemiology studies for assigning exposures to individuals in a cohort. While there are variations on the approach, typically air pollution measurements are fit to a regression model, in which the independent explanatory variables are land use and land cover indicators that to varying degrees, are proximal to each measurement location. After identifying the parsimonious set of variables for the model, and validation of the LUR, the model is used to predict an air pollution concentration surface for the study region of interest. Often individuals are simply assigned an exposure based on the modeled concentration at their residential address. The use of LUR models for exposure assessment makes numerous assumptions, but it is generally understood that LUR exposure assignments as previously described can only serve as coarse surrogates for true personal exposures. This talk reviews previous studies that shed light on potential deviations from the LUR-derived exposure and personal exposure measurements, including: time-activity patterns of individuals, time spent indoors or in transit, variations in exposure for individuals using personal air quality samplers, air pollution concentration levels along major

roadways that individuals may be exposed to during commute travel, and the distance-decay phenomenon from alternative air pollutant dispersion models. I will discuss recent work by Dons, et al. (2014), which illustrates using an agent-based modeling approach, a framework for incorporating personal mobility in the use of LUR models to better estimate exposures, and particularly short-term peak exposures. Further, I will discuss the practical feasibility of using travel diaries, GPS data-loggers, and smartphones to improve understanding of mobility patterns for integrating time-activity data with LUR models for exposure assessment.

Keywords: A-activity patterns, A-exposure models

Mo-S-C4: Tobacco Smoke as a Source of Harmful Exposures in the Workplace and the General Population

Mo-S-C4-01
Population Trends in Exposure to Cigarette Smoke in the United States

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Abstract: The first national estimate of exposure of the U.S. population to secondhand smoke (SHS) based on serum cotinine (COT) measurements was obtained from samples collected in 1988-1991 as part of the Third National Health and Nutrition Examination Survey (NHANES III). The data showed widespread exposure to nicotine: 88% of nonsmokers had measureable COT (≥0.050 ng/mL). In 1999 NHANES became a continuous biennial sampling of the U.S. population, and COT has been measured in each of the surveys since then. An early analysis of 1988-2002 NHANES data showed a significant decline of approximately 70% in COT concentrations in U.S. nonsmokers. For this presentation we analyzed all the NHANES COT data from 1988-2012 to examine recent population trends in exposure to nicotine. We calculated the geometric mean (GM) of COT concentrations in each survey period for all NHANES nonsmoker participants and by participant age, gender and race/ethnicity. We also calculated COT GMs of all nonsmoker participants for the time period 1999-2012 in order to investigate SHS exposure by age and by number of smokers in the home. All demographic groups of nonsmokers showed significant declines in the exposure to SHS over the 25 years of the surveys. Overall GM COT levels decreased 84% in nonsmokers: from 0.219 ng/mL in 1988-1991 to 0.035 ng/mL in 2011-2012. In contrast, mean COT levels in U.S. smokers did not change significantly during the same time period. In all age groups, mean nonsmoker exposure levels increased significantly with the number of smokers in the home. We also analyzed COT levels and other exposure biomarker results from NHANES participants. Our results indicate that tobacco smoke is a significant source of exposure for many environmental toxicants for both smokers and for nonsmokers with secondhand smoke exposure.

Keywords: A-second-hand smoke, A-biomarkers

Mo-S-C4-02
Population Exposure to Tobacco: Results of the Canadian Health Measures Survey (CHMS) Cycle 1 (2007-2009)

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Abstract: The Canadian Health Measure Survey (CHMS) is a general population survey that consists of household interviews and direct measurements of blood and urine for environmental exposures, chronic diseases, infectious diseases, fitness and nutritional status. In CHMS Cycle 1, urinary measures of cotinine were collected for approximately 5000 participants aged 6-79. Further biomarkers of exposure to tobacco, including nicotine, cotinine N-glucuronide, 3'-hydroxy cotinine (3-HC), 3'-HC-N-glucuronide, nicotine N-glucuronide, and anabasine were also measured for a sub-set of 2500 participants aged 12-79, along with NNAL and NNAL-glucuronide, the biomarkers of exposure to the tobacco-specific lung carcinogen, NNK. In this study, population exposure to tobacco and NNK were estimated using the 2007-2009 sub-set of biomarker data and household interviews. Cotinine was also compared against a panel of tobacco biomarkers to study population exposure to second hand smoke (SHS). The statistical analysis of data from the household interviews showed that 20.5% of Canadians are smokers, compared to 19.9% when cotinine biomarker data was used. The self-report data also found that 23.4% of non-smokers are exposed to SHS but when cotinine biomarker data was used, SHS exposure was estimated at only 8.8%. SHS exposure estimates based on the other individual biomarkers were also lower than self-report data, at 8.9%, 7.0%, 3.6% and 15.6% for cotinine-total, 3'-HC-total, nicotine-total and NNAL-total, respectively. In contrast, the use of a panel of tobacco biomarkers to estimate SHS exposure found 17.3% of the population to have detectable levels of at least one of

the four major biomarkers of tobacco exposure i.e. nicotine-total, cotinine-total, 3-HC-total and NNAL-total. Our results suggest that cotinine is a reliable measure for estimating the prevalence of tobacco use among the Canadian population, but a panel of tobacco biomarkers may provide more accurate estimates of SHS exposure.

Keywords: A-biomarkers, A-second-hand smoke, Tobacco-specific nitrosamines

Mo-S-C4-03
Urinary Concentrations of Polycyclic Aromatic Hydrocarbon Metabolites in Smokers, Passive Smokers and Non-smokers in the United States

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Abstract: Polycylic aromatic hydrocarbons (PAHs) are a class of carcinogenic compounds found in tobacco smoke. In the United States, the National Health and Nutrition Examination Survey (NHANES), conducted in two-year cycles, provides an ongoing exposure assessment of the civilian, non-institutionalized population to a wide range of environmental chemicals, including PAHs. We report urinary concentrations of ten hydroxyl polycyclic aromatic hydrocarbon metabolites (OH-PAHs) from the latest NHANES cycles, for Americans aged 6 years and older and evaluated concentration trends. There were approximately 2700 participants with PAH measurements for each NHANES cycle. We used sample weights to account for the unequal probability of selection and log transformed the concentrations to compute all of the estimates. After excluding users of snuff or smokeless tobacco, we categorized NHANES participants as non-smoker (serum cotinine <0.015 ng/mL), exposed to second hand smoke (SHS) (serum cotinine 0.015-10 ng/mL), or active smoker (serum cotinine >10 ng/mL). We included age, sex, race/ethnicity, urinary creatinine and serum cotinine concentrations in multiple linear regression models. Smoking status was confounded by age; therefore, age was retained as a significant factor in the final model. The geometric mean (GM) concentrations of all OH-PAHs in active smokers were significantly higher than in non-smokers, after adjusting for age, sex, race/ethnicity and urine creatinine. For example, the adjusted GM of the naphthalene metabolites in heavy smokers (with serum cotinine >300 ng/mL) were approximately 8 times higher than in non-smokers. In active smokers, the fact that urinary OH-PAH concentrations correlated with serum cotinine concentrations suggested that smoking was their main source of PAH exposure. We will also demonstrate the usefulness of PAH NHANES data to track the US population exposure to tobacco smoke over time.

Keywords: A-biomonitoring, A-second-hand smoke, Tobacco smoke, general population, polycyclic aromatic hydrocarbon

Mo-S-C4-04
Contribution of Tobacco Smoking to the Biomarker Levels of Exposure to Harmful Metals: The Korea National Health and Nutrition Examination Survey from 2008 to 2010

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Abstract: South Korea has one of the highest smoking rates among men globally, approximately 50%. However, the association between smoking and biomarker levels of hazardous compounds among Korean men is unclear. We examined the differences of biomarker levels of exposure to hazardous chemicals among male smokers and nonsmokers in South Korea. Data from the Korea National Health and Nutrition Examination Survey (KNHANES) from 2008 to 2010 were used to compare the biomarker levels of exposure to hazardous chemicals in tobacco smoke. The KNHANES is a South Korean national survey conducted by the Korea Centers for Disease Control and Prevention. The data from KNHANES IV and V were gathered from nationally representative samples extracted from the standard survey of households using a systematic sampling method. Using an optimum cutoff value, we distinguished smokers from nonsmokers and examined the associations of urinary concentrations of metals and cotinine. We used PROC SURVEY to integrate survey weights for statistical analyses. Results of our analyses demonstrated that active smoking is the major source of exposure to these metals.

Keywords: A-biomarkers

Mo-S-C4-05

Occupational Exposure to Second-hand Tobacco Smoke in the United States: NHANES 1999 - 2008

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Abstract: Background: Exposure to second-hand tobacco smoke (SHS) increases risk for acute and chronic negative health effects among nonsmokers. SHS exposure among nonsmokers can occur in the home, in public places, and also in the workplace. Objective: The objective of this study is to identify occupations with the highest risk of SHS exposure in the workplace. Methods: Sample data used in the study were serum cotinine data from the National Health and Nutrition Examination Survey (NHANES) over a period from 1999 to 2008. Nonsmokers (with serum cotinine <=10 ng/mL) were categorized into 18 working groups based on self-reported occupations. Results: During 1999-2000, workers among food preparation/service and construction/extraction occupations had the highest geometric means (GM) for serum cotinine (0.141(95%CI: 0.098, 0.203) and 0.110 (0.065, 0.185) ng/mL, respectively), while education/training/library and farming/fishing/forestry occupations had the lowest GMs (0.050 (0.042, 0.060) and 0.055 (0.036, 0.085) ng/mL, respectively). During 2007-2008, SHS exposure was highest in food preparation/service (GM: 0.096 [0.062, 0.149] ng/mL) and installation/maintenance/repair (0.081 [0.054, 0.120] ng/mL), while the occupations with the lowest serum cotinine levels were legal (0.018 [0.015, 0.021] ng/mL) and education/training/library (0.025 [0.020, 0.031] ng/mL). Serum cotinine levels decreased 49% from 1999-2000 to 2007-2008. During the same period, the two largest SHS exposure deductions were identified in the legal (71%) and personal care/service (63%) occupations, while the two lowest reductions were observed in the farming/fishing/forestry (19%) and installation/maintenance/repair (22%) occupations. Conclusions: The overall results indicate that SHS exposure varied significantly among different occupations, and that targeted efforts may be needed to decrease SHS at food preparation/service workplaces.

Keywords: A-second-hand smoke, A-biomarkers, D-occupational, A-workplace, serum cotinine, tobacco control, biomonitoring, nicotine metabolite

Mo-S-D4: Development and Application of Tools and Models to Improve Exposure Assessments in Air Pollution Health Studies

Mo-S-D4-01

Comparing Single Pollutant and Multipollutant Indicators for Gasoline and Diesel Vehicles in Different Urban Areas

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Abstract: A variety of single-pollutant and multipollutant metrics can be used to represent exposure to traffic pollutant mixtures to evaluate the health effects of mobile sources. Integrated mobile source indicators (IMSIs) that combine air quality concentration and emissions data have recently been developed and evaluated using data from Atlanta, GA, and were found to track concentration trends in traffic-related pollutants. IMSIs were then applied to a health study for Atlanta residents and found to be associated with cardiovascular health outcomes. In the current work, we apply IMSIs for gasoline and diesel vehicles to two other cities (Denver, CO and Houston, TX) with different emissions profiles and compare their spatial and temporal variability to single-pollutant (NO_X, CO, and EC) indicators and multipollutant source apportionment (SA) factors. Denver and Houston were chosen to contrast against Atlanta with respect to emissions profiles, topography, and population size. Across cities, both multipollutant gasoline metrics were most strongly correlated with CO (r = 0.46-0.95), while multipollutant diesel metrics were most strongly correlated with EC (0.80-0.99). NO_X correlations with SA factors varied across cities (0.27-0.70), while correlations with IMSIs were relatively consistent (0.62-0.79). In general, single-pollutant metrics were more correlated with IMSIs (0.62-0.96) than with SA factors (0.29-0.99). A spatial analysis indicated that the IMSIs were strongly correlated (r > 0.7) between two sites in each city, and in some cases, spatial correlation for the IMSIs was higher than for SA factors or single-pollutant indicators. These findings provide confidence that IMSIs are able to represent mobile source air pollution in cities with differing topography and source profiles using readily available data. The views expressed in this abstract are those of the authors and do not necessarily reflect the views or policies of the U.S. Environmental Protection Agency.

Keywords: C-air, B-particulate matter, multipollutant, mobile sources

Mo-S-D4-02

Association between On-Road Particulate Matter Mixtures and Acute Cardiorespiratory Response in a Commuters Panel Study

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Abstract: BACKGROUND: We conducted the Atlanta Commuters Exposures studies to examine the hypothesis that exposures to traffic pollution mixtures occurring during rush hour car commuting lead to acute changes in cardiorespiratory response. METHODS: We recruited 100 adults to conduct two 2-hour scripted highway commutes during rush hour in Atlanta. A suite of in-vehicle particulate components were measured in the subjects' private vehicles. Health measurements were conducted before and immediately after the commutes and in 3 hourly intervals after commutes. Factor analysis of the particle species was conducted using a varimax rotation method to organize all PM components into co-varying groups. Associations between exposures and response were examined using mixed-effects linear regression analyses. RESULTS: Results indicate that in-cabin particles derive primarily from 3 processes: the resuspension of road dust containing crustal elements and previously-deposited brake pad residue with a contribution of normal fuel combustion; incomplete combustion processes producing PAHs and carbon particles; and non-deposited particles ablated from brake pads. Exhaled nitric oxide (eNO) levels, an indicator of upper airway inflammation, were significantly elevated after commuting ranging from 8.3 - 13.7% higher than baseline levels ($p < 0.001$) at each of measurement period. Positive associations existed between in-vehicle iron (Fe) concentrations, predominant within the crustal factor, and eNO measured following the commutes (IQR increase in Fe = 4.2% increase in eNO post commute [95% CI: 0.3 - 8.3 %]). CONCLUSIONS: While commuting, individuals are cumulatively exposed to elevated particulate and gaseous chemical pollution, noise, and psychosocial stress. The current results suggest that the development of novel exposure metrics that better reflect the multiplicity of exposures occurring during typical commuting may serve as more sensitive indicators of biological response.

Keywords: B-particulate matter

Mo-S-D4-03

Evaluation and Application of Real-time Personal O3 and NO2 Monitors for Personal Exposure Assessment

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Abstract: Real-time monitoring techniques were applied to better characterize personal exposures to O3 and traffic-related pollutants in two health studies. A real-time O3 monitor was applied to measure personal exposures. Real-time O3, NO2, and black carbon monitors were also integrated in a portable platform to measure pollutant concentrations in microenvironments. Real-time personal O3 exposures were measured for 20 children with asthma in Newark, NJ. Each child was monitored for 10 consecutive days. The association between personal O3 exposures and FeNO and spirometry measurements were examined. The median concentrations of personal daily O3 exposures were 2-10 times lower than the corresponding ambient concentrations. However, the high-end exposure concentrations were similar to the ambient concentrations, indicating that personal activity and home ventilation pattern play an important role in personal exposures. Poor associations between personal exposures and ambient concentrations were observed, indicating the importance of personal exposure measurement for O3. A CairSens NO2 sensor, a microAeth AE51 black carbon monitor, and a 2B Model 205 O3 monitor were integrated in a portable platform to measure microenvironmental concentrations of O3 and traffic related pollutants in Iztapalapa, Mexico City. Human exposures will be reconstructed with the monitoring results and exposure levels will be classified. Human immune responses will be associated with measured exposures. A prototype of this portable platform was tested in Newark, NJ for its feasibility. The portable platform was suitable for both mobile monitoring and residential indoor and outdoor monitoring. The platform did not generate noticeable noise, and was applied for simultaneous residential indoor and outdoor monitoring for 10 days. The study is sponsored by American Lung Association (SB230016N, PI: Qingyu Meng), EPA STAR (R834579, PI: Robert Laumbach) and NIEHS (5RO1ES020382-02, PI: Stephan Schwander).

Keywords: C-air

Mo-S-D4-04

The Impact Air Pollution Averting Can Have on Model Estimated Ozone Exposures Experienced by Asthmatic Children and Associated Health Risk on High Ozone Days

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Abstract: We estimate the reduction in peak ozone exposures and health risks for a simulated study group when their afternoon time spent outdoors is reduced in response to high air pollution events. First, literature was reviewed to quantify three key variables needed to simulate this averting behavior: awareness of air pollution health effects and air quality alerts, the averting participation rate of study subjects, and the duration of the averting response. Then, using EPA's Air Pollution Exposure Model (APEX), we estimated population-based ozone exposures and decrements in forced expiratory volume in one second (FEV1) in asthmatic school-age children on several high ozone concentration days in three urban study areas (Detroit, Atlanta, and Denver). Finally, we compared exposure and risk estimates considering no averting, averting at literature-derived rates, and averting at twice literature derived rates. Most people (>90%) appear aware of high air pollution events and associated health effects, particularly asthmatics and those residing in an urban area. Approximately 30% of asthmatics reduce their outdoor activities on alert days by 20-40 minutes. The percent of simulated asthmatic children experiencing peak exposures and FEV1 decrements was decreased by approximately 2 percentage points when compared with results where there was no averting, with limited variability across the study areas. Simulations performed using twice the literature-derived averting participation rate and event duration resulted in a greater than two-fold reduction in percent of asthmatic children exposed or experiencing FEV1 decrements. It is anticipated that these model results will better inform air quality alerts that recommend reducing time spent outdoors on bad air quality days, specifically in describing not only who is potentially at risk, but at what time-of-day and how much time reduction is needed to have the greatest impact on improving public health.

Keywords: A-activity patterns, A-exposure models, D-children, D-susceptible, averting

Mo-S-D4-05

An Investigation of Traffic-related Air Pollution Exposure Measures in the Canadian Healthy Infant Longitudinal Development (CHILD) Birth Cohort and the Risk for Developing Allergies in Early Years

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Abstract: To accurately estimate health impacts of low levels of air pollution exposure, assess gene-environment interactions and the impact of different exposure periods, there is an increasing emphasis on individual-level temporally-varying exposure estimates in large cohort populations. We provide an overview of the traffic-related air pollution (TRAP) exposure estimation approaches developed in the Canadian Healthy Infant Longitudinal Development (CHILD) study and demonstrate their application to the analysis of association with atopy. Our approaches use multiple data sources to: account for temporal changes and residential mobility, examine indoor infiltration of TRAP based on a season-specific model, and facilitate stratified analyses based on time activity patterns. 2482 children ≥ 1 year old and with skin prick tests for inhalant (Alternaria, Der p, Der f, Cat, Dog, Cockroaches) and food-related allergens (soybean, milk, peanuts, eggs) were included in the analysis. TRAP exposure (Adjusted OR [95%CI] per 10µg/m3 NO2 increase 1.16 [1.0;1.4]) during the first year of life but not during pregnancy (1.01 [0.8;1.2]) increased the risk for development of atopy for any of the ten allergens . When residential mobility was not adjusted for, we found reduced precision and weaker association (1.10 [0.96;1.3] first year). This association was stronger among those for whom the exposure was less susceptible to misclassification (i.e. participants spending more time in the home 1.2 [1.0; 1,5] vs. those spending more time away 1.1 [0.9;1.5] and participants not attending daycare 1.6 [1.3 ; 2.0] vs. daycare attendees 1.05 [0.8;1.3]). A portion of this difference is likely attributable to other exposures related to daycare attendance. Our results regarding indoor PM infiltration were inconclusive. This work showcases the utility of incorporating information from different sources to improve exposure to gain better understanding of vulnerable time windows in birth cohort studies.

Keywords: A-exposure models, C-air, D-prenatal

Mo-S-E4: Assessing Non-Chemical Exposures for Environmental Health

Mo-S-E4-01

Area-Level Socioeconomic Deprivation, Air Pollution and Term Birth Weight in New York City

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Abstract: Numerous studies have linked air pollution and area-level socioeconomic deprivation with adverse birth outcomes. Far fewer studies have examined differential impacts of air pollution across the socioeconomic gradient, with mixed results. We leveraged unique exposure and population data for New York City - a city where spatial patterns in social and environmental conditions vary widely - to examine separate and joint associations of area-level deprivation and air pollution on term birth weight. Air pollution exposure was assessed as the mean concentration over pregnancy duration within 300 m of maternal residence, using New York City Community Air Survey (NYCCAS) data. Socioeconomic deprivation was defined based on spatially-stratified Principle Components Analysis on census variables previously associated with pregnancy outcomes. Vital records for hospital births 2008-2010 were restricted to full-term, singleton births to non-smoking mothers (n = 252,967). We observed non-linear associations between air pollution exposures and deprivation; mothers residing in areas in the least-deprived decile had significantly higher (p<.0001) near-residence nitrogen dioxide (NO_2) exposures (34.4 ppb, SD 6.5), on average, than did mothers residing in more deprived areas (area $NO_2$for all other SDI deciles ranged from 23.6 to 28.3 ppb). We are currently developing penalized spline models to examine non-linear exposure-response relationships, and effect modification of air pollution-birth weight relationships by area-level deprivation. Refined exposure assessment of air pollution and socioeconomic deprivation across a large, heterogeneous population may enable a better understanding of potential combined effects.

Keywords: C-air, D-susceptible, A-geospatial analysis/GIS, A-epidemiology, A-ecological exposure

Mo-S-E4-02

Central Nervous System Consequences of Developmental Exposure to Concentrated Ultrafine Particles

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Abstract: Air pollutants induce inflammation and oxidative stress in brain and have been associated with impaired cognition and attention, and increased risk for autism and schizophrenia. As early development is a period of particular vulnerability of brain, we assessed brain development and behavioral consequences of early postnatal (PN) exposure to real-time concentrated ambient particulate matter (CAPS; ultrafine particles) for 4hr/day on PN 4-8 and 10-13, a period of significant neurogenesis and gliogenesis, in mice, with or without an additional adult (AD) exposure at PN55-59. Mean CAPS counts approximated 200,000 particles/cm3, and mean particle mass concentration was 96.4ug/m3 across exposures. Notably, PN CAPS produced lateral ventricle enlargement (ventriculomegaly) at 24 hr post exposure which persisted and was male-specific. Ventriculomegaly has been associated with both autism and schizophrenia, and is a predictor of poor neurodevelopmental outcome. Interestingly, human studies show that males are more likely to be diagnosed with autism and schizophrenia, consistent with these observations. AD only CAPS also produced ventriculomegaly in males. PN CAPS in males also reduced levels of glial fibrillary acidic protein (GFAP) in corpus callosum and in hippocampus, and increased the microglia marker IBA-1, suggestive of glial cell loss and of 'functional disconnectivity', also a feature of both autism and schizophrenia, but a transient astrocytic response in females. PN CAPS increased hippocampal glutamate in both sexes, suggestive of excitotoxicity. PN CAPS impaired learning/short term memory and prodced impulsive behavior In males, and deficits in learning, locomotor activity and short-term memory in females. Collectively, these findings demonstrate a vulnerability of developing brain, particularly in males, to even low levels of air pollution, and raise the possibility that such exposures could serve as risk factors for autism and/or schizophrenia. NIH R21ES019105.

Keywords: B-particulate matter, A-behavior, brain, D-vulnerable

Mo-S-E4-03

Assessing Perceptual and Biological Measures of Chronic Stress Among Low Income, Ethnically Diverse Pregnant Women

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Abstract: Telomere length is a biomarker of cellular aging and predictor of chronic disease. The association between psychosocial stressors and shortened telomere length suggests telomeres may mediate relationships between chronic stress and adverse health outcomes. However, little is known about regulation of telomere biology during pregnancy. Our pilot study examined whether conditions of chronic adversity are associated with shortened telomeres and other biological markers of the chronic stress response among low-income pregnant women. We recruited 72 pregnant women who obtained health care at San Francisco General Hospital in San Francisco, California which predominantly serves patients with no health insurance. We administered a survey to participants during mid-pregnancy about their socioeconomic status, perceptions of neighborhood conditions, and relative social status. A blood sample was collected during labor, and telomere length was measured from DNA by quantitative PCR. The majority of participants were foreign-born, Spanish-speaking, Latinas (67%). Age, race/ethnicity, country of origin, education, and neighborhood perceptions were independently associated with telomere length in multivariate models. Shorter telomeres were found in older women, Latinas, particularly those who were Mexican-born, and those with higher education. There was a dose-response relationship between higher educational attainment and shorter telomeres (p-trend = 0.006). Women who chose an affirmative or neutral response to the statement, "I would move from this neighborhood if I could", had shorter telomeres (p=0.02) than women who disagreed with this statement. This is one of the first studies to examine predictors of telomeres during pregnancy. Future work should confirm these findings and examine their implications on fetal development.

Keywords: D-prenatal, A-biomarkers, A-cumulative exposure, D-vulnerable, chronic psychosocial stress

Mo-S-E4-04

Validating Administrative Social Stressor Indicators Using Survey Data on Perceived Stress Across New York City

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Abstract: Chronic psychological stress has been linked to respiratory health, both independently and in combination with air pollution. A biological stress response occurs when the demands of a stressor are perceived to overwhelm one's capacity to manage those demands effectively. Because individual level measures of stress are often unavailable, administrative social stressor indicators (e.g., crime rates) are frequently used as a proxy; however, the extent to which such proxies accurately represent individual stress perceptions is not well understood. We used survey and geographic information system (GIS) methods to characterize relationships between individual stress perception and administrative social stressor indicators, to identify valid stressor indicators for population-level analysis. Our spatially-stratified, citywide survey (n = 1549) assessed a range of psychosocial domains, including neighborhood disorder, buffering resources, and mental health. We assigned publicly-available, areal-level stressor indicators (n = 20) to survey participants, by residential location. Self-report perceived stress varied substantially across individuals. We used linear mixed models to examine administrative stressor indicators as predictors of individual perceived stress, adjusting for season, and individual confounders. In our sample, administrative indicators of community violence and socioeconomic composition consistently predicted self-report stress (p < 0.05), while indicators of noise, built environment, and property crimes did not. Thus administrative indicators and domains may vary in how reliably they reflect chronic stress. We are also evaluating differences across space (i.e., between communities) and socio-demographic characteristics (e.g., age, residential tenure). Validating the resonance of administrative stressor indicators can improve analyses of chronic stress as a possible modifier of environmental exposures, and a contributing factor to health disparities.

Keywords: D-susceptible, A-environmental justice, A-geospatial analysis/GIS, D-vulnerable, D-community

Mo-S-E4-05
Simulating Multiple Chemical and Non-chemical Exposures for a Community-based Cumulative Risk Assessment in New Bedford, Massachusetts

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Abstract: Cumulative risk assessment requires models of joint exposures to multiple chemical and non-chemical stressors, but it is challenging to apply these models with sufficient geographic and demographic resolution to accurately identify high-risk subpopulations. For an effects-based cumulative risk assessment of a low-income community living near a Superfund site (New Bedford, Massachusetts), we developed a modeling platform to provide high geographic resolution exposure estimates. First we developed and applied a simulation approach to combine coarse-resolution multivariable demographic data from the Public Use Microdata Sample of the American Community Survey with US census tract resolution constraints using probablistic reweighting with simulated annealing. The resulting synthetic microdata included detailed individual demographics for all New Bedford simulated residents as well as census tract of residence. We then developed regression models from publicly available datasets predicting exposures as a function of covariates in the microdata, focusing on exposures relevant to two outcomes of interest (attention deficit hyperactivity disorder-like behavior and blood pressure). This included models of smoking, alcohol consumption, fish consumption, and other risk factors from New Bedford-specific data within the Behavioral Risk Factor Surveillance System; models including prenatal PCB, lead, mercury, and DDE exposures from an established birth cohort in New Bedford; and models of adult exposures to lead, cadmium and PCBs from the National Health and Nutrition Examination Survey. Finally we applied the exposure regression models to the synthetic population. The resulting exposure models illustrated important correlations among predictors of chemical and non-chemical stressors in the New Bedford community, and the calculated individual-level exposures provided insight regarding high-risk neighborhoods and demographic groups.

Keywords: A-cumulative exposure, A-exposure models, A-risk assessment, D-community

Mo-S-F4: Integration of Air Quality, Exposure, and Source Apportionment Modeling for a Health Study of Asthmatic Children in Detroit: Results from the Near-road Exposure and Effects of Urban Air Pollutants Study (NEXUS)

Mo-S-F4-01
Near-roadway Gradients and Solubility of Particulate Species During NEXUS

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Abstract: Traffic-related air pollution is considered a public health concern, especially among populations living or working near a roadway. During the Near-Road Exposures of Urban Air Pollutants Study (NEXUS), dichotomous filters were collected at upwind and downwind sites of a multilane highway to evaluate ambient concentrations and spatial gradients of fine (<2.5 μm) and coarse (2.5-10 μm) particulate matter (PM). Filters were analyzed by X-Ray Fluorescence (XRF), then extracted in water and subsequently digested in a hot acid leach (HNO_3, HCl) prior to analysis by High-Resolution Inductively Coupled Mass Spectrometry (HR-ICP-MS) to determine solubility levels (soluble mass/total mass) of different species. Of the measured elements, 12 species were above their method limit of detection, i.e., Ba, Cu, Fe, Ti, Zn, Mn, Mg, Pb, Si, Al, K, and S. Significant variability was observed among water to total solubility, ranging from highly soluble (>70% soluble: Zn, S, Ba) to relatively low solubility species (<20% soluble: Fe, Ti). Similar to results in other roadway field studies, meteorology largely influenced near-road concentrations, with peak concentrations during periods of low wind speed (<1 m s-1) and when the wind direction was perpendicular to the roadway (downwind). While overall fine or coarse PM mass did not significantly decrease within 300 m from the roadway, individual species displayed different roadway gradients. Regional/urban pollutants, such as S and K, decreased more gradually from the roadway than brake and tire wear pollutants of various solubility levels (Ba, Cu, Fe, Ti). These results suggest that near-road populations can be exposed to elevated levels of potentially toxic, soluble PM that can generate reactive oxygen species. The views expressed in this abstract are those of the authors and do not necessarily represent the views or policies of the U.S. Environmental Protection Agency.

Keywords: C-air, B-particulate matter, B-metals, Near-roadway pollution, Roadway Gradients, Near-roadway pollution, Roadway Gradients

Mo-S-F4-02
Variability in Source Impacts for Residential Indoor and Outdoor PM2.5 in NEXUS Homes

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Abstract: A primary goal of NEXUS is to investigate associations between exposure to traffic-related air pollution and the respiratory health of asthmatic children living near major roadways in Detroit, MI. Understanding the contribution of traffic sources to exposure and how that varies between participants is critical to the study. Traffic-related source impacts were examined using daily PM2.5 species measured indoors and outdoors at 25 participant homes, outdoors at two area schools, and within 100m of a major highway (I-96). PM2.5 sample filters were analyzed for black carbon (BC) using transmittance and for water soluble and acid-extractable trace elements using High-Resolution Inductively Coupled Plasma-Mass Spectrometry (HRICP-MS). Residential air exchange rates were measured concurrently. PM2.5 species related to traffic sources (e.g. Ba, Cu) were highest at the I-96 site whereas BC, Zn and Pb were elevated at a school located near an international border crossing with heavy diesel traffic and downwind of an industrial area. PM2.5 species measured outdoors at participants' homes near major roadways also had elevated levels of Ba and Cu. Ba and Zn were highly water-soluble across all sites and indoor levels were ~80% of outdoors. However, only 50% of the Cu and Pb in outdoor samples were water-soluble. The Positive Matrix Factorization for Exposure (EPA PMFex) receptor model was applied to the data to identify combinations of PM2.5 species that represent different sources contributing to measured levels both outdoors and indoors, and to quantify their relative impacts. Traffic sources included combustion-related emissions and brake and tire wear. The contribution of traffic-related and industrial sources varied, while regional sulfate and crustal contributions were more consistent across sites. Infiltration of traffic-related PM2.5 sources indoors ranged from 40-60%, increasing with air exchange rates, and was lower than regional sulfate but higher than crustal.

Keywords: C-air, B-particulate matter, A-exposure models

Mo-S-F4-03
Air Quality Modeling of Traffic-related Air Pollutants for the NEXUS Study

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Abstract: A major challenge in traffic-related air pollution exposure studies is the lack of information regarding pollutant exposure characterization. Air quality modeling can provide spatially and temporally varying exposure estimates for examining relationships between traffic-related air pollutants and adverse health outcomes. This paper presents a hybrid air quality modeling approach and its application in NEXUS in order to provide spatial and temporally varying exposure estimates and identification of the mobile source contribution to the total pollutant exposure. Model-based exposure metrics, associated with local variations of emissions and meteorology, were estimated using a combination of the AERMOD and RLINE dispersion models, local emission source information from the National Emissions Inventory, detailed road network locations and traffic activity, and meteorological data from the Detroit City Airport. The regional background contribution was estimated using a combination of the Community Multiscale Air Quality (CMAQ) model and the Space/Time Ordinary Kriging (STOK) model. To capture the near-road pollutant gradients, refined "mini-grids" of model receptors were placed around participant homes. Mini-grids gave anonymity to 50 or 100 m, a distance sufficient to protect participants' identity. Exposure metrics were calculated from mini-grids to produce an estimate at each home location (n=160). Exposure metrics for CO, NOx, PM2.5 and its components (EC and OC) were predicted for multiple time periods including daily (24h period) as well as AM and PM rush hours. The exposure metrics were evaluated in their ability to characterize the spatial and temporal variations of multiple ambient air pollutants compared to measurements across the study area. Preliminary results of the epidemiologic analyses using model-based exposure estimates indicate a potential to help discern relationships between air quality and health outcomes.

Keywords: C-air

Mo-S-F4-04
Exposure Modeling of Residential Air Exchange Rates for NEXUS Participants

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Abstract: Due to cost and participant burden of personal measurements, air pollution health studies often estimate exposures using local ambient air monitors. Since outdoor levels do not necessarily reflect personal exposures, we developed the Exposure Model for Individuals (EMI) to improve exposure estimates in health studies. A critical aspect of EMI is estimation of the air exchange rate (AER) for individual homes where people spend most of their time. The AER, defined as the airflow into and out of buildings, can substantially impact indoor air pollutant concentrations and resulting occupant exposures. Our goal was to evaluate and apply an AER model to predict residential AER for the Near-Road Exposures and Effects of Urban Air Pollutants Study (NEXUS), which is examining traffic-related air pollution exposures and respiratory effects in asthmatic children living near major roads in Detroit, Michigan. We developed a model to predict AER based on building characteristics related to air leakage, local airport temperatures and wind speeds. Cross validation was used with a subset of NEXUS homes (N=24) with daily AER measured on five consecutive days during fall 2010 and spring 2011. Individual predicted and measured AER closely matched with median absolute differences of 36% and 24% for the fall and spring, respectively. The model was then applied to predict daily AER metrics for multiple time periods (e.g., AM/PM rush hours, overnight) for all NEXUS homes (N=193) during the study (Jan. 2010 - Dec. 2012). The AER predictions show (1) substantial house-to-house (spatial) variations (0.1 - 2.6 h^{-1}) from building leakage differences; (2) slow AER oscillations from seasonal temperature changes; and (3) large transients from wind speed fluctuations. This study demonstrates the ability to predict spatiotemporal variability of residential AER in support of improving health study exposure assessments.

Keywords: A-exposure models, A-built environment, B-particulate matter

Mo-S-F4-05
Using Modeled Estimates of Exposure to Traffic-related Air pollutants to Identify Respiratory Health Impacts for the NEXUS Cohort

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Abstract: The Near-Road Exposures and Effects of Urban Air Pollutants Study (NEXUS) was conducted to better understand the impact of mobile sources on near-road air quality, exposure, and adverse health outcomes. A specific goal is to characterize respiratory effects in asthmatic children due to traffic-related air pollutants. Children, ages 6-14 and with questionnaire responses from their caregiver that suggested persistent asthma, were recruited on the basis of residential proximity to high traffic roads in Detroit, Michigan in three traffic groups: high traffic/high diesel (HD), defined as homes <200 m of roads with >6,000 commercial vehicles/day and >90,000 total vehicles/day (AADT); high traffic/low diesel (HT): homes <200 m of roads with >90,000 AADT but <4,500 commercial vehicles/day; and low traffic (LT): homes >300 m from roads with >25,000 AADT and >500 m from roads with >90,000 AADT. Children in the LT group were drawn from the same neighborhoods as the other groups, but lived further from the high-traffic corridors to minimize possible confounding from unmeasured neighborhood-associated covariates. Ultimately, 129 children were enrolled with similar distribution across the three traffic categories. Children were studied quarterly from fall 2010 through fall 2012. While the three groups form distinct exposure categories, we also used dispersion modeling to predict concentrations from local and regional emission sources. Traffic sources were modeled using a detailed link-based inventory, the MOVES2010 emission factor model, and the RLINE emission model. Model results show significant differences in exposures, both within and between each of the three exposure categories, which are reflected in exposure-health outcomes such as cough, asthma control test (ACT) scores, and spirometry outcomes. These results show the importance of understanding the variation of exposure between participants in the study, and the contribution of traffic sources to exposure.

Keywords: C-air, D-children, A-exposure models, A-longitudinal metrics, A-geospatial analysis/GIS

Mo-O-G4: Chemicals in Consumer Products - III

Mo-O-G4-01
Exposure to Bisphenol A (BPA) in Fresh, Frozen and Canned Food from Texas, U.S.A

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Abstract: This study reports on an analysis of 204 samples of food obtained from Dallas Texas in 2010 for Bisphenol A (BPA). These samples included 92 samples of frozen and fresh foods and 112 samples of canned food. This data showed a meaningful difference in BPA concentrations in fresh and frozen foods compared to canned foods. BPA was detected in 7% of fresh and frozen foods, with a maximum concentration of 0.4 ng/g wet weight (ww). BPA was detected in 73% of canned foods, with concentrations from 0.2 - 149 ng/g ww. A limited assessment of the exposure to BPA from food ingestion based on these data was conducted. Adult BPA intakes for these categories of foods were calculated: fruit, vegetables, meat (i.e., beef, pork, poultry), fish, and fruit juices. Intake totals considered average overall ingestion rates, the fraction of the foods that are canned and non-canned, and the average BPA concentrations for each category. The total ingestion intake of BPA was 12.6 ng/kg-day, of which 12.4 ng/kg-day was canned foods, most of which was canned vegetables at 11.9 ng/kg-day. This contrasts with total BPA intakes estimated from urinary BPA from the National Health and Nutritional Evaluation Surveys, which approximately range from 30 to 70 ng/kg-day for adult central tendency (NHANES cycles 2005/6 - 2009/10). Comparisons with measurements in canned foods in other surveys indicate that, except for vegetables, the concentrations found here were lower by one to two orders of magnitude. This could explain a portion of the difference in the intake estimates. This shortfall could also be explained by food and non-food pathways not considered in this limited intake assessment, including cosmetics, dust-related exposures and exposures from thermal paper such as credit card receipts.

Keywords: A-exposure models

Mo-O-G4-02
Exposure to BPA in Children -- Media-based and Biomonitoring-based Approaches

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Abstract: Bisphenol A (BPA) is a high production volume chemical used in industrial and consumer product applications. Exposure is ubiquitous, and many studies have identified potential adverse health effects in animals and humans. Children's exposure is of particular concern due to potential developmental effects. We surveyed the literature on BPA exposure for children, focusing on data from the United States. Exposure is estimated by age group in two different ways. The 'forward' approach uses information on BPA concentrations in food and other environmental media combined with contact rates for each medium. The second ('backward') approach relies on urinary biomonitoring data, extrapolating backward to the intake which would have led to the observed biomarker level. The forward-based results suggest that estimated intakes of BPA are overwhelmingly dominated by canned food consumption, and that on a body weight basis, intakes are higher for younger ages. Mean intake estimates ranged from ~126 ng/kg-day for the youngest children (1 year of age) to about 73 ng/kg-day among those 16-20 years old. Biomonitoring-based intakes show the same trend of lower intakes for older children, with a median intake of 121 ng/kg-day for 2-6 years, compared with 33 ng/kg-day for 16-20 years. A limited evaluation of intakes for infants considered ingestion of breast milk, formula, and baby foods, as well as limited biomonitoring data. Intakes were estimated to range from 40 to 150 ng/kg-day. Given uncertainties and limitations in the available data, this analysis suggests that the 'forward' and 'backward' methods provide comparable results and identify canned foods as a potentially important source of BPA exposure for children. Disclaimer: The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the U.S. Environmental Protection Agency.

Keywords: A-biomonitoring, A-biomarkers, D-children

Mo-O-G4-03
Cashiers' Exposure to Bisphenol A (BPA) from Occupational Receipt Handling
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Abstract: Bisphenol A (BPA) is an endocrine disruptor with mixed in vivo and epidemiological evidence of possible adverse effects at environmentally-relevant exposure levels. While it is well understood that dietary sources dominate chronic, low-level BPA exposure in the general population, recent studies have suggested that dermal contact from handling BPA-coated thermal printing papers (e.g. receipts) may lead to elevated exposure for some workers. The retail cashier workforce is made up of a large fraction of women of reproductive age who may be particularly vulnerable to endocrine disruption. We are investigating the hypothesis that cashiers experience elevated BPA exposures due to dermal contact while handling BPA-coated cash register receipts at work. Data collection is currently underway to evaluate the pre- to post-shift change in urinary BPA concentration among cashiers working a full day shift while consuming a diet designed to be low in BPA. Information about the frequency of receipt handling throughout the shift, dietary compliance, use of hand lotions, sanitizers and hand washing is obtained through participant interviews and will help to evaluate the contribution of multiple factors to urinary BPA levels in cashiers. In order to confirm eligibility, receipts are analyzed for BPA using gas chromatography/mass spectrometry in our lab. To date, we have found a lower proportion of receipts that contain BPA than anticipated based on literature reports (24% vs. 40-80%). As of February 2014, we have enrolled 7 of 28 participants (n=4 handling BPA-free receipts as comparison group). Urine results will be available summer 2014. An evaluation of exposure is a necessary first step to assess risk, address measurement error in epidemiologic studies, and develop effective exposure reduction intervention strategies. Despite the obvious need, our study will provide the first evaluation of the extent of cashier dermal exposure to BPA from receipts.

Keywords: D-occupational, A-biomonitoring, A-workplace, Bisphenol A, cashiers, Bisphenol A, cashiers

Mo-O-G4-04 - Withdrawn

Posters

MP: Poster Viewing

Mo-P-01
Exposure Assessment of Taxi Drivers to Environmental Nanoparticles in Shenyang, China
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Abstract: Airborne particulate matter (PM) released from combustion sources such as diesel exhaust is an important pollutant in urban atmospheres. PM has been suspected to be a causative factor in lung cancer and respiratory diseases. The sources and health effects of PM have been evaluated by the size of PM such as PM10 and PM2.5. Although environmental nanoparticles with diameters of less than 0.1 μm (PM0.1) occupy only a small proportion of PM per weight in the air, the nanoparticles can bring substantially greater health effects than larger particles because they can deposit in the lung alveoli and enter the blood circulation. However, concentrations of mass and hazardous chemicals in the nanoparticles collected in life environment are still unclear. In this study, we investigated exposure of the taxi drivers to the environmental nanoparticles in road environment about in Shenyang, China. Size-fractionated particles (<0.1 μm, 0.1-0.45 μm, 0.45-1.0 μm, 1.0-2.5 μm) were collected inside and outside the taxies while running by using a prototype portable nanoparticle sampler with a slight modification (Furuuchi et al., Aerosol Air Qual. Res., 10, 30-37, 2010). The levels of PM0.1 mass and polycyclic aromatic hydrocarbons (PAHs) and their nitro derivatives (NPAHs) were monitored for the collected particles. The concentration of PM0.1 mass around the taxi cars were in the range of 21.9 - 35.4 μg/m3. Among the PM fractions, the high concentrations of PAHs and NPAHs were observed in the 0.1-0.45 μm and PM0.1 fractions, indicating that fine particles less than 0.5 μm (PM0.5) may greatly contribute to PM2.5 from automobile exhaust. This study was supported by the Environment Research and Technology Development Fund (5RF-1302) of the Ministry of the Environment, Japan.

Keywords: B-nanoparticles, C-air, D-occupational, A-sampling methods, A-analytical methods

Mo-P-02

The Association between Inhibition of Maternal Acetylcholinesterase Activity and Birth Outcomes among Agricultural Farmworkers in Thailand

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Abstract: Although prenatal exposure to organophosphate (OP) and carbamate pesticides was found the association with birth outcomes, there was no report about the association between the intermediate end points such as cholinesterase activity inhibition and birth outcomes. This longitudinal study investigated acetylcholinesterase (AChE), butyrylcholinesterase (BChE) activities in maternal bloods at 3 time points: at enrolment (7-12 weeks), 32 weeks of pregnancy and delivery, and cord blood from pregnant farmworkers receiving antenatal clinic at Fang Hospital, Chiang Mai province from March 2011-February 2012. The mean±SD AChE activity (5.5±1.0 U/mL) at enrolment during a high farming activity period was significantly lower than AChE activities at 32 weeks and delivery (6.1±0.9 and 5.9±1.1 U/mL, respectively). However, no differences were observed in BChE activities in maternal blood collected at these three time points (2.6±0.5, 2.4±0.6 and 2.5±0.6 U/mL, respectively). The activity of AChE enzyme in cord blood was significantly lower than in maternal blood. Mean AChE activity from total maternal blood samples collected during high pesticide-applying season (March-April) was lower than low pesticide-applying season (July-February). Seasonal differences were not observed with BChE. We found that newborn's body weight and length gradually decreased with increasing AChE inhibition level, however, only the decrease of body length was significant (p<0.05). To our knowledge, this is the first study that reports the association between %inhibition of AChE which was related to pesticide exposure and birth outcomes. Furthermore, the result also demonstrates a robust trend in AChE with pesticide-applying season supporting its use as a stable biomarker of effect for long-term, acute exposures to anticholinesterase-inhibiting pesticides especially in female farmworkers. The results of this study also support the establishment of cholinesterase monitoring program for health risk assessment in prenatal clinic in Thailand.

Keywords: cholinesterase; birth outcome; pregnant farmworkers; pesticide; Thailand

Mo-P-03

Hazardous PCBs Concentration in Guánica Bay: An Invisible Community

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Abstract: Environmental contamination surrounding minority communities, poses a serious threat to public health as they bear disproportionately higher burden of environmental disease. In Guánica Bay, PR, environmental pollution has been a major public health concern for the past several decades. Sediment samples collected recently, suggest the presence of hazardous concentration of polychlorinated biphenyls (PCBs) in the Bay. Two over-arching objectives of this project are to: a) characterize and quantify PCBs concentration in Guánica Bay, b) develop an understanding of the health effects of PCBs and the role of exercise to reduce the toxicity of PCB exposure. In collaboration with community members, the Bay was sampled at 17 different locations. EPA 3550B and 8082 methods were employed to analyze the samples for the concentrations of main Aroclors of PCBs. A bi-directional partnership with community stakeholders has been initiated to assess and address community exposures to PCBs. The analysis of the samples suggests that concentration of PCBs (Aroclors of PCB-1012 + PCB-1260) in the sediments ranges from 52 to 14080 μg/kg. The analysis also suggests elevated concentrations of polycyclic aromatic hydrocarbons at most sites. Learning about these concentrations, the community is very concerned about PCB confirmation in the Bay. Rising from these concerns, the University of Miami is working with the concerned stakeholders to identify community exposure to potential sources of exposure and to engage them in strategies to reduce community exposure to PCB. The hazardous concentrations of PCBs (second highest ever reported in NOAA's database), found in Guánica Bay, demands immediate actions, including the declaration of the Bay as a "superfund site" (under CERCLA). Engaging the concerned stakeholders is critical to identify potential sources of exposure and to conduct environmental sampling (of seafood these communities consume) to develop interventional strategies.

Keywords: exposure assesment

Mo-P-04

The Influence of Season and Gers on Urinary1-hydroxypyrene Levels of Children in Ulaanbaatar, Mongolia

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Abstract: Objective: This study is conducted to investigate the influence of season and living environment on children's urinary 1-OHP levels in Ulaanbaatar, Mongolia. Methods: Our study subjects were 320 children aged from 11 to 15 years old living in gers, brick houses and apartments in ger and non-ger areas of Ulaanbaatar. Spot urine samples and questionnaires were collected three times for each subject in three seasons, i.e. September (warm) and December (cold) in 2011and March (moderate) in 2012. Urinary 1-OHP was analyzed by high-performance liquid chromatography with fluorescent detection (HPLC/FLD). Generalized Estimating Equation (GEE) models were applied to estimate seasonal effects on 1-OHP levels, adjusting for demographic and environmental factors. Results: Children's urinary 1-OHP levels showed significant seasonal difference with 0.30 ± 0.57 µmol/mol creatinine in cold season, 0.14 ± 0.12 µmol/mol creatinine in moderate season, and 0.14 ± 0.21 µmol/mol creatinine in warm season. The GEE model showed Urinary 1-OHP levels in cold and moderate seasons were respectively 2.13 and 1.37 higher than the warm season. Urine 1-OHP levels for children living in ger areas were 1.27 higher than those living in non-ger areas. Children who lived in either gers or brick houses had respectively 1.58 and 1.34 higher 1-OHP levels compared with those living in apartments. Children's urinary 1-OHP levels were associated with either NO_2 or SO_2 concentrations at their home addresses in Ulaanbaatar. Conclusion: Mongolian children's urinary 1-OHP levels were significantly elevated during cold seasons, and for those living in ger areas or in ger or brick houses in Ulaanbaatar. Children's urinary 1-OHP levels were associated with fuel combustion from home heating and transportation.

Keywords: Ger, children, season, 1-hydroxypyrene, Polycyclic aromatic hydrocarbons, Ulaanbaatar, Mongolia

Mo-P-05

Evaluation of Vegetation as a Barrier to Near-highway Pollutant Transport onto a School Campus
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Abstract: Aims Elevated concentrations of traffic-related air pollutants exist near highways and children attending schools adjacent to highways are potentially exposed. Vegetative barriers, composed of trees and bushes, are a potential intervention to reduce near-road pollutant concentrations. The aim of this study is to measure the gradient of particle number (PNC) and black carbon (BC) concentrations on a school campus located next to a major highway; measure the density of vegetation during different seasons; and identify the impact of vegetation on the gradient. Methods We monitored PNC, BC and meteorology, along two 50m-transects (R and P) at a school adjacent to Interstate-85. The school was selected based on its proximity to the highway and existing barrier of evergreen and deciduous trees. Calculations of leaf area index (LAI) were made by integrating photographs into CAN-EYE software. Results We collected 15 days of data over four campaigns in March/April, May, November and January. Monitoring took place between 8:00 and 14:00. Median concentrations of PNC and BC were 10,426 #/cm3 and 1.7ug/m3, respectively. Concentrations decreased by approximately 13% for PNC and 10% for BC between 10m and 50m. LAI was calculated as 3.6 in May, 1.8 in November and 2.5 in January. In univariate models, LAI showed an inverse effect on log PNC (-.385; $p<.001$) and log BC (-.022:p=.349) for transect P, but a direct effect on log PNC (estimate 0.199; $p<.001$) and log BC (0.453; $p<.001$) for transect R. Preliminary multivariate models estimate a direct association of LAI when controlling for other variables. Conclusions Our results show a decrease in PNC and BC with increasing distance from highway. The opposing effect estimates of LAI on concentrations comparing two transects reflects differences in the representativeness of the overall measurement based on specific small scale arrangement of vegetation. A forthcoming analysis will investigate the associations in greater detail.

Keywords: B-particulate matter, C-air, D-community, D-children

Mo-P-06
Continuous Measurement of Indoor and Outdoor PM2.5 at One House in Japan
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Abstract: PM2.5 is one of the main concerns about air pollution in Japan as well as in foreign countries. Many studies about PM2.5 have been conducted in Japan, but most of studies were ambient air measurement. It is still unclear about personal exposure about PM2.5, because we don't have enough information about the relationship between indoor and outdoor concentrations. Short-term effects of PM2.5 are also important as well as long-term effects. Therefore we conducted continuous measurements of indoor and outdoor PM2.5 at one home. We used LD-5S continuous sampler (Sibata Scientific Technology Ltd., Japan). The concentrations of indoor and outdoor PM2.5 are described, and the difference and the relationship between both measurements are discussed. Outdoor concentration is higher than indoor but time trends at both measurements are similar, although we are still conducting the measurement and we can't show the final results here. Effect of ventilation and human behavior on the relationship between outdoor and indoor PM2.5 will be discussed.

Keywords: B-particulate matter, A-epidemiology, C-air

Mo-P-07
Notification of Pesticide Applications to Minimize Workplace Exposures: A Feasibility Study
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Abstract: Minimization of workplace exposure to off-target movement of agricultural pesticides during applications is a high priority issue for the Washington State Department of Health. The focus of this project was to evaluate the feasibility of a notification system activated by an orchard applying pesticides that would allow work crew supervisors in adjacent orchards to ensure that workers were not located in areas where off-target movement of pesticides might occur. In theory, users would indicate their intention to spray specific farmland and neighboring property owners would be automatically notified through simple, cost-effective smart phone or similar technology. The specific goals of this project were to: (1) interview tree fruit industry personnel responsible for pesticide applications regarding the desirability of a notification system and barriers to the implementation of such a system, (2) examine existing pesticide spray notification systems to determine their strengths and limitations, as well as their relevance to the Washington tree fruit industry, and (3) evaluate the ability of the Washington State University (WSU) Decision Aid System (DAS) to incorporate neighbor-to-neighbor spray notification. Results from 20 interviews, the framework of existing notification systems, and applicability to DAS are reported. Next steps include engaging a variety of stakeholders such as pesticide applicators, farm owners and managers, farmworker groups, research and education communities, and state agencies to determine how to best develop an agricultural spray notification system in the State of Washington.

Keywords: B-pesticides, D-occupational, Prevention

Mo-P-08
Blood 2,5-dimethyfuran as a Sensitive and Specific Biomarker for Cigarette Smoking
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Abstract: Introduction: Environmental monitoring has identified 2,5-Dimethylfuran (DMF) as a unique component in tobacco smoke, and thus DMF in human specimens has the potential to be a biomarker of tobacco smoke exposure. This study evaluates the validity of blood DMF for determining smoking status using two representative surveys of the general U.S. population. Methods: DMF concentrations in whole blood were measured on 1,154 and 3,326 participants in NHANES 2003-2004 and 2005-2006, respectively. Using self-reported smoking status categories as reference, the sensitivity (percent of smokers correctly detected), specificity (percent of nonsmokers correctly classified as such), and Kappa's Statistic (percent non-chance agreement) were computed for blood DMF as well as for serum cotinine, a conventional marker of exposure to tobacco smoke. All analyses were weighted to account for NHANES' complex sampling design. Results: The mean concentrations of blood DMF were 0.10-0.11 ng/mL, 0.02-0.03 ng/mL, and <MDL (method detection limit) in daily, non-daily and non-smokers, respectively. The sensitivity and specificity of blood DMF for determining daily smokers were 93.6-94.4% and 98.4-98.8%, respectively, in comparison to 100% and 20.0-23.8% for cotinine. Blood DMF and self-reported smoking status showed very high agreement in daily smokers (Kappa = 92.8-93.3%), and fair agreement in non-daily smokers (Kappa = 33.7-36.4%). By comparison, cotinine had poor

agreement in both daily and non-daily smokers (Kappa = 6.9-12.4%). Coffee intake did not influence blood DMF levels. Conclusions: Using blood DMF avoids using an "arbitrary" cut-off for optimizing sensitivity and specificity. Blood DMF's higher specificity and better agreement for identifying current daily smokers than serum cotinine may make it a useful biomarker in epidemiologic studies.

Keywords: A-biomarkers, A-second-hand smoke, B-VOCs

Mo-P-09
Modul'ERS: a Modular Computational Tool for Human Health Risk Assessment
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Abstract: In France, risk assessment studies have to be conducted before the implementation or the enlargement of some new facilities and before the reuse of some contaminated sites. These studies have to be performed in accordance to four principles : precautionary, specificity, proportionality, transparence. Until now, no devoted software has been developed in France to assess future exposure and risks for such studies. Because of that, many problems have been reported in exposure assessment studies leading to inconsistency between risk assessment studies and a lack of confidence in results provided. INERIS develops and diffuses modeling tools in the framework of one's missions for the Ministry in charge of the Environment. A modeling and simulation platform (MODUL'ERS) based on the equations presented in this handbook has also been developed. Our main objectives during its conception were to provide a tool (1) suited to different site conditions and tier studies, (2) transparent for any stakeholders and helpful to perform uncertainties analysis. MODUL'ERS consists in a library of preset module enabling the users to build models in accordance with the site conceptual model (that is to say the pathways from the source to the receptor), by downloading modules and connecting them, to create an exposure matrix. Many options are also available to create a customized application. To improve transparency of studies all the equations, parameters can be viewed by the users, as well all the intermediate calculations performed. Especially, hyperlinks enable to browse among variables and their equations. Some reports will be also published to make more transparent the assignment of values to input parameters, by describing the values collected and the choices made (best-estimate, ranges, probabilistic distributions).Coupling with the GIS-based platform PLAINE, MODUL'ERS is able to map environmental inequalities.

Keywords: A-exposure models, A-risk assessment, C-multimedia, C-soil, A-environmental policy

Mo-P-10
Characterization of Fungal Spores and Fragments Released in Various Conditions
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Abstract: Fungal particles released during growth and sporulation contain both intact spores and fragment particles which can cause various health effects in humans. It is unclear if fragment particles originate from fungal culture or from the growth material. The aim of this study was to measure the concentration of fragments and spores released from pure fungal cultures during aerosolization as well as to compare their elemental compositions. Particles from three fungal species (Aspergillus versicolor, Cladosporium cladosporioides and Penicillium brevicompactum), grown on agar and gypsum board for 1, 4 and 18 weeks were aerosolized using the Fungal Spore Source Strength Tester (FSSST) at three different air velocities (5, 16 and 27 m/s). Released spores (da > 0.8 μm) and fragments (da < 0.8 μm) were detected and counted using Optical Particle Size Spectrometer (0.3 - 10 μm) and LAS-X II (0.1 - 1 μm) respectively. The morphology and elemental composition of the particles were analyzed using a transmission electron microscope (TEM) coupled with an energy dispersive spectrometer (EDS). P. brevicompactum and A. versicolor grown on gypsum board produced the highest concentration of spores from 1 month old cultures at an air velocity of 27 m/s while 4 months old C. cladosporioides at an air velocity of 5 m/s and 1 week old P. brevicompactum at 27 m/s produced the highest concentration of fragments. When grown on agar, the highest concentration of spores and fragments were released from 1 week old P. brevicompactum at an air velocity of 27 m/s. Fragments and spores had similar elemental composition showing carbon and oxygen in abundance with minor detection of sodium, potassium, phosphorus, calcium, magnesium and silicon. Preliminary results on elemental composition of fragments and

spores indicate that the fragments are of fungal origin. The amount of released fragment particles is influenced by air velocity and fungal species.

Keywords: B-microbial agents, aerosolization, elemental composition, spores, fragments

Mo-P-11
Measuring Sucralose in Recreational Waters to Identify Human-Based Sources of Fecal Pollution

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Abstract: Recreational water quality studies have established the relationship between health effects in swimmers and water quality as measured with bacterial and molecular indicators of fecal contamination. Data from these studies have been used to establish water quality criteria to provide for the safety of recreational water users. However, the microbial indicators E. coli and enterococci used to monitor water quality may not accurately reflect the true risk of exposure to beach bathing waters. These two indicators are found in the feces of all warm-blooded animals, making it impossible to distinguish the source of fecal contamination. This has resulted in a situation where all recreational waters are treated the same with respect to water quality despite the general belief that exposure to waters contaminated by animals does not present as great a risk as exposure to recreational waters contaminated by human feces. Sucralose, a commercial ingredient in artificial sweeteners, presents a potential solution for identifying waters that are contaminated with human feces. Its value as a human fecal marker derives from the following facts: it is a synthesized chemical not found in nature, it is not metabolized as it passes through the body, and it is not degraded by the wastewater treatment process. The 2007 EPA Sanitary Survey Project identified 18/61 Great Lakes beaches that had potential sources of pollution related to discharges from waste water treatment plants. These beaches provide sites for testing sucralose to determine its effectiveness for detecting the presence of human waste in recreational waters. The use of on-line solid phase extraction-LC/MS/MS for quantifying sucralose in beach waters will be presented. Data will be presented on the occurrence of sucralose, E. coli, enterococci and selected genetic markers for human-associated Bacteroides in selected Great Lakes beaches and the results will be compared to those obtained by the EPA Sanitary Survey Project.

Keywords: A-analytical methods, A-risk assessment, B-microbial agents, occurrence, human fecal contamination, occurrence, human fecal contamination

Mo-P-12
A Tool to Reduce Uncertainty in Risk Characterization: Combining Bio-accessibility of Metals in Soils from Simulated Gastrointestinal Fluids with in vitro Cell-based Bioassays for Toxicity

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Abstract: There has been a steady growth in our understanding of risk and concerns related to environmental and occupational toxicants. While exposure to harmful contaminants such as asbestos, lead, and other heavy metals remain of great concern, events such as 9/11 and its subsequent aftermath and human health impacts caused by the explosion debris have taught us that potential contaminants can come in many forms. Some risk assessment tools are limited in their scope, and some, like in vivo animal models are costly, time consuming, and thereby limited in their widespread use. Consequently, simulated human gastrointestinal fluids have emerged as an in-vitro surrogate that has become a well-established tool for bio-accessibility estimates and basis for in vivo bioavailability calculations. A human liver heptocellular carcinoma cell line (HepG2) will be employed to quantitatively asses risk by evaluating the relationship between bio-accessible metal exposure levels, an estimate of bioavailability, and subsequent cell uptake and cytotoxicity. In addition, a quantitative link between metal bio-accessibility extraction and analyses to in vitro toxicological response would further validate and complement results of oral bio-accessibility and bioavailability measurements via sequential extraction. The benefits of quantifying the effects of the bio-accessible fraction of soil by means of in vitro cell culture analysis include: 1) reducing costs; 2) providing a better assessment of the biological link to human exposure and response; and 3) improving risk assessment and intervention strategies. Using simulated human body fluids and human cells, instead of animal model surrogates, to evaluate the transport/transformation of heavy metals in dusts and soils should provide a clearer picture of what happens inside the human body post ingestion.

Keywords: A-risk assessment, B-metals, C-soil, D-children

Mo-P-13

Aggregate Exposure to Aluminum from Diet, Personal Care Products, Cosmetics and Medications

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Abstract: Aluminum salts and aluminum lakes are used as functional ingredients in personal care products, cosmetics and medications, and aluminum occurs in most foods and drinking water. In cosmetic uses, aluminum is largely insoluble, which means very little of the applied aluminum is bioaccessible for skin absorption. In animal studies, oral exposure to very high levels of soluble Al have been linked to toxicological effects, with JECFA assigning a Provisional Tolerable Weekly Intake (PTWI) of 2 mg/kg/week in 2012. Consumers are therefore exposed to aluminum from a number of routes, with exposure in the population being variable due to differences in consumer habits and practices resulting from differing dietary patterns and the usage of medications, personal care products and cosmetics. The aim of this study is to characterize the distribution of exposure in different consumer populations and to assess the relative contributions of the different sources of exposure. A probabilistic model characterizing the different routes of exposure was developed, taking into account the variability in consumer habits and practices and the occurrence and concentrations of aluminum in different foods and consumer products. Dermal absorption and oral ingestion and the related concepts of dermal penetration and bioavailability are considered in order to combine exposures from different routes. The major source of aluminum exposure comes from the diet, with the other sources providing only a fraction of total exposure. In addition to providing a refined assessment of total aluminum exposure, this work can be used as a case study on how to approach future complex aggregate exposure questions.

Keywords: A-aggregate exposure, B-metals, C-consumer products, C-food, A-activity patterns

Mo-P-14

Estimations of Personal Exposure Using a Validated Chlorine Plume Dispersion Model

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Abstract: Background: Atmospheric dispersion models can serve as valuable tools in estimating personal exposure to air pollutants, especially in cases of exposure to transient gases. Aims: We used a validated plume dispersion model generated by the Hazard Prediction and Assessment Capability (HPAC) computer program to assess outdoor individual exposure for those in the Graniteville, South Carolina, USA (2005) chlorine release post-event registry. HPAC utilizes the SCIPUFF dispersion model, SWIFT weather model and the UDM for predictions in urban environments. Methods: An HPAC chlorine gas plume model, previously validated using post-incident observed environmental indicators (such as plant damage, acid pitting corrosion, and animal casualties), was used to estimate outdoor personal exposure for 634 individuals whose exposure locations were geocoded on an ArcMap geographical information systems (GIS) layer. Surface dosage at 1.5 meters above the ground was generated for each minute of exposure, eight-hour cumulative dosage calculated (ppm/sec) and U.S. Environmental Protection Agency (US-EPA) 30-minute Acute Exposure Guideline Levels (AEGLs) identified. Results: Registrant exposures for those in the plume varied widely. Cumulative exposure adjusted for an eight-hour period ranged from one ppm/sec to 337,631 ppm/sec. Of the 634 geocoded individuals, 352 had 30-min estimated exposure above AEGL-3 (28 ppm); 65 above AEGL-2 (2.8 ppm) and 42 above AEGL-1 (0.5 ppm). The remaining (175) were outside of the plume model and considered unexposed. Reported time of exposure before evacuation ranged from five minutes to several hours: 466 were exposed to the chlorine plume for over one hour, 38 between 0.5 to one hour, and 130 under 0.5 hours. Conclusions: We were able to estimate personal exposure to chlorine gas using a validated dense-gas plume dispersion model, although adjustments must be made for indoor exposures because the majority of exposures were indoors due to time of day.

Keywords: A-exposure models, A-geospatial analysis/GIS, A-emergency response, A-cumulative exposure

Mo-P-15

Exposure Apportionment by Location in Ibadan, Nigeria: Measuring Personal Exposure to PM2.5

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Abstract: Background: Household air pollution (HAP) is the environmental risk factor responsible for the most life-years lost due to disability globally. Exposure to HAP while pregnant can lead to negative birth outcomes, specifically low birth weight (below 2,500g). HAP is primarily caused by burning biomass, such as wood, for cooking fuel. In addition to HAP, there are many sources of air pollution in urban areas. Objective: An ethanol cookstove intervention in Ibadan, Nigeria followed 300 pregnant women through the course of their second and third trimesters. The aim of this paper is to examine the relative exposure to household and ambient air pollution of the 150 control participants still cooking with traditional cookstoves. Methods: Each participant was outfitted with personal fine particulate matter (PM2.5), carbon monoxide (CO), and GPS monitors for 72 consecutive hours during each trimester of the study. Temporal exposure data for PM2.5 will be linked to the spatial data for each participant using Esri's ArcGIS 10.2 software. Taking the accuracy of +/=10 m into account, data points that fall within 10 m of the house's coordinates will be considered as HAP exposure. Air pollution data collected away from each subject's house can be used to create estimates of ambient air pollution levels. Results: Preliminary analysis indicates that the difference between household and non-household air pollution exposure levels can be determined using this method. Identifying pollution hot spots away from the home will shed more light on exposure patterns. The ratio of ambient to household air pollution exposure will be compared to the Global Burden of Disease (GBD) at the country, regional, and global level.

Keywords: A-cumulative exposure, A-geospatial analysis/GIS, A-indoor environment, C-air, B-particulate matter

Mo-P-16

University Students' Exposure Levels to Secondhand Smoke in Various Hospitality Venues: Findings from South Korea

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Abstract: [Background] In South Korea, young adults' smoking prevalence is relatively higher than that of other age groups. Although most hospitality venues are subject to regulations mandating a complete indoor smoking ban pursuant to Article 7 of the Enforcement Rules of the National Health Promotion Act, information is limited on university students' secondhand smoke (SHS) exposure levels in hospitality venues after the implementation of the national smoking ban. This study evaluated indoor secondhand smoke levels in various venues and compared the levels with those measured inside campus buildings. [Methods] Using a portable real-time measurement instrument, Sidepak Model AM510 (TSI Inc.), we measured fine particulate matter (PM2.5) concentrations as an exposure marker of SHS. On weekdays, we performed measurements inside of campus buildings (from 12:00 to 2:00 pm) and in hospitality venues (e.g., PC game rooms, billiard rooms, and pubs) from 6:00 pm to 8:30 pm. On weekends, we performed measurement at clubs and bars, which are recognized as trendy venues among young adults. [Results] The median PM2.5 concentration was 73, 182, 63, and µg/m3 in campus buildings, billiard rooms, and pubs, respectively. The levels at clubs, nightclubs, and hookah bars were as high as 623, 138, and 250.1 µg/m3, indicating that PM2.5 concentrations were 3 to 12-times higher than the exposure guideline for outdoor particulate matter (50 µg/m3) that will be implemented on January 1, 2015 in South Korea. [Conclusion] Our study provides evidence for the introduction of more rigorous policy initiatives aimed at encouraging a complete smoking ban in venues, particularly clubs and periodic monitoring the impact of the national smoking ban.

Keywords: A-second-hand smoke

Mo-P-17

Expanding the Scope and Versatility of U.S. EPA's Consumer Exposure Models

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Abstract: The Consumer Exposure Module (CEM) is a chemical exposure assessment tool used by the U.S. Environmental Protection Agency (EPA) which estimates human exposure to chemicals from use of 44 consumer products using 6 exposure models. EPA has revised CEM to expand its scope and versatility. The revised CEM includes the ability to evaluate chemical emissions from more than 50 types of consumer products and articles -using over a dozen exposure models. Exposures to volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs) can now be estimated via inhalation, dust and drinking water ingestion, mouthing, and the dermal pathway in residential and non-residential environments for multiple receptor age groups. A suite of exposure models were examined for their applicability as screening tools to estimate SVOC and VOC release from consumer products and articles, subsequent partitioning to indoor and environmental media, and human intake. Available screening level models were evaluated based on input data requirements and the ability to estimate emission rates and partitioning between environmental media, both at steady state and as a function of time. The user interface was enhanced to provide greater flexibility to alter default input data and assumptions; conduct sensitivity analyses; review intermediate estimates (e.g., emission rates and exposure media concentrations by time step); and to save results and intermediate estimates in several formats. Revisions to the scope, flexibility, and usability of CEM have enhanced its ability to assess a broad range of exposures and will help EPA to support its new chemicals and existing chemicals programs. The views of the authors of this abstract are those of the authors and do not represent Agency policy or endorsement.

Keywords: A-exposure models, C-consumer products, B-SVOCs, A-exposure factors

Mo-P-18 – Withdrawn

Mo-P-19

PAHs Exposure Assessment for Community Elderly (PEACE) through Personal Particulate Sampling and Urinary Biomonitoring in Tianjin, China

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Abstract: Elderly expouse levels to polycyclic aromatic hydrocarbons (PAHs) has been analyzed through personal particulate sampling and urinary biomonitoring in summer and winter of 2011 in Tianjin, China. 101 subjects from two adjacent communities were recruited in this present study. Personal particulate samples were collected continuously from the subjects for 24 h, while first morning urine samples of elderly were collected when particulate measurements finished. In personal particulate samples, 18 PAHs were measured, and in urine samples 12 mono-hydroxylated metabolites (OH-PAHs) from 5 parent PAHs (naphthalene, fluorene, phenanthrene, pyrene and chrysene) were analyzed. The exposure levels of elderly population were much higher than other countries, while in winter were even higher than some occupationally exposed population reports, suggesting serious health risks exist in cold season. Comparison of personal particulate sampling and urinary biomonitoring results suggests that inhalation is the major route for NaP exposure, whereas ingestion may be a more important route for 3-ringed or larger PAHs. The correlation between 1-OHP and other metabolites support the use of 1-OHP as a useful surrogate representing total PAH exposure.

Keywords: A-biomonitoring, B-particulate matter, D-community, A-risk assessment

Mo-P-20

Using Community-Based Participatory Research (CBPR) to Identify Areas of Concern Regarding Neighborhood Children's Exposures to Air Pollution Using Tree Leaves as Biomonitors

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Abstract: Background:Disproportionate exposure to air pollution leads to environmental justice concerns in urban areas, and existing regulatory monitoring networks may insufficiently identify intra-neighborhood variability. CBPR provides knowledge needed to explore any disparities in intra-neighborhood air pollution exposures; using it to engage neighborhood youth in sample collection and analysis using a novel method of tree leaves as biomonitors, they have an opportunity to experience research related to air pollution exposures. Aims:We partnered with a community organization to 1) identify neighborhood-perceived areas of concern related to children's exposures to outdoor air pollution, 2) validate a method of obtaining spatially-resolved, intra-neighborhood air pollution measurements using tree leaves and 3) educate youth and involve them in a novel monitoring technique. Methods:Areas of concern-where children are most likely to spend time outdoors-were identified by Homewood Children's Village (HCV), Pittsburgh, PA. Sampling locations (n=22) near areas of concern were chosen based on proximity of candidate trees and telephone poles to hang air monitors. Neighborhood youth assisted with air monitor deployment and collection of leaf samples, and will be assisting with leaf sample analysis. Results:Neighborhood youth were educated on health effects of air pollution and air pollution monitoring techniques. They will participate in leaf sample analysis and dissemination of results to HCV. Conclusion:Utilizing knowledge unique to this neighborhood was instrumental in identifying perceived air pollution areas of concern related to where children spend time outdoors. Analysis is ongoing to characterize intra-neighborhood air pollution-related exposures. This study increased youth awareness about local air quality and related health effects. Results will be used to inform a multi-level intervention to address childhood asthma challenges in the neighborhood of Homewood.

Keywords: D-community, A-biomonitoring, B-particulate matter, C-air

Mo-P-21

A Characterization of Radiofrequency Fields Associated with the Aclara STAR® Network Smart Water Meter Transmission Units (MTUs)

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Abstract: The City of Toronto's water meter program is switching to a wireless water meter system. Once complete, all water usage data will be transmitted remotely by an Aclara MTU using radiofrequency (RF) signals to the water utility, replacing the practice of an employee visiting each location to take a reading. Public participation in the meter program is mandatory and enforced under a municipal code. Due to public interest and concern related to this additional source of RF in the environment, Toronto Public Health enlisted the Environmental and Occupational Health team at Public Health Ontario (PHO) to conduct a study characterizing RF emissions from the MTUs. In Canada, Health Canada's Safety Code 6 (SC6) outlines limits for human exposure to RF electromagnetic energy in the frequency range from 3 kHz to 300 GHz. RF emitting devices must meet requirements outlined by SC6. A Narda SRM-3006 was used in scope mode to capture both duration and magnitude of RF peaks at 458.7625 MHz which was a unique frequency used by the water meter transmitters. RF measurements were taken in controlled conditions to look at exposure as distance increased linearly from the MTU as well as from a fixed location while the MTU was rotated over 360° relative to the measurement probe. RF levels during typical usage scenarios were considered through ambient measurements at 3 residential locations and a daycare facility. RF levels decreased as distance from transmitter increased both in controlled situations and in typical usage scenarios. The poster will provide select results from the scenarios described above and comparisons to specifications provided by the manufacturer, SC6 and the International Commission on Non-Ionizing Radiation (ICNIRP) guidelines.

Keywords: smart meters, radiofrequency, RF, EMF, water meters

Mo-P-22 - Withdrawn

Mo-P-23 - Withdrawn

Mo-P-24
Effects of Disease Status on Variability in Oxidative Stress Responses to Traffic Exhaust Exposure: Oxford Street II Study

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Abstract: Subjects with different susceptibilities show a considerable amount of variability in responses to pollutant exposure, but few studies have attempted to assess the sources of inter-personal variability. As part of an ongoing study of cardio-respiratory effects of diesel-traffic exposure in persons with chronic obstructive pulmonary disease (COPD), ischemic heart disease (IHD), or free of these diseases (40 subject per group), we compared biomarker levels of oxidative stress in response to real-life diesel traffic exposure by disease status. To date, we have completed analysis on 24 healthy volunteers, 22 COPD and 9 IHD patients. We are examining intra-subject differences in response to a two-hour walk on a city street with high diesel-traffic density compared to a walk in a nearby traffic-free park. Urine samples were collected from each participant 2 hours before and 24 hours after the walk. Two biomarkers, i.e. malondialdehyde (MDA) and 8-hydroxy-2'-deoxyguanosine (8-OHdG), were analyzed using HPLC-fluorescence/ECD. After the walk on the diesel-traffic street, concentrations of 8-OHdG (mean ± standard deviation) increased by 29±74%, 99±155%, and 121±275% for healthy, COPD, and IHD subjects, and concentrations of MDA increased by 37±94%, 109±245%, and 97±265% for the three groups of subjects. In contrast, after the walk in the traffic-free park, concentrations of 8-OHdG increased by 28±112%, 68±115%, and 41±117% for healthy, COPD, and IHD subjects, and concentrations of MDA increased by 31±151%, 54±121%, and 35±98% for the three groups. Subjects with COPD and IHD show higher biomarker responses to diesel-traffic exposure than to traffic-free exposure, while healthy subjects showed comparable biomarker responses. Preliminary results indicate that individuals with COPD and IHD had higher magnitudes of changes in oxidative stress following traffic exposure. The findings will help to improve risk assessment by considering the effect of disease susceptibility factors.

Keywords: A-biomarkers, A-epidemiology, D-susceptible, C-air

Mo-P-25
Baby Wipe Lotion Exposure: A Probabilistic Modeling Approach
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Abstract: Fundamentally unique aspects of childhood exposures to chemicals, such as those associated with diapering, lead to the need for specific exposure data for safety assessments. Due to the challenges of measuring baby wipes lotion exposure, we used three types of data to develop a comprehensive probabilistic model of exposure: data on the number of baby wipes used/day, data on amount of lotion transferred by each wipe, and publicly available US NHANES data on the population distribution of body weight as a function of age. Separate models of each of these three types of data were then combined, in a Monte Carlo analysis, to characterize both the median amount of lotion transferred (mg/kg/day), and percentiles of the distribution around the median, as a function of age. This was done separately for each of the geographies in which wipes usage studies have been conducted by P&G: US, Germany, UK. Overall, these models predict a reduction in lotion transfer with increasing age, driven by a declining number of wipes used/day and an increase in body weight as the children grow. The 50th, 90th, and 95th percentiles of average daily lotion transfer for females for the three countries were as follows: US - 160, 290, 330 mg/kg/day; Germany - 180, 300, 340 mg/kg/day; and UK - 190, 320, 360 mg/kg/day. For Germany and US males the ranges were similar. A slightly higher number of wipes was used by the UK boys leading to higher lotion transfer than other country/gender combinations, which were all fairly similar. The effect of child's gender and significance of this is unclear. This poster will provide a breakdown of age and gender specific values for lotion exposure. This model can be used for future assessments of exposure to baby wipe ingredients.

Keywords: A-exposure models, D-children, A-statistical methods, A-risk assessment, C-consumer products

Mo-P-26

Exposure assessment method for the prospective cohort study of workers potentially exposed to engineered nanomaterials in France (EpiNano project)

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Abstract: The lack of epidemiological and biomedical data on the human health potential risks related to the engineered nanomaterials (ENM) exposure is a substantial gap for validating experimental results, risk-assessment modelling and developing consistent risk management guidelines if needed. Considering that despite these uncertainties, ENM handling spreads in industry, the French government decided to launch an epidemiological surveillance of workers occupationally exposed to ENM. However the determination of workers' exposure to ENM is challenging because traditional industrial hygiene methods are hampered by a shortage of equipment and methodologies for personal sampling of nanomaterials, analysis of their physicochemical characteristics and their large heterogeneity. To conceive an alternative method, Quintet ExpoNano work-group was constituted including French specialists of occupational ENM exposure measurement, safety and health. Workers potentially exposed to either TiO2 nanoparticles or carbon nanotubes will be identified using a 3-level approach: 1-identification and selection of companies concerned with these ENM exposure (based on compulsory declaration of ENM used and produced and company inclusion questionnaire), 2-in site exposure assessment and identification of the jobs/tasks with ENM exposure (based on field-based form for job/task-expose matrix construction, further supplemented with measurements), and 3-identification of workers concerned. Workers identified will be included in the prospective cohort, with data of interest collected by questionnaire. Questionnaires and field-based form are designed and currently under validation tests in the field. These tools as well as the EpiNano project will be presented and discussed.

Keywords: epidemiology, industrial hygiene, occupational exposure, nanoparticles, nanomaterials

Mo-P-27

A Novel Transportable Neutron Activation Analysis System to Quantify Manganese in Bone *In Vivo*: System Setup and Validation

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Abstract: Overexposure to manganese (Mn) can lead to various neurological disorders including "manganism", a devastating neurological disorder with symptoms closely resembling Parkinson's disease. The progressive and irreversible characteristics of chronic Mn neurotoxicity make early diagnosis of body Mn burden an urgent issue. Data in literature have suggested that the amount of Mn in bone accounts for ~40% of total body burden and the half-life of Mn in bone is much longer than other organs. We hypothesize that bone Mn (MnBn) may serve as a valuable biomarker for long-term cumulative Mn exposure. To test this hypothesis, we have constructed a neutron activation analysis system and validated its usefulness for non-invasive quantification of MnBn. Thermal neutrons have a high cross section to interact with 55Mn; the resulting 847 keV characteristic γ-rays can then be captured. By measuring the 847 keV γ counts from the irradiated bone, MnBn concentration can be calculated. Our lab has a DD neutron generator with a flux up to $3 * 10^9$ neutrons/sec. Optimized settings including moderator, reflector, shielding and their thicknesses were selected based on MCNP5 simulations. Hand phantoms with different Mn concentrations were irradiated using the optimized DD neutron generator irradiation system. The Mn characteristic γ-rays were collected by a HPGe detector system with 100% relative efficiency. Calibration line between μg Mn/g dry bone (ppm) and Mn/calcium (Ca) counts ratio was obtained, which showed a significant linear relationship. The detection limit was calculated to be about 0.85 ppm with an irradiation dose of 50 mSv to the hand. The whole body effective dose was about 31 μSv. The current effort is devoted to reduce the detection limit to 0.6 ppm with a combination of two 100% HPGe detectors. Given the average normal MnBn concentration of 1 ppm in general population, this system is promising in MnBn quantification in humans.

Keywords: A-biomarkers, A-cumulative exposure, B-metals, D-occupational

Mo-P-28

Rapid Determination of the Nonsteroidal Anti-inflammatory Drugs (NSAID) Paracetamol, Ibuprofen, *Aspirin, Indomethacin and their Metabolites in Urine by On-line LC/LC-MS/MS*

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Abstract: Paracetamol (acetaminophen), ibuprofen and aspirin are heavily sold over-the-counter analgesics and anti-pyretic drugs and are commonly used for self-treatment of several afflictions. Indomethacin is a prescription medication for symptomatic therapy of rheumatic diseases. Especially paracetamol is often used during pregnancy. Recent association studies suggest increased reproductive disorders in males after prenatal exposure to these substances in the past. Despite the widespread use of these substances and the suggested endocrine disrupting effects there is limited exposure data available based upon human biomonitoring measurements. We expanded our recently developed online LC-MS/MS method for the determination of paracetamol in human urine to include aspirin, ibuprofen and indomethacin as well as selected metabolites including paracetamol-3-mercapturate, salicyluric acid and 2-hydroxyibuprofen. After enzymatic hydrolysis of their glucuronide conjugates, target analytes were extracted from urine and enriched with turbulent flow chromatography on a Waters Oasis ® HLB column. Final chromatographic separation was carried out on a Thermo AccucoreTM Phenyl-X column followed by sensitive tandem mass spectrometric detection. Isotope-labelled internal standards were used for quantification. We achieved limits of quantification of 1-5μg/L depending on the analyte, thus sufficiently low to detect both possible background exposures (as we already described for paracetamol) and medically indicated treatments. The latter can result in urinary levels in the mg/L or g/L range. We will provide first human biomonitoring data on these analgesics both for users and the general population. This method can be used in the future in population studies to (retrospectively) classify NSAID users and NSAID consumption in the general population or potentially susceptible subsets like pregnant women or children.

Keywords: A-biomonitoring, B-pharmaceuticals, NSAID, HIGH PERFORMANCE LIQUID CHROMATOGRAPHY, URINE, NSAID, HIGH PERFORMANCE LIQUID CHROMATOGRAPHY, URINE, NSAID, HIGH PERFORMANCE LIQUID CHROMATOGRAPHY, URINE

Mo-P-29
Urinary Biomarkers of Household Air Pollution: Findings from Nepal
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Abstract: Background: Approximately 50% of the global population relies upon biomass fuels (wood, charcoal, crop residue, dung) for cooking and/or heating purposes. Household air pollution (HAP) resulting from the use of these solid fuels is of particular concern, given the range of known adverse human health outcomes resulting in an estimated 4 million deaths annually. While a vast majority of epidemiological studies have relied exclusively on questionnaire as well as environmental monitoring for the quantification of HAP exposure, a more robust exposure assessment method, such as biomarker based approaches are needed to quantify the individual level measure of exposures. Objective: To evaluate urinary metabolites of 1,3 butadiene as a biomarker of exposure to HAP in Nepal. Methods: We analyzed urine samples from 606 cytologically/histologically confirmed lung cancer cases and 606 age and gender matched controls collected from B.P. Koirala Memorial Cancer Hospital between 2009 and 2012, using liquid chromatography tandem mass spectrometry (LC-MS/MS) based methods. The urinary metabolite of 1.3 butadiene (monohydroxybutyl mercapturic acid or MHBMA) was detected in multiple reaction monitoring (MRM) mode and quantified using isotope labeled internal standard (MHBMA-d6). We used multiple linear regression to quantify the relationship between questionnaire based measure of exposure to HAP and the urinary metabolites of 1,3 butadiene adjusting for known confounders (age, ethnicity, tobacco use, SES status, and geographic residence). Results/Conclusion: LC-MS/MS analysis is being currently conducted to quantify the level of MHBMA in urine samples. Our results will show the usefulness of MHBMA as a biomarker of exposure to HAP in large scale studies. This study is the first of its kind investigating biomarkers of HAP focusing on a population in Nepal.

Keywords: A-biomarkers, A-indoor environment, A-global health

Mo-P-30
External Validation of Exposure Models at a Medium-sized Plant
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Abstract: The present study was performed to evaluate exposure models from three tasks at a paint manufacturing plant. Four exposure models including Targeted Risk Assessment (TRA), EMKG-Expo-Tool (Easy-to-use workplace control scheme for hazardous substances), Stoffenmanager, and Advanced REACH (Registration, Evaluation, Authorization, and restriction of Chemicals) Tool (ART) were evaluated. Full-shift exposure measurements of parachlorobenzotrifluoride (PCBTF) were collected from a pre-staging task (n=10), a batch-making task (n=12), and a filling task (n=5). For the TRA, Stoffenmanager, and ART tools, a point estimate representing 90th% of exposure distribution was obtained, while a range of exposure estimation was obtained for the EMKG-EXPO-Tool. The performance of each model was evaluated into two or three groups due to different amount of PCBTF used per shift (> 1000, 100-1000, and < 100 liters for the pre-staging; 100-1000 and < 100 liters for the batch-making and filling tasks). For the personal exposure measurements, 90th% of exposure distribution was estimated using either log-normal (n>=3) or uniform distribution (n=1). The Stoffenmanager generated always higher concentrations (1.1-20.6 times) than the PCBTF time-weighted average (TWA) exposure measurements for all three tasks. The TRA produced higher exposures for the pre-staging task and lower exposures for the other tasks than the TWA exposures. The ART generated significantly lower exposures (0.02-0.3 times) than the TWA exposures except for the pre-staging task where the PCBTF amount > 100 and 100-1000 liters. Only the TWA exposures of filling task regardless of the PCBTF amount and batch-making task with PCBTF amount < 100 liters were within the estimated ranges of EMKG-Expo-Tool. Since these exposure models were recommended as screening tools (i.e., expecting overestimation of exposures to be conservative), overall, our findings suggested that the Stoffenmanager performed better than the other models.

Keywords: A-exposure models

Mo-P-31
High-Throughput Exposure Assessment Tool (HEAT) for Exposure Based Prioritization of Chemicals
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Abstract: The ToxCast/Tox21 research programs are generating vast quantities of in-vitro based toxicity data using state-of-the art high-throughput screening (HTS) assays. U.S.EPA has proposed to use these data to establish health benchmarks for chemicals that can be used for prioritizing chemicals for in-vivo testing. HTS exposure assessment approaches are needed in order to evaluate the potential human health risks of these chemicals. To meet this need, Dow is developing software entitled the High-Throughput Exposure Assessment Tool (HEAT). The purpose of the tool is to produce high-throughput screening level exposure assessments for large numbers of chemicals used in multiple commercial products. The initial scope of this tool was limited to near-field exposures. The tool groups chemicals in specific use categories, defines worst-case near-field exposure scenarios for each use category, and uses a combination of generally applicable exposure models to derive screening estimates of external doses by route (dermal, inhalation, oral). The exposure algorithms from existing near-field exposure assessment tools used by U.S. and EU regulatory bodies were leveraged [ConsExpo tool (for consumer exposure) and the Chemical Screening Tool for Exposures and Environmental Releases (ChemSTEER) tool (for worker exposure)]. Additional product categories/worker activity patterns were added to cover a wider range of exposure scenarios.

Keywords: A-exposure models, A-chemical prioritization, A-indoor environment, A-risk assessment, C-consumer products

Mo-P-32
Calibration and improvements of a portable XRF technology to quantify lead in bone in vivo
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Abstract: Lead is a ubiquitous toxin, which has been shown to have adverse health effects on many systems in the body. Bone serves as a valuable biomarker for long-term lead exposure. With recent advancements in portable XRF technology and calibration methods, we have developed a system to measure lead in bone in vivo. The main goals in this study were to improve the sensitivity of the system, determine the best calibration method, and validate the system for in vivo measurement. We investigated four calibration methods, namely background subtraction, bone calibration, bone adjustment calibration, and traditional peak fitting. System calibration is important, as with larger soft tissue thickness the detected lead x-ray signals can be low and difficult to quantify. The device was calibrated using phantoms of known lead concentrations for background subtraction and traditional peak fitting methods, bone of known lead concentrations for bone calibration method, and bone and phantom comparisons for bone adjustment method. Using these calibration methods we measured the bare cadaver bone and goat bone samples with Lucite used to replicate soft tissue, and cadaver bone with and without intact soft tissue. There was strong correlation between the K x-ray fluorescence (KXRF) and portable XRF bone lead results for bare cadaver and goat bones. There was also strong correlation between KXRF and portable XRF results for goat bone with Lucite, however, the results for cadaver bone with Lucite did not show the same correlation. As a final assessment the device was used on cadaver bone with intact soft tissue, and the results of these experiments showed a good correlation with previous KXRF data. Our results suggest that the portable XRF bone lead measurement has a detection limit of 3.4 ppm with 2 mm soft tissue thickness, the best calibration method for use with in vivo data is the background subtraction method, and that the technology needs to be validated in a larger human population.

Keywords: A-risk assessment, A-epidemiology, A-biomarkers, A-biomonitoring

Mo-P-33
Constituents Comparison of Ambient Particulate Matter to Extracted Liquid for Toxicology Applications
C. L. Roper, L. G. Chubb, B. Tunno, L. Cambal, J. L. Carr Shmool, D. Michanowicz, C. Fattman, J. Clougherty; University of Pittsburgh, Pittsburgh, PA

Abstract: Exposure to ambient fine particulate matter(PM2.5) in epidemiologic studies has been associated with a number of adverse health effects.Understanding the mechanisms of PM2.5-associated health effects has become a focus of toxicology studies.To date, research has focused on standard reference materials(SRMs) from single sources.While well-characterized, SRMs lack the complexity found in ambient mixtures.Developing methods for extraction of filter-based PM2.5 allows for ambient mixtures to be researched which are more

relevant to health effects but it is imperative to ensure that these methods result in samples that are physicochemically representative of ambient air. Ambient PM2.5 samples collected throughout Pittsburgh were characterized for metals and organic constituents.Co-located samples were extracted through sonication in methanol and re-suspended in cell media for toxicology research.The extracted liquid was re-suspended onto filters and analyzed in the same manner as the ambient samples to allow for comparison between ambient PM2.5 and the extracted liquid.Particle size distribution was measured to determine particle size in the extraction liquid. Extraction efficiency of total PM2.5 mass was 89.9±4.4%.Physicochemical comparisons of particle size distribution, metals, and organics concentrations will be performed for ambient and extracted samples. Extraction estimates based solely upon PM2.5 mass removed do not reflect the differential removal of constituents.Comparison between ambient and extraction liquid samples suggests that the methods were more effective in metals removal compared to organics.Several factors contribute to the reduced removal of organics including:the volatile nature, reactivity, and polarity differences among compounds.Extraction methods utilizing alternative solvents or combinations thereof may result in higher organics yields and therefore an extracted liquid that is more representative of ambient samples for toxicology studies.

Keywords: B-particulate matter

Mo-P-34
Spatial Toxicology: In vitro Inflammatory Assessment of Intra-urban Spatially Varying Particulate Matter

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Abstract: Ambient fine particulate matter(PM2.5) concentrations have been associated with various health outcomes related to respiratory and cardiovascular inflammation.PM2.5 varies spatially in both concentration and composition in intra-urban environments due in part to variation in sources.Determining the impact of spatially varying PM2.5 on inflammatory responses may identify causal constituents and sources most relevant to PM2.5-associated health effects. Cell lines allow for an in vitro assessment of variation in inflammatory responses related to intra-urban spatially varying PM2.5 . PM2.5 samples were collected at intra-urban locations(n=5) with previously observed contrasts in PM2.5 composition and concentration.Co-located samples were used for ambient characterization or extracted and re-suspended in a set volume of Dulbecco's Modified Eagle Medium(DMEM) for inflammatory research.Mouse alveolar macrophage cells(AMJ2-C11) were treated with extracted PM2.5 samples from each location for 3, 24 or 48h.Total macrophage cell counts and IL-6 levels were measured for all treatment and controls to assess inflammation. Characterization of ambient PM2.5 confirmed differences in concentration as well as composition(metals and organic constituents) across an intra-urban environment.Inflammatory research indicated a positive association between total macrophage counts and time points in all treatments and controls. IL-6 differences are hypothesized to be both time and location dependent. Spatial differences in PM2.5 are apparent in concentration and composition in an intra-urban environment and these differences are reflected in inflammatory marker variation.Researching inflammatory makers aside from IL-6 will elucidate pathways activated following exposure to PM2.5.Developing large-scale in vitro and in vivo studies that address the impact spatially varying PM2.5 has on inflammation can help identify suites of causal components that are key to PM2.5 -associated health effects.

Keywords: B-particulate matter, A-sampling methods

Mo-P-35
Multi-pollutant Mobile Platform Measurements of Traffic-associated Air Pollutants Adjacent to the I-40 Corridor in Albuquerque, NM

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Abstract: Background: Living in close proximity to major roadways has consistently been identified as a risk factor for adverse health outcomes associated with exposure to fine particle air pollution. However, current approaches to measuring exposure to ambient air pollution that rely on a limited number of fixed-site monitors likely underestimate near-roadway exposures, particularly when they are sited based on regulations designed to characterize regional-scale concentrations. This can lead to differential misclassification of exposure in epidemiological studies. **Objective:** Use a multi-pollutant mobile monitoring platform developed by the

University of Washington Center for Clean Air Research to determine the composition and spatial extent of traffic-associated air pollution in two residential neighborhoods along the I-40 corridor of Albuquerque, NM. **Results:** Daily monitoring using the mobile platform took place on 7 afternoons in April 2012 and consisted of simultaneous measurements of 16 unique pollutants at a sampling frequency of 10 seconds. We found that NOx, black carbon, CO2 and particles smaller than 1 μm were significantly elevated at the edge of the roadway, whereas particles greater than 1 μm were not elevated. A significant depletion of ozone concentrations was also observed, consistent with titration of O3 with vehicle-derived NO. All pollutants returned to background levels within 300m of the edge of the roadway. **Conclusions:** Mobile monitoring can efficiently capture the spatial patterns for multiple pollutants arising from a single line source, and the inter-relationships among those pollutants. This capability will allow for the identification of multi-pollutant mixtures associated with traffic sources and their variability in complex urban settings. The improved understanding of near-roadway air pollution may facilitate more reliable assignment of near-roadway exposures for use in epidemiological studies.

Keywords: A-sampling methods, B-particulate matter, C-air, D-community, mobile monitoring

Mo-P-36
Microbial and Inorganic Contamination in Private wells along the Santa Cruz River, Arizona
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Abstract: Previous studies have shown that the Santa Cruz River downstream of a wastewater treatment plant that serves both the U.S and Mexico has levels of several microbial and chemical contaminants that are of public health concern. The goal of this study was to investigate the quality of drinking water from private wells within 1-mile of the Santa Cruz River, and to determine whether there were differences in microbial and chemical concentrations between dry and wet seasons. Samples (22 in each season) were collected during a dry season (June 20th-July 9th 2013) and a wet season (July 29th-August 7th) in 1 liter propylene bottles and analyzed for total coliforms, Escherichia coli, arsenic, cadmium, chromium, copper, lead, mercury, and nitrate. Arsenic was above the Environmental Protection Agency's Maximum Contaminant Level (MCL) in 6/22 wells, and 5/22 wells during the dry and wet season, respectively. In the dry season, nitrate was in exceedance of the MCL in 8/22 wells, and in 6/22 wells in the wet season. During the dry season, total coliforms were detected in 19/22 wells with a median concentration of 67 Colony Forming Units (CFU)/100ml, and no E. coli detected. However, in the wet season, total coliforms were detected in 18/22 wells with a median concentration of 211 CFU/100ml, and E.coli was detected in 9/22 wells with a range of 1 to 25 CFU/100ml for detectable samples. Cadmium (p-value=0.048) and chromium concentrations (p-value<0.0001) were significantly higher in the dry season. Drinking water from these wells may result in exposure to E.coli, nitrate and arsenic exceeding municipal drinking water standards. Interventions are needed to ensure well users get their water tested on a regular basis, and be made aware of the possible health effects resulting from exposure to these contaminants.

Keywords: B-microbial agents, C-water, B-metals, A-environmental justice, D-community

Mo-P-37
Evaluation of the Association Between Urinary 3-phenoxybenzoic Acid Levels and Self-perceived Depression Symptoms Among the Rural Elderly Population in Asan, South Korea
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Abstract: [Background] Recently, a large number of studies reported an increase in the incidence or prevalence of depression among the aged population in South Korea as well as other countries. Several studies have also reported that the occurrence of depression among the rural population is associated with exposure to environmental risk factors such as pesticides. This study aimed to evaluate the association of self-perceived depression symptoms with exposure to insecticides using 3-phenoxybenzoic acid (3-PBA) as a biomarker after controlling for socioeconomic confounding factors among persons aged 60 years and older in rural areas of South Korea. [Methods] Under a cross-sectional study design, the participants of this study (161 men and 239 women) were randomly recruited from rural areas of Asan. Exposure to environmental risk factors was assessed using a questionnaire and analysis of 3-PBA levels in urine. Logistic regression analysis was used to assess the association between pesticide exposure and self-perceived depression symptoms. [Results] The adjusted odds ratio for self-perceived symptoms of depression was higher in women with considerable farming experience (10 years or longer) than that in those with little (3 years or fewer) or no farming experience. Our

study showed that among female participants, the unit increase in 3-PBA levels was likely positively associated (OR: 1.13 95% CI: 1.01-1.26) with an increased risk of depression after adjusting for socioeconomic confounding factors including insurance type, daily physical condition, marital status, and age. [Conclusion] Further studies, including an intervention study, are needed to elucidate the association of exposure level to pesticide and degree of depression symptoms

Keywords: B-pesticides

Mo-P-38
Associations between Airborne Concentrations of Black Carbon and Fine Particulate Matter (PM2.5) in Urban Hotspots of South Korea

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Abstract: Black carbon (BC) is an important constituent of fine particulate matter (PM2.5) because of its known effects on human health. In this study, we present the BC and corresponding PM2.5 concentrations measured in urban hotspots of South Korea. PM2.5 and BC concentrations were measured using the SidePak AM510 Personal Aerosol Monitor (TSI Inc., St. Paul, MN) and MicroAeth Model AE51 (Magee Scientific, Berkeley, CA). We conducted our measurements between 8:00 a.m. and 10:00 a.m., and between 6:00 p.m. and 8:00 p.m. to capture the morning and afternoon distributions of the pollutants during the daily rush-hour period at hotspots, including bus terminals and roadside curbs, in Seoul and other satellite cities of Seoul in summer 2013. The median concentrations of PM2.5 and BC ranged from 6.3 to 15.6 µg/m3 and from 1.9 to 8.5 µg/m3, respectively. The BC concentration accounts for 20% to 70% of the PM2.5 concentrations. The overall correlation coefficient between the PM2.5 and BC concentrations was 0.63 (p < 0.001), ranging from 0.32 to 0.72 (p < 0.001) depending on the sampling site.

Keywords: B-particulate matter

Mo-P-39
Evaluation of Fine Particulate Matter (PM2.5) Concentrations Measured by a Portable Nephelometer in Comparison with the Federal Reference Method Using a Filter Measuring System in the National Urban Air-quality Monitoring Site of Seoul, South Korea

D. Yun, S. Kim; SoonChunHyang Univ., Asan, Republic of Korea

Abstract: [Background] Epidemiological studies have recently shown that exposure to fine particulate matter (PM2.5) is associated with adverse short- and long-term respiratory and cardiovascular health effects. For better understanding of individual exposure level to PM2.5, portable monitors have been used to measure PM2.5 concentrations. However, the lack of validation of the usefulness of portable monitors limits its applicability. This study investigated the association between PM2.5 concentrations estimated by a portable monitor and those measured by the federal reference method (FRM) in the national urban air-quality monitoring site of Seoul, South Korea. [Methods] We used the SidePak AM510 Personal Aerosol Monitor (TSI Inc., St. Paul, MN) as our portable monitor for measuring PM2.5 concentrations and compared the values obtained with the FRM equipped with a filter measurements system in the national urban air-quality monitoring site of Seoul. Measurements were conducted every other day in the winter and spring seasons of 2014. [Results] The PM2.5 daily mean concentrations estimated using SidePak ranged from 13.4 to 161.9 µg/m3. The Spearman correlation coefficient was 0.99, and the correction factor suggested was 0.55±0.09. Adjusted SidePak data with the correction factor showed good agreement with the reference values obtained using the FRM.

Keywords: B-particulate matter

Mo-P-40
High urinary 1-hydroxypyrene levels among rural populations in upper northern Thailand

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Abstract: Open biomass burning has been recognized as a major source of severe particulate air pollution in upper northern Thailand during dry season. Populations in rural areas mostly engage in agricultural field work. Getting rid of corn stove and rice straw is often open burning off in situ as common practice. Exposure to

airborne particulate matters (PM) and its PM-bound polycyclic aromatic hydrocarbons (PAHs) from such incomplete burning is a matter of health concern. We measured urinary 1-hydroxypyrene (1-OHP) levels, a biomarker of exposure to PAHs, among 2 rural populations: primary school children and their parents. All participants, in pairs, were living in rural areas of 5 upper northern provinces including Chiang Mai (CM, n=79), Chiang Rai (CR, n=63), Lamphun (LPh, n=55), Lampang (LP, n=59) and Mae Hong Son (MHS, n=54). Their reference groups were those living in urban areas of the same provinces. The study protocol was approved by the Human Experimentation Committee, Research Institute for Health Sciences (RIHES), Chiang Mai University. Morning void urine samples (50 mL) were collected and 10 mL urine aliquots were analyzed for 1-OHP using a method described by Prapamontol et al. using high performance liquid chromatography with florescence detection (HP1100)). Quality assurance of 1-OHP analysis was successfully confirmed by G-EQUAS (Lab #254) results. Levels of urinary 1-OHP were skewed and then geometric means (GM) were used. The results were adjusted with urinary creatinine (Cr) and reported as nanomole/mole Cr. GM levels of urinary 1-OHP from rural vs urban children and their parents from 5 provinces ranged from 59.7-363.8 vs 369.4-821.7 and 120.7-369.4 vs 597.5-1,092 nanomole/mole Cr, respectively. Rural children and their parents had urinary 1-OHP levels higher than those from urban areas about 3.8 and 4.1 fold, respectively. Open biomass burning occurred in the rural areas might be attributable to high urinary 1-OHP levels.

Keywords: 1-hydroxypyrene, rural populations, northern Thailand

TUESDAY, OCTOBER 14, 2014

Tu-S-A1: Exposure in Commercial Aircraft Cabins - II

Tu-S-A1-01
Characterization of Bleed Air Thermal Degradation Products'
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Abstract: The aircraft cabin is an enclosed environment with a high density of people relative to its volume. To provide sufficient fresh air a sophisticated air handling system has been developed which mixes ~50% outside air from the engine's compressor stage ('bleed air') with ~50% filtered, re-circulated air. The bleed air which is at high temperature (200-250°C) can be contaminated with synthetic lubricating oil from leaking bearing seals. The oil can thermally decompose exposing passengers and crew to a mixture of compounds. A compressor/heater apparatus was used to simulate bleed air with a range of temperatures and pressures. Finely atomized oil was introduced into the simulate bleed air stream prior to compression using a Laskin nozzle. Air samples collected using activated charcoal and DNPH-cartridges were analyzed for volatile organic compound by GC/MS and for aldehydes by HPLC/UV, respectively. Thermal degradation of the oil and formation of a series of oxygenated compounds were observed above 185°C, with some increases in production as the temperature was increased to 310°C. Higher pressure bleed air, resulted in higher contaminant concentrations. Initial identification based on mass spectral library matches indicate that the most prevalent compounds observed were series of aldehydes from formaldehyde to hexanal, ketones, the unsaturated aldehyde crotonaldehyde, substituted tetrahydrofurans, organic acids, lactones and alkenes. Confirmation and estimated emissions rates are being evaluated by comparison to commercially available standards. In addition, decomposed oil and tricresyl phosphate were present. These compounds include irritants that can be associated with a series of non-specific symptoms.

Keywords: A-indoor environment, A-sampling methods, B-VOCs, D-occupational, aircraft

Tu-S-A1-02
Exposure to Flame Retardant Chemicals on Airplanes: Source Characterization, Air/Dust Measurements, and Biomonitoring of Flight Attendants
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Abstract: To protect the flying public and flight crew from fire hazards, the Federal Aviation Administration (FAA) requires that materials within aircraft have flame retardant properties. Flame retardant chemicals are used in materials on airplanes to slow the propagation of fire and can migrate from their source products, creating the potential for exposure. PBDEs, one class of flame retardants, have demonstrated neuro- and developmental toxicity and the potential for endocrine disruption. Several newer and commercially important flame retardant chemicals are now being incorporated into products to replace PBDEs; toxicological evidence suggests that these compounds have important human health implications. This presentation will describe the results of research on exposure to flame retardants conducted as part of the Federal Aviation Administration funded Center of Excellence - Air Cabin Environment Research (ACER). The study was conducted in several phases and included: baseline health survey of flight crew; air samples in aircraft cabins; characterization of FRs in airplane dust; measurements of FRs on the hands of flight attendants; and measurements of FRs in serum of flight attendants after a cross-country flight. In our initial baseline health survey of a national sample of flight attendants in 2007, the reported prevalence of thyroid disease was higher than rates reported in the literature reported for females of comparable age. In addition, for many of the FRs studied, the air and dust concentrations were higher than found in U.S. households, and similar to occupationally exposed workers in industrial settings. Because this symposium is a review of ACER research conducted over the past 10 years, some of the results have been published previously (Environmental Health; Journal of Exposure Science and Environmental Epidemiology). However, we will also present new results on serum concentrations of FRs and thyroid hormones in flight attendants.

Keywords: B-flame retardants, B-SVOCs, C-air, C-surfaces, D-occupational

Tu-S-A1-03

Characterization of the Frequency and Nature of Bleed Air Contamination Events in Commercial Aircrafts

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Abstract: Each year millions of people travel by commercial aircrafts. The Bureau of Transportation Statistics indicates that, from 2002 to 2013, approximately 620 to 850 million passengers flew in commercial airplanes each year in the United States. Eighty percent of passengers were domestic travelers who traveled inside the US, and twenty percent were international passengers who flew to or from the US via international flights. With these passengers occupying enclosed aircrafts compartments for 1 to 20 hours, any contamination of the air supply systems has the potential to cause serious health hazards. Contamination of the bleed air used to pressurize and ventilate aircraft cabins is of concern due to the potential health and safety hazards for passengers. Databases from the Federal Aviation Administration and other sources were examined in detail to determine the frequency and nature of air contamination events. The frequency of incidents is categorized by model, engine, and other parameters of aircrafts. The purpose is to identify aircrafts make and models with elevated probabilities for contamination events. The focus of the study is on aircraft models that are currently manufactured and used by major airlines. Incidents examined in this study include those related to smoke, oil odors, fumes, and any kind of discomfort that might be related to fluid odor, reported by the cabin crew members, between 2007 and 2012. In addition to the reported frequency of incidents for different aircraft models and derivative models, the analysis attempts to identify engines and auxiliary power units (APU) of aircrafts that had incidents to check for the probability of a specific APU or engine for being the source of contamination. While substantial variations are found in frequencies, it is also found that the contamination events are widely distributed across nearly all common models of aircraft.

Keywords: A-indoor environment, C-air, Bleed Air Contamination, aircraft cabin exposures, health hazards in airplanes

Tu-S-C1: Recent Findings in Assessment of Dermal Exposure and Absorption - I

Tu-S-C1-01

Multicomponent Skin Diffusion Model for Assessing Formulation Effects on Dermal Absorption

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Abstract: This talk will provide an update on the development of a multicomponent, finite dose skin diffusion model, which is an extension of the single component model available on the NIOSH/CDC website at http://www.cdc.gov/niosh/topics/skin/finiteSkinPermCalc.html. The multicomponent model allows one to explicitly consider the effects of formulation excipients on absorption of a chemical agent of interest, both in the formulation as it dries down on the skin and also within the skin. The technology may be applied to solvent mixtures, to aerosolized pesticide formulations that contact the skin, and to cosmetic and personal care products. Examples will be shown of a topical anti-inflammatory agent delivered to skin from propylene glycol solutions and a to-be-selected occupational exposure scenario.

Keywords: A-risk assessment, D-occupational, A-exposure models, diffusion model, dermal absorption, diffusion model, dermal absorption

Tu-S-C1-02

In Vitro Dermal Absorption of Nicotine from Electronic Cigarette Mixtures

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Abstract: Nicotine plus flavorings in a propylene glycol (PG) vehicle are the components of electronic cigarette mixtures (e-cigarette "juices"), which are vaporized and inhaled by the user. Dermal exposure to nicotine occurs in the mixing and filling of e-cigarettes in the manufacturing process. The nicotine solutions are mixed in the factory and dispensed into individual electronic cigarette cartridges. Workers may be supplied with inappropriate or inadequate PPE: contamination of the fingertips has been reported. In order to investigate the potential for nicotine uptake from skin exposures, *in vitro* human epidermal permeation of nicotine was undertaken from surrogate and commercial e-cigarette juices and from neat nicotine donor formulations. Steady-state fluxes (J_{ss}, $\mu g/cm^2/h$) and lag times (τ, h) were measured from 3 skin samples taken from each of 3 human donors (n = 9)

for each formulation. Nicotine in PG at 24 mg/mL produced an average J_{ss} of 4.0 and an average τ of 10.1. Some flavoring components substantially enhanced nicotine permeation. A commercial e-juice containing menthol and 25 mg/mL nicotine produced an average J_{ss} of 10.2 with an average τ of 8.3. A commercial e-juice containing limonene and 25 mg/mL nicotine produced an average J_{ss} of 23.7 with an average τ of 5.0. Neat nicotine J_{ss} was 175 and τ was 1.9.These data were applied to a dermal risk assessment paradigm, assuming an 8 h exposure to volar surfaces of all fingers followed by washing, to estimate total systemic nicotine uptake (mg) over a work shift. The estimates are: for nicotine in PG, 8.2; for menthol e-juice, 18.3; for limonene e-juice, 31.1; for neat nicotine, 151. These data demonstrate the potential for substantial nicotine absorption through the skin from contact with e-cigarette refill solutions and the neat nicotine used to mix those solutions. The data reinforce the need for adequate personal protective equipment for workers when mixing and dispensing nicotine solutions.

Keywords: A-risk assessment, D-occupational, C-consumer products, Nicotine, e Cigarettes, Nicotine, e Cigarettes

Tu-S-C1-03
Efficacy of Skin Decontamination by Washing
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Abstract: Washing with soap and water is generally presumed effective in removing chemical contaminants from skin and is an essential component of both occupational and personal hygiene. However, only limited experimental investigations directly addressing chemical decontamination by soap and water washing have been conducted (although a considerably larger number of absorption experiments involving washing at termination provide some information). In addition, no theoretically robust model of washing has been presented and warnings have even been raised that washing might actually increase dose via "wash-in." Further investigation of washing phenomena is therefore warranted. Activities intended to contribute to this process have been conducted. They involve 1) development of a skin-washing model and 2) biomonitoring experiments. A computer model that describes simultaneous transport of an agent of concern and water has been developed. The model describes one-dimensional transport in a two-layer membrane (stratum corneum and viable epidermis) by finite difference approximation. Water transport includes hydration and swelling of the stratum corneum, and concentration dependent diffusion. Parallel experiments have been conducted with human volunteers using DEET as a surrogate compound. Initial chemical loading on the skin, washing method, and delay until washing were the experimental variables. Twenty-four hour urine samples were collected for up to five days to facilitate biomonitoring of excreted DEET metabolites.

Keywords: absorption, chemical, dermal, hygiene, wash-in, absorption, chemical, dermal, hygiene, wash-in, absorption, chemical, dermal, hygiene, wash-in, absorption, chemical, dermal, hygiene, wash-in, absorption, chemical, dermal, hygiene, wash-in

Tu-O-D1: Occupational Exposure - I

Tu-O-D1-01
Minerals as Occupational and Environmental Hazards
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Abstract: The interface of occupational and environmental health is nowhere more apparent than when dealing with naturally occurring minerals of concern including silica and fibers of asbestos and other minerals, such as the zeolite mineral, erionite. Inhalation of airborne mineral particles can lead to diseases such as silicosis, asbestosis, lung cancer and mesothelioma and it is necessary to safeguard the health of employees who might be exposed. While mining and quarrying are obvious occupations where such risks may be encountered, other employees working in the outdoor environment, such as in wildland fire mitigation activities, may also encounter hazards from this source. This will be illustrated through investigations into risks to Forest Service workers from exposure to asbestos and erionite. A component of worker protection is accurate characterization of exposures. The Exposure Assessment Branch of NIOSH is carrying out research projects to improve exposure characterization methodologies, including sampling and analytical procedures. In some cases, it has been useful to rely on complementary work that has been going on in the environmental health field. This presentation will provide an update of research projects involving silica, chrysotile and amphibole asbestos and erionite. The

information will be of use to those involved in worker health and safety and to those concerned for the welfare of the public.

Keywords: D-occupational, B-particulate matter

Tu-O-D1-02
Preliminary Results of Occupational Exposure of Hairdressers to Cosmetic Products

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Abstract: In recent years more attention has been given to chemical exposure in hairdressers. This increasing interest is largely due to the various sources of exposure. This chemical exposure includes exposure to hair dyes, shampoos, hair conditioners and hair sprays. Particularly in France, little information to assess professional exposure of hairdressers is available. In 2013, the INRS (Institut National de Recherche et de Sécurité) published a report where exposure of hairdressers had to be largely estimated due to the lack of data. In order to gather information to assess exposure in hairdressers, eleven hairdressing salons were visited. All salons were located at Brest city (France). Preferentially small hairdressing salons were visited. Information about the frequency of the main activities in hairdressing salons, duration of activities and professional practices during these activities were collected. Other information such as composition and amount of the main products used as well as the symptoms developed by hairdressers was obtained. Surveyed subjects were composed by men and women. Observations revealed that from all salons, 36% had mechanical ventilation and 9% had natural ventilation. Moreover, 39% of subjects declared having skin problems linked to the use of cosmetic products and 11% reported having respiratory symptoms. In contrast with reported symptoms, nearly 93% didn't use gloves when applying shampoo and 96% when preparing hair dyes. Considering the incidence of symptoms, a worst case scenario was considered in order to evaluate the chemical exposure in an average hairdresser worker. Calculations revealed that dermal professional exposure to hair dyes corresponds to 30 mg/kg/day and dermal exposure to professional shampoo corresponds to 11 mg/kg/day. Until now, few studies have assessed exposure in hairdressers from a model using measured parameters. Exposure values suggest that more attention should be given to chemical exposure in hairdressers.

Keywords: D-occupational, A-exposure models, A-risk assessment

Tu-O-D1-03
Translating Evidence Based Exposure Assessment into Occupational Health Promotion in Resource Limited Settings

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Abstract: Chemical exposure assessment in occupational environment and related health disorders in poor urban settings is extremely neglected in Pakistan. A human biomonitoring study of 120 petrol pump workers using serum naphthalene, pyrene and urinary 1-hydroxyprene was conducted to quantify occupational exposure. The health risks based on self-reported health status was also noted using a questionnaire. We categorized health disorders into physical (e.g. skin lesions, eye redness, dryness of tongue/lips, appetite loss, acidity after meals at workplace) and neurasthenic symptoms (e.g. energy loss, fatigue, fainting, twitching, sleeplessness, irritability, body aches). Results of HPLC based serum analysis showed that mean concentration of blood naphthalene was 106 µg L-1 which had significant correlation with cigarette smoking by (r=0.49; p<0.01). However, pyrene body burden (mean 19.18 µg L-1) appeared to be a significant predictor of urinary 1-hydroxyprene pyrene (69.9 µmol mol-1 creatinine). There was fairly high significant effect of daily work-hours and job duration on serum pyrene levels. Workers exposed to 6 hour per day or more had significantly high prevalence of physical disorders (OR=2.79, 95% CI=1.28-6.09). Neurasthenic symptoms were found in 65% of the subjects and were associated with years of involvement in job. Ten years or more occupational work at petrol pumps attributed substantial development of neurasthenic effects (OR=2.80, 95% CI=1.23-6.34). We conclude that subjects associating disturbances in physical and neurological behavior with petrol related occupation rated their overall health and functional capacity significantly poorer than that of urban area general population. To promote health of petrol pump workers, reduction in work hours and provision of masks and gloves could be introduced as occupational health interventions.

Keywords: A-biomonitoring, A-exposure factors, D-occupational

Tu-O-E1: Advances in Pesticide Exposure Assessment - II

Tu-O-E1-01

Granular Activated Carbon Filtration Influence on Metal and Persistent Organic Pesticide Levels in Girls the Greater Cincinnati OH Area

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Abstract: Background: Granular activated carbon (GAC) is a treatment technology that is effective at removing many organic compounds from drinking water. The Greater Cincinnati area is a natural laboratory for testing the efficacy of GAC, since until 2012 two water providers used the same source water, but one did not use GAC. We have previously reported on the efficacy of GAC in removing perfluoroalkyl compounds. Methods: Metals and persistent organic pesticides were measured in the urine and blood, respectively of 357 and 312 girls from the Cincinnati site of the Breast Cancer and the Environment Research Program Puberty Study. Differences in mean metal and pesticide levels and water source, breastfeeding duration, bottled water use, parity and provider education were assessed using ANCOVA analysis for strontium, manganese, tin, molybdenum, hexachlorobenzene, oxychlordane, PP-DDT and trans-nonachlor. Results: No significant differences were found between water providers for any metals or PP-DDT. Hexachlorobenzene levels were significantly lower with increasing time with a water provider who used GAC. Levels of oxychlordane were lower in girls who did not get their water from the Ohio River at sample; there was no difference between utilities that used GAC and those who did not. Levels of trans-nonachlor were significantly higher in girls where the water source was Ohio River and the water provider did not use GAC, compared to those where the water provider did. There were significant associations with duration of breast feeding for all four pesticides. Conclusions: There may be differences in persistent organic pesticide exposure in the Greater Cincinnati area, depending on drinking water source and treatment train technology. Funding from NIH, U01-ES12771, P30-ES006096, T32-ES10957

Keywords: A-biomarkers, C-water, D-children, A-exposure factors

Tu-O-E1-02

Measurement of Non-Persistent and Persistent Pesticides in Human Milk at Two Time Points And Relationships With Maternal and Child Biomarkers Measured in Blood and Urine

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Abstract: The presence of persistent pesticides in human milk, their relationships with biomarkers of exposure measured in other biological matrices, and the changes over time have been widely reported. Yet, no studies have determined these relationships for non-persistent pesticides. Understanding these relationships may help determine potential lactational exposures to children. We used gas chromatography-tandem mass spectrometry to measure 25 pesticides including organophosphates, pyrethroids, organochlorines, carbamates and a triazine in human milk samples from women residing in an agricultural region of CA who were participants of the Center for the Health Assessment of Mothers and Children of Salinas (CHAMACOS). Milk samples (n=52) were collected near delivery (DL) and repeat samples were collected six months postpartum (6M) in 27 women. Chlorpyrifos, DDE, DDT, and hexachlorobenzene were measured in maternal and cord blood collected from mothers at DL; OP metabolites were measured in urine collected from mothers at DL and children at 6M. Two non-persistent pesticides, chlorpyrifos and atrazine, and six persistent pesticides, o,p'-DDE, p,p'-DDE, o,p'-DDT, p,p'-dicofol, heptachlor epoxide, and hexachlorobenzene, had detection frequencies >50% in milk at both time points. Preliminary analyses showed that except for chlorpyrifos and o,p'-DDT these compounds were statistically significantly correlated at both time points; concentrations were generally lower at 6M than DL. Chlorpyrifos in milk was not correlated with markers in maternal or child blood or urine. In contrast, p,p'-DDE was highly correlated (r>0.98) between milk, and maternal and cord blood. Pesticides were detected in human milk, indicating the potential for direct exposures to neonates and young children. Although concentrations of persistent pesticides may be predictable over time and in various biological matrices, there were no consistent patterns seen with the non-persistent pesticide chlorpyrifos.

Keywords: B-pesticides, D-children, C-food, A-biomonitoring

Tu-O-E1-03

Toddlers' Inhalation Exposure to Pyrethroids in Homes

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Abstract: The increasing application of pyrethroid insecticides in residential settings has elevated public concerns about exposures to these chemicals and possible adverse health effects. Household dust is a recognized reservoir for pyrethroids and indoors can increase the risk of exposure. Dust resuspension resulting from human's activities can increase human's inhalation exposure to pyrethroids. Young children (one to three years old) are at an early stage of mastering walking skills. The result is that a toddler's breathing zone is closer to the floor, and their floor activities contribute to the resuspension of dust. Their physical development stage also makes them vulnerable to exposure to toxicants, such as pyrethroids. Little is known about toddlers' personal inhalation exposure levels to pyrethroids applied indoors since it is difficult to directly measure their exposure with personal samplers. We simulated a toddler's exposure to pyrethroids from dust in a carpeted room using PIPER (the Pre-toddler Inhalable Particulate Environmental Robotic). PIPER serves as a platform to collect air samples at the breathing zone height while mimicking the movement of toddlers. Pyrethroid concentrations in carpet dust collected using a vacuum dust sampler in the center and corner of the room were 0.097mg/g and 0.840mg/g, respectively. The concentration of pyrethroids in resuspended dust collected, using PIPER was in a range of 1.0-2.3mg/g. Thus, the use of vacuum samples may lead to an underestimate of toddlers' personal inhalation exposure to pyrethroids in residential houses.

Keywords: Pyrethroids, Children, PIPER, Inhalation Exposure, Dust Resuspension

Tu-O-F1: Indoor Environments - I

Tu-O-F1-01

Evaluation of Indoor Pollutant Emissions from Portable Air Cleaners

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Abstract: A wide variety of portable standalone air purifiers are marketed in the US for residential and commercial use. Various studies have shown that some of these devices, such as electrostatic precipitators, ionizers and ozone generators, can have a negative impact on air quality and public health through emissions of ozone and associated indoor pollutants. Other air cleaners rely on technologies such as photocatalytic oxidation (PCO), plasma generation and microbial thermal inactivation, for which the impact on indoor air quality has not been fully studied. Some of the latter can potentially generate undesired harmful byproducts, such as fine and ultrafine particles and/or reactive oxygen species (ROS). We have investigated the primary emissions and secondary reaction byproducts from the operation of six portable air cleaners with a significant market presence in California. Tests were carried out using a 20-m3 room-sized environmental chamber under realistic conditions. Volatile organic compounds (VOCs), ultrafine particulate matter, ozone and ROS were quantified with the air cleaners operating in clean chamber air and in the presence of a challenge VOC mixture. We have also evaluated the removal efficiency for VOCs and particulate matter. While some devices achieved significant removal efficiencies of some indoor pollutants, others were shown to emit high levels of ozone (up to 3 mg/h) and VOCs as primary emissions (e.g., 85 µg/h toluene) or secondary byproducts (e.g., 16 µg/h formaldehyde and 111 µg/h benzaldehyde). A device emitting high ozone levels also produced a significant amount of ultrafine particulate matter, reaching chamber concentrations of 3×10^3 #/cm3, corresponding to an estimated secondary organic aerosol yield of 1-5 %. Chamber-derived emission rates are used to predict typical indoor levels, and to evaluate occupant exposures by comparing predicted concentrations with California reference exposure levels and Proposition 65 risk levels.

Keywords: C-consumer products, A-built environment, B-VOCs, A-indoor environment, C-air

Tu-O-F1-02

Ultrafine Particle Emissions from "Non-stick" Coated Cookware

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Abstract: Cookware coated with polytetrafluorethylene (PTFE) (brand name "Teflon") is widely used because food is easily cleaned from its surface. However, when heated, the coating degrades and can release several fluorinated compounds, including perfluorooctanoic acid (PFOA). PFOA is globally dispersed and occurs in the blood of many persons. It has been associated with kidney and testicular cancer in human populations living

near a plant manufacturing PFOA. Previous studies have noted birds dying on exposure to fumes from pans heated to 202 ^{o}C. Few studies have reported on ultrafine particles released from coated pans. We report here on emission rates of ultrafine particles from coated pans heated to temperatures in the range of 120-180 ^{o}C. Two coated pans (one used, one new) were heated for 4-6 minutes on the heating coil of an electric burner that had been reheated multiple times until it no longer emitted ultrafine particles (UFP) > 10 nm. A TSI Model 3007 was used to count particles >10 nm. The temperature of the burner coil was measured throughout the heating period using a probe directly contacting the coil. Alternatively, the temperature of the pan was measured using the same probe. The pan was reheated without cleaning it in successive experiments of the same duration (usually 6 minutes) until the peak number of particles emitted reached an asymptote. It was observed that higher levels were produced following washing the pan as recommended in warm soapy water, perhaps due to a film left by the detergent. Both pans tested emitted UFP > 10 nm at a rate of 0.88-1.1 X 10^{12} particles min^{-1}. This was sufficient to achieve concentrations of 250,000 cm^{-3} in a small room of 25 m^{3} volume. Additional experiments in two homes with heated cookware were performed to confirm these findings.

Keywords: B-nanoparticles, C-consumer products, C-air, A-indoor environment, A-exposure factors

Tu-O-F1-03
Case Study: PM10/PM2.5 at a Local Private Gym with Mechanical Ventilation in a Retrofitted Industrial Building
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Abstract: INTRODUCTION: Despite the positive health outcomes associated with physical activity/fitness, poor indoor air and environmental quality (IEQ) can adversely impact human health, performance and comfort. Exercising in areas with high particulate concentrations may increase adverse health effects as the particle deposition fraction increases from rest to intense exercise. The aim of this study was to assess the IEQ of a retrofitted private gym in Central New Jersey during hours of operation in the cooling season, July-September 2013. METHODS: Air samples were taken for four hours once per week for seven weeks during the study period. Among the quantitative measurements, PM of the coarse or respirable (PM10) and fine (PM2.5) size fractions, in micrograms per cubic meter (or μg m-3), were recorded both indoors and outdoors (only one hour, between about 17:00-18:30). Direct reading laser-based instruments with internal data loggers were used: two Sidepak AM510 Personal Aerosol Monitors (TSI Corp, Minneapolis, MN), with changeable impactors for PM10 and PM2.5. Prior to each sampling period, impactors were lubricated and instruments calibrated to a zero PM concentration. Flow calibration was conducted weekly with a BIOS Dry Cal Defender 510. RESULTS: PM10 concentrations were typically higher indoors than outdoors. Consistently week-to-week higher concentrations of PM2.5 were detected when the samplers were outdoors versus indoors. This is in part because the gym was located near the intersection of a primary road and a secondary road leading into a commercial/industrial area (then a state freeway). CONCLUSIONS: Human activity is a source of generating PM10. Wear and tear of fitness machines may contribute to indoor accumulation of PM10-2.5 size fraction. PM10 may be too large to penetrate through the building envelope and can be captured by filters within the heating, ventilating and air conditioning system; PM10 particles found indoors likely came from indoor sources.

Keywords: A-indoor environment, B-particulate matter, C-air, D-community, A-activity patterns

Tu-O-G1: Traffic-Related Exposures - I

Tu-O-G1-01
A Community-participated Air Monitoring and Education Projects in Heavy Diesel Truck Trafficked Urban Areas, NJ
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Abstract: Citizen science is a form of research that involves community members in the entire research process. Community engagement in a science project allows scientists to accomplish research objectives more effectively and feasibly. Community groups in NJ, particularly those in close proximity to truck routes, have serious concerns about potential health effects associated with diesel emissions. To promote citizen science and to better address community concerns about diesel emissions, two citizen science projects were jointly conducted by the researchers from Rutgers University, community scientists and members from Elizabeth and Newark, NJ, and scientists from NJDEP. Two types of projects were developed. One project was implemented through after-school program. A total of 15 high school students in Elizabeth participated in the project, with a

total of nine 5-hour study sessions over half a year. Another project was implemented via in-class program. A total of 28 9th grade students from Newark participated in the project, with a total of forty-six 80-min sessions over 5 months. The students participated in the development of research questions and designs to characterize the impact of traffic on air pollution. They conducted air sampling for black carbon, PM2.5, and ultra-fine particles using real-time monitors in a "hot spot" of traffic-related air pollution and a relatively clean area on both weekday and weekend days, performed statistical analysis and examined the impact of location, day of the week, truck traffic, and meteorological conditions on the air pollution levels. Each lesson plan was successfully developed and implemented through the two citizen science projects. It provided guidance and tools for teachers and community members to adequately educate students about the nature and problems associated with diesel emissions and air pollution as well as to develop an air sampling plan for traffic-related air pollution within the context of community concerns.

Keywords: D-community, C-air, A-environmental justice

Tu-O-G1-02
Comparison of Traffic-related Ultrafine Particle Number Concentrations on Roads and at Nearby Residential Locations in Boston, Massachusetts (USA)
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Abstract: Background: Exposure to traffic-related ultrafine particles (UFP; <100 nm diameter) may be associated with cardiovascular disease. Epidemiologic studies often use mobile monitors and stationary fixed sites to characterize UFP. Relatively little work has been done to compare UFP concentrations on roadways to nearby residential sites and to determine how the difference could impact individual exposure estimates. Aims: The aim of this work was to monitor particle number concentration (PNC; a proxy for UFP) on roads and at nearby residential locations in an effort to generate individual estimates of exposure for the Puerto Rican Health Study in Boston. Methods: A study area covering ~45 km2 was selected based on residences of the cohort. Between May 2012 and November 2013 PNC was measured by mobile monitoring along the same route on 59 days (2-4 hours per day), and during this same period PNC was measured immediately outside of 14 participant homes continuously for six weeks per residence. Results: Median on-road PNC was up to 2-fold higher than PNC measured immediately outside participant homes <100 m from roads. Ambient PNC in residential areas within 100 m of major roads (>20,000 vehicles/day) were higher than residential areas >100 m from major roads (25,000 particles/cm3 versus 20,000 particles/cm3). A slight exponential decrease in mean annual PNC occurred with increasing distance from major roads. PNC within 50 m of major roads were ~45% higher than areas 400-800 m from major roads. Median annual PNC varied significantly between seasons with the highest median concentration in winter (37,000 particles/cm3) and the lowest in summer (18,000 particles/cm3). Conclusions: Residential areas closest to major roadways have the highest ambient PNC levels as compared to those further away, but are still at levels up to 2-fold lower than those measured on the road. These results could have implications for reducing exposure misclassification in epidemiological studies.

Keywords: B-particulate matter, C-air, A-epidemiology, A-exposure models

Tu-O-G1-03
Exposure Assessment to Traffic-related Air Pollution by Land Use Regression in Kyiv, Ukraine
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Abstract: Background. Numerous studies proved that exposure to traffic-related air pollution has adverse effects on health. Although land use regression (LUR) models are increasingly used to provide exposure estimates of spatial variation of outdoor air pollution, this work presents first attempt in Ukrainian setting to describe variation in traffic pollution through the LUR method. Aim. The goal of this study was improvement of exposure assessment approaches through LUR model development. Methods. Air pollution concentrations were estimated based on field campaign conducted at 30 street and residential sites in Darnytskyi district of Kyiv city to measure NO2, CO, PM10, PM2.5, and PM1 concentrations. Additionally, meteorological parameters, fleet intensity and structure were registered. 40 indicators of traffic, land use, population density, physical geography and meteorology were derived by ArcGis 10.1 and employed as independent variables in subsequent regression models' development. Results. Some traffic (number of vehicles, road distance, road length), land use (dwelling counts, area of residential neighborhood and parks, vegetation index (NDVI)) and meteorological

variables (wind speed and relative humidity) were the most important predictors of traffic-related air pollution variability. R2 values for final LUR models were 0.90 for NO2, 0.77 for CO concentrations and 0.59, 0.79 and 0.81 for PM10, PM2.5, PM1 concentrations respectively. The validation of prediction models demonstrated good agreement between observed concentrations and predicted levels (average of 3-10% difference). Conclusion. Developed models explained approximately 75% of the pollutants' spatial variability in near-roadway residential neighborhoods. The results suggest that a good predictive surface can be derived using LUR method, which will be used on the next stage of research to estimate exposure to different air pollutants and corresponding human health risks in the near-roadway residential areas.

Keywords: C-air, A-exposure factors, A-exposure models, traffic-related air pollution

Tu-S-A2: Pesticide Exposure and Risk Assessment - I

Tu-S-A2-01
Updates from U.S. EPA's Office of Pesticide Programs - Keeping Stakeholders Informed
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Abstract: The U.S. EPA's Office of Pesticide Program (OPP) conducts human and environmental health risk assessments as part of the registration and registration review process for all pesticides in U.S. commerce. Over the last several years, OPP has been active in updating a number of its human health risk assessment databases, software programs, policies and assessment practices as well as developing and implementing new approaches to improve and advance exposure and risk assessments of pesticides. Brief discussion will be provided of various updates regarding pesticide human health risk assessment including: incorporation of more recent food consumption data in the Dietary Exposure Evaluation Model (DEEM) and the Joint Institute for Food Safety and Applied Nutrition (JIFSAN) commodity consumption calculator; application of U.S. EPA's Reference Concentration (RfC) Methodology in pesticide inhalation risk assessments; assessment of agricultural spray drift; the Worker Protection Standard; and incorporation of epidemiology and pesticide incident information in risk assessments. Providing periodic updates to public and industry stakeholders allows for equitable and efficient application of policies and regulations.

Keywords: A-environmental regulation, B-pesticides, A-exposure models, A-risk assessment, C-food

Tu-S-A2-02
Intakes of Pesticides from Community Duplicate Diet Samples
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Abstract: Calculation of intake of selected pesticides was accomplished using food samples collected from individual representatives of a defined demographic community using a community duplicate diet approach. Nine participants were identified in Apopka, FL from which intake assessments of organophosphate (OP) and pyrethroid pesticides were made. From these nine participants, sixty-seven individual samples were collected and subsequently analyzed by gas chromatography/mass spectrometry. Measured concentrations were used to estimate intakes for individuals and for the community. Individual intakes of total OP and pyrethroid pesticides ranged from 6.7 - 996 ng and 1.2 - 16,000 ng, respectively. The community intake was 256 ng for OPs and 3430 ng for pyrethroid pesticides. The most commonly detected pesticide was permethrin, but the highest overall intake was of bifenthrin followed by esfenvalerate. These data indicate that the community in Apopka, FL, as represented by the nine individuals, was potentially exposed to both OP and pyrethroid pesticides at levels consistent with a dietary model and other field studies in which standard duplicate diet samples were collected. Higher levels of pyrethroid pesticides were measured than OPs, which is consistent with its decreased usage. The diversity of pyrethroid pesticides detected in food samples was greater than expected. Continually changing pesticide usage patterns need to be considered when determining analytes of interest for large scale epidemiology studies. The Community Duplicate Diet Methodology is a tool for researchers to meet emerging exposure measurement needs that will lead to more accurate assessments of intake which may enhance decisions for regulation. Successfully determining the intake of pesticides through the diet will allow for accurate assessments of pesticide exposures to a community of individuals, thereby significantly enhancing the research benefit realized from epidemiological exposure studies.

Keywords: A-exposure factors, B-pesticides

Tu-S-A2-03

Cumulative Risk Assessment: US and EU Methodological Approaches

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Abstract: Cumulative risk assessments in support of science-based regulatory decision making have been conducted in the U.S. over the past two decades. In Europe, during recent years a number of guidance documents and frameworks for the risk assessment of chemical mixtures have been developed. This presentation will briefly summarize the important milestones marking the evolution of cumulative risk assessments both in the US and Europe. The concepts and frameworks that underpin the cumulative risk assessments will be presented. There will be a comparison of methodology currently used in the US with that being developed in Europe. Possible future methodological approaches for evaluating cumulative health effects will also be discussed.

Keywords: A-cumulative exposure

Tu-S-A2-04

Cumulative Aggregate Risk Evaluation System (CARES)-The Next Generation

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Abstract: CARES® refers to the Cumulative and Aggregate Risk Evaluation System, of which several versions were developed from 2001-2011. The last version, CARES V.3.0, represented a then state-of-the-art software program designed to conduct complex human exposure and risk assessments, such as the aggregate and cumulative exposure and risk analyses required for pesticides under the Food Quality Protection Act. CARES represents a population- and calendar-based probabilistic model that attempts to simulate a "realistic" estimation of overall exposure to the U.S. populations of interest by integrating information from multiple databases. The US EPA expressed the need to revise CARES for their use, and use by other stakeholders, particularly for advanced probabilistic modeling, e.g., the upcoming pyrethroid cumulative risk analysis. In addition, the PC-based system was becoming cumbersome and expensive to maintain as new operating versions emerged and other new databases needed to be incorporated into the system. In response to the major updates required for advancing the state of the science and data supporting CARES, and to maintain the relevance of the program, a new project and task force was assembled in late 2013 to develop the new system, CARES-Next Generation (NG). The next version of the software will be a cloud-based application, containing updated exposure models, databases and functionality. In particular, updated food consumption information from the NHANES "What We Eat in America" database (2003-2008) and the EPA's updated Standard Operating Procedures for residential exposure assessment will be incorporated. This talk describes the key elements of this cloud based CARES-NG and progress toward CARES-NG availability. Strengths and weaknesses compared to CARES V.3.0 and other pesticide regulatory exposure models will be presented.

Keywords: B-pesticides, A-aggregate exposure, A-cumulative exposure, C-food, D-occupational

Tu-S-A2-05

EU Update on Dietary Risk Assessment: An Industry Perspective

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Abstract: In 2005, the EU MRL regulation 396/2005 was published, and it includes the legal obligation to consider aggregate and synergistic effects during MRL setting for pesticides. The requirement is also part of the EU Regulation 1107/2009. In the past years, the European Food Safety Authority (EFSA), DG SANCO and institutions have initiated multiple projects in order to fulfill this requirement. The projects include the hazard and the exposure side. In 2013, EFSA has published the procedures for defining cumulative assessments groups; CAGs will be based on organ or system toxicity. High efforts are put in the collection of appropriate consumption/monitoring data, but also the development of an appropriate IT tool for performing probabilistic dietary risk assessments. In the presentation, the current status, but also an outlook on future needs from industry perspective will be provided.

Keywords: A-risk assessment, B-pesticides, C-food

Tu-S-B2: Emerging Technologies and their Application in Human Exposure Science Research

Tu-S-B2-01

Observations from Laboratory and Field-based Evaluations of Select Low-cost Sensor Performance

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Abstract: The US EPA is currently involved in detailed laboratory and/or field studies involving a wide variety of low cost air quality sensors. These devices include sensors associated with the monitoring of nitrogen dioxide, ozone, fine particulate matter (PM2.5), and volatile organic compounds (VOCs). The majority of these sensors are commercially available at costs well under $1000. Performance characteristics being examined include pollutant detection limits, reproducibility, accuracy, bias, and response times, among others. Either direct laboratory comparison involving characterized exposure chamber trials or field based comparisons involving Federal Reference/Federal Equivalent Methods (FRM/FEM) are being performed. Select results from both the field and laboratory evaluations of various sensor types will be reported as well as the test protocols being applied. A general market survey (examples) of sensors fitting this low cost category will be discussed. Preliminary findings indicate that these sensors have the potential of providing good agreement with reference comparisons under the test conditions being applied. In particular, some gas phase sensors are highly linear (r > 0.95) over their response range and often with detection limits < 10 ppb. Response times for gas phase sensors < 2 minutes are not uncommon. Concentration agreement (± 30 %) between some low cost sensors and reference PM monitors would appear achievable. Data normalization to account for PM response bias (positive/negative) appears to be a useful approach in reducing overall data uncertainty. Low cost Volatile Organic Compound (VOC) sensors are only now being introduced to the commercial market and evaluations would indicate highly variable response under identical test conditions.

Keywords: C-air, A-sensor technology, B-particulate matter, B-VOCs, emerging technology

Tu-S-B2-02 - Withdrawn

Tu-S-B2-03

Lessons Learned from Field Evaluations of Novel Sensors

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Abstract: The air we breathe is the main source of population exposure to pollutants. If the incidence of acute exposures at levels of the order of ppm is demonstrated, it is admitted that chronic exposure to low levels, few ppb, can have an impact on human health. Low concentration level measurements are routinely performed but the devices used are usually heavy, bulky and expensive. Recent years have consequently seen the development of an increasing quantity of miniature devices for low concentration level monitoring. Their aim is not necessarily to reach standard analyzers performances, even if data quality objectives have been recently proposed, but mainly to authorize mass-deployment of well-known reliable and robust sensors over wide areas. Very interesting performances are often reached and demonstrated under simple laboratory conditions but, real life conditions, i.e. field conditions, sometimes reserve behaviors which make them unusable. Key parameters that permit this new cost efficient technology, named Cairsens, to reach USEPA and EU data quality objective will be presented. The analytical characterization of their performances has shown for example that the O3+NO2 version of the sensor was able to measure 0-250 ppb of O3, within an excellent linearity, R2> 0.98, and capable to detect better than 10 ppb in less than 90 s. These key parameters have also demonstrated their efficiency when they have been applied to specific and continuous field monitoring of NO2 during more than one year without any maintenance. The excellent behavior of the low ppb level H2S sensor, less mediatized molecule even if known for its acute and chronic effects at the ppb level, will be presented and compared to some US States ambient air guidelines. As an illustration of its potential, this sensor is capable to measure 0-1000 ppb of H2S and to detect better than 10 ppb with a response time (T10-90) inferior to 90 s.

Keywords: C-air, A-sensor technology

Tu-S-B2-04
Sustainable and Real-time Community Air Pollution Surveillance (SR-CAPS)
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Abstract: This project aims to expand the capability of our low-cost prototype and develop a Sustainable and Real-time Community Air Pollution Surveillance (SR-CAPS). We are developing two different versions of SR-CAPS: indoors and outdoors. While both versions will have onboard battery and run on AC/DC power, the outdoor version will be self-sustaining, which will be powered by solar energy. By expanding the capability of our prototype, and SR-CAPS will record gaseous (CO, NO2, O3 and SO¬2) and particulate pollutants (by size, type and concentration) and meteorological conditions (temperature and relative humidity). The temporal resolution of SR-CAPS will be one minute for optical and bio-chemical sensors, and fifteen minutes for particulate size and type distribution. A unique feature of SR-CAPS will be on-board storage and WiFi capabilities, and data can be accessed by community members via a smart phone application in real-time. The preliminary results from the prototype show that SR-CAPS will predict robust estimates of fine particulate (PM2.5) and meteorological conditions. For example, a unit of particulate (in μV) predicts 561 particles ≥0.5μm ($p < 0.01$; 95% CI: 526-599; $R2 \sim 85.7\%$) and 1.41μg/m3 of PM2.5 ($p<0.01$; 95% CI: 1.35 to 1.48; $R2 \sim 76.2\%$). When these data are calibrated with onboard CO and NOx estimates, and relative humidity, R2 improved to ~ 93%. SR-CAPS will have onboard microscope and digital camera, and the rolling polycarbonate filter. This enables analysis of particulate size and type distribution in real-time. With all these sensors and utilities onboard, the cost of SR-CAPS is $1,000. SR-CAPS will be deployed in eight public parks in Miami-Dade county, and two units (one unit each indoors and outdoors) each in two randomly selected elementary schools. In summary, SR-CAPS offers a low-cost multi-pollutant community air pollution surveillance, which has potential for community engagement to reduce community exposure and its associated health risks.

Keywords: A-exposure models, C-air, A-cumulative exposure, D-community, A-indoor environment

Tu-S-B2-05
Community Air Monitoring and the Village Green Project
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Abstract: Cost and logistics are practical issues that have historically constrained the number of locations where long-term, active air pollution measurement is possible. In addition, traditional air monitoring approaches are generally conducted by technical experts with limited engagement with community members. EPA's Village Green Project (VGP) is a prototype technology designed to add value to a community environment - VGP is a park bench equipped with air and meteorological instruments that measure ozone, fine particles, wind, temperature, and humidity at a one-minute time resolution, with the open-source Arduino microprocessor operating as the system controller. The data are streamed wirelessly to a database, passed through automatic diagnostic quality checks, and then made publically available on an engaging website. The station was designed to minimize power use; it consumes an estimated 15W and operates entirely on solar power, is engineered to run for several days with minimal solar radiation, and is capable of automatically shutting down components of the system to conserve power and restarting when power availability increases. Situated outside a public library in Durham, North Carolina, VGP has also been a gathering location for air quality experts to engage with community members. During the time span of June, 2013 through January, 2014, the station collected about 3500 hours of ozone and PM2.5 data, with over 90% up-time operating only on solar power. Preliminary comparison with regional regulatory monitoring stations revealed general matching of area-wide trends for PM2.5 ($R2 > 0.6$) and ozone ($R2 > 0.8$). The design features incorporated in VGP as well as other emerging technologies may enable the generation of additional air quality time series to complement regulatory data and improve community exposure estimates.

Keywords: C-air, D-community

Tu-S-C2-01

Dermal Absorption of Benzo[a]pyrene: Assessment of Flux from Weathered Soil and Application to Risk Assessment of Contaminated Sites

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Abstract: Soil cleanup standards and site-specific estimates of risk are based in part on predicted human exposure to soil contaminants. Chemicals in soil may be transferred to the skin surface via dermal contact, and from there, systemically absorbed. Because dermal absorption from soil is generally not rapid, characterization of the rate of uptake is important in predicting absorbed dose. For PAHs, USEPA currently recommends that risk assessments assume the dermal absorption from soils to be 13% of the total applied dose. However, fractional absorption is dependent on contaminant skin load, so dermal absorption is best described in terms of gradient-driven flux not percent absorption. To improve the general understanding of the potential for dermal absorption of PAHs from contaminated soil, we conducted experiments with four soils of varying organic carbon and black carbon content. Weathering of ^{14}C-labeled benzo[a]pyrene (BaP) on the soils was conducted for eight weekly cycles in which soils were hydrated and dried. In vitro experiments were then conducted to investigate the effect of soil characteristics and BaP concentrations on flux into and through skin. Soils were applied to human cadaver epidermis at nominal initial concentrations of 3 and 10 ppm, and soil/skin contact was maintained for 8 or 24 h. Flux through skin was determined by the appearance of ^{14}C-label in the receptor solution, and flux into skin was assessed from ^{14}C-label recovered in skin after swabbing to remove residual soil and BaP. Experiments were also conducted with solvent-deposited BaP at a similar chemical load. Cumulative 24-h fluxes into and through skin from aged soils were lower than from solvent-deposited BaP, reflecting the reduced thermodynamic activity in soil. This research is particularly relevant in light of EPA's draft toxicity profile for BaP, which introduces a dermal cancer slope factor for use in risk assessment of BaP exposures, including exposures from soil.

Keywords: A-risk assessment, C-soil, Dermal absorption, PAH, Dermal absorption, PAH

Tu-S-C2-02

Measurements of Dermal Uptake of Diethyl Phthalate (DEP) and Di(n-butyl) Phthalate (DnBP) Directly from Air

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Abstract: This talk will present results from chamber experiments, currently in progress, in which lightly clothed (only shorts) human subjects are exposed for six hours to elevated air concentrations of DEP (~ 150 ug/m3) and DnBP (~ 50 ug/m3). In preliminary experiments, subjects followed a restricted diet and avoided the use of personal care products over the course of two days. Urine samples, which were collected at the beginning and three more times during this period, indicated that relatively low background body burdens of DEP and DnBP could be achieved with this approach. Hence, during the chamber exposure experiments the subjects are following a restricted diet and avoiding the use of personal care products. These restrictions begin 12 hours before and last until 48 hours after the exposure begins. During week one of the actual dermal exposure experiments three subjects are exposed to chamber air while wearing a hood and breathing clean air (exposure only via the dermal pathway), while on a following day three subjects are exposed to chamber air without wearing a hood (exposure via both inhalation and dermal pathways). Urine samples are collected immediately before the exposures and for 48 hours after the exposures. During week two the order is reversed, with the first set of subjects exposed without wearing hoods and the second set of subjects exposed while wearing hoods. The urine samples will be subsequently analyzed for metabolites of DEP and DnBP. For each subject, dermal uptake of DEP and DnBP will be compared to uptake from the combination of inhalation and dermal absorption. Mechanistic modeling predicts that dermal uptake directly from air will be substantial compared to that from inhalation for these two phthalates. These experiments will test those predictions.

Keywords: A-biomonitoring, B-phthalates, A-exposure models, A-indoor environment, A-built environment

Tu-S-C2-03
Dermal Exposure and Flame Retardants

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Abstract: Many flame retardants added to polyurethane foam and electronics are semivolatile organic compounds (SVOCs) with moderate to high logKow. For a number of these compounds, we have shown that the levels measured on hand wipes are associated with concentrations in both indoor dust and serum (or urine). Hand wipe and serum levels are negatively associated with frequency of hand washing as ascertained by questionnaire. The straightforward explanation is that a primary exposure route is contact of hands with dust or contaminated surfaces followed by hand-to-mouth behavior, particularly for children. But the data are at least partly consistent with other explanations. For example, the inverse association of serum levels with hand washing might be due to confounding by other healthy behaviors such as diet. Associations between serum and skin levels may be partly caused by excretion of lipophilic compounds with skin lipids or skin cells as has been demonstrated before for some compounds, at least at high dose. In addition to contact with dust or surfaces, SVOCs may partition directly to skin from air that is also in equilibrium with dust. Finally, correlation studies cannot separate ingestion of material on hands from dermal absorption: the presumed importance of hand-to-mouth behavior partly rests on uncertain exposure factors for incidental dust ingestion. Further progress on these problems requires improved observational studies that can differentiate between parallel or reverse pathways or experimental methods not subject to these drawbacks. For example, we have recently found that PBDEs are measurable on both palms and backs of hands but are significantly higher on palms. Combinations of sequential hand wipes plus hand washing with soap and water indicate that hand washing is effective at reducing PBDE levels. Application of wipes to products suggests that this approach may be an effective non-destructive method for estimating flame retardants in products.

Keywords: B-flame retardants, B-SVOCs, A-sampling methods, A-indoor environment, A-biomarkers

Tu-O-D2: Occupational Exposure - II

Tu-O-D2-01

Differences in Asbestos Occupational Exposures Between Workers of Developed and Developing Countries: The Case of Automotive Mechanics

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Abstract: Background: Asbestos containing brake and transmission products that require manipulation before installation are still common in developing countries. Few studies have analyzed exposures resulting from these manipulations. In higher income countries where manipulation processes of these products were suspended decades ago, several studies have suggested that auto-mechanics are not at excess risk of developing asbestos related diseases. Aims: Compare personal exposure to asbestos of auto mechanics working in developed and developing countries, and determine differences in work practices between both groups. Methods: Since 2010 our research group has studied exposures and working conditions of brake and transmission mechanics in Colombia. This information was complemented by a systematic review of the scientific literature to determine differences in asbestos exposure and work activities of auto mechanics between developed and developing countries. Results: Most of the studies report phase contrast microscopy (PCM) concentrations. For brake mechanics, the 8-hr TWA PCM concentrations ranged from 0.001 to 0.216f/cc in developing countries, and from 0.0001 to 0.140f/cc in developed countries. For transmission mechanics, the 8-hr TWA PCM concentrations ranged from 0.006 to 0.196f/cc in developing countries, and from 0.011 to 0.052f/cc in developed countries. Conclusions: Studies conducted in developing countries report high asbestos exposures, which in many cases are not in compliance with occupational standards. Although similar results are reported in studies conducted in developed countries many decades ago, asbestos exposures have decreased over time in these countries. Current asbestos exposures in developing countries result from the manipulation of asbestos containing auto parts, and the absence of adequate industrial hygiene controls. Asbestos controls and regulatory policies that are commonplace in developed countries need to be expanded to the developing world.

Keywords: D-occupational, C-air, asbestos, personal exposure, asbestos, personal exposure

Tu-O-D2-02
Accounting for Spatial and Temporal Variability in Occupational Hazard Mapping

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Abstract: Technological advancements in exposure assessment have recently increased the accuracy, reliability, and affordability of portable, direct-reading monitors. These monitors can rapidly assess exposures to occupational or other indoor hazards. By coupling an estimated exposure with a known location, contour plots of the hazard concentration over space, known as concentration maps, can be created. These maps are used to assess the spatial variability of hazards. While we believe there is great potential for direct-reading instruments to aid in the identification and mitigation of indoor exposure hazards, it can be dangerous to apply such a methodology without understanding the uncertainties associated with this new form of exposure assessment. Using direct-reading instruments, we generated a measurement datasets of noise intensity and aerosol mass concentration at high levels of spatial and temporal resolution at two facilities. Instruments were deployed as static monitors, located both near and at a distance from known sources, and as a roving monitor that traversed the facility along predetermined routes at ~1 m spatial resolution. Data from the high-resolution measurement campaigns were used to generate reference concentration maps for each facility. The reference map accounted for both spatial and temporal variation using spatiotemporal Kriging, which takes into account the correlation of measurements in both time and space. The reference concentration map provided a best estimation of the true spatiotemporal distribution of hazard concentration in the facility and was used to evaluate simpler statistical approaches (i.e., Traditional and Bayesian Kriging) that do not account for temporal variation. We assessed the reliability of the roving monitor data, a method gaining popularity in occupational exposure assessment, and the improvement of time weighted average concentration map accuracy and representativeness if data from static monitors were included.

Keywords: A-indoor environment, A-geospatial analysis/GIS, B-particulate matter, D-occupational, A-exposure models

Tu-O-D2-03
Modeling Determinants of Exposure: Dermal Mass Loading, Respirable, and Total Airborne Beryllium at a Beryllium Oxide Ceramics Facility

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Abstract: Previous epidemiologic studies have demonstrated elevated prevalence of beryllium (Be) sensitization at a ceramics facility, though a preventive program has reduced sensitization rates. The primary aim of this study was examine work factors associated with total and respirable Be concentrations (μg/m3) and dermal mass loading rates (μg/hr). The second aim was to examine the ratio of total/respirable dust in air. Fifteen workers wore simultaneous total and respirable dust personal air samplers and cotton over-gloves, with multiple samples collected per worker (1-4). During sampling, an industrial hygienist obtained qualitative data on determinants of exposure (e.g., tasks, material form). Orthogonal regression was used to examine associations between total and respirable Be by job/process group. Exposure measurements were log-transformed and mixed-effects models were constructed in SAS Version 9.3. Median ratios of total/respirable ranged from 4.2 (Maintenance) to 9.2 (Forming). Higher ratios were observed in jobs/processes involving dry solids and powder material forms. Results demonstrated that task-related determinants were strongly associated with both total and respirable Be and dermal mass loading ($\alpha \leq 0.05$). For example, the task Machining was associated with increased total and respirable Be. Powder Handling was associated with increased total airborne Be and dermal mass loading, although not associated with respirable Be. Tasks such as Inspection, Metalizing, and Laundry were associated with lower total and respirable Be and dermal mass loading. In addition, lower dermal mass loading was associate with increased % time outer gloves were worn, and greater process enclosure was associated with lower total and respirable Be. We found these models useful in defining tasks and controls associated with different exposures to help guide prevention strategies.

Keywords: B-metals, A-exposure factors, A-exposure models

Tu-O-D2-04

Methodological Approaches for Asbestos Sampling Campaigns and Data Analysis of Highly Polluted Occupational Environments in Developing Countries

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Abstract: Background: Asbestos sampling campaigns are needed to determine asbestos exposures. Conducting asbestos sampling campaigns in auto-mechanic shops (AMS) located in developing countries has unique challenges. Many facilities lack proper ventilation controls, and operating conditions are highly variable. Samples collected in this type of AMS pose difficulties for data analysis and interpretation. Furthermore, achieving voluntary participation of owners and workers can be difficult, because of mistrust and concerns about potential legal implications of the results. Aim: Explain the strategies applied in asbestos sampling campaigns of AMS located in developing countries and methodological approaches used for data analysis and interpretation, and share our experience on how to convince auto-mechanics and shop owners to participate in these studies. Methods: Sampling campaigns have been conducted in 12 brake and transmission repair shops in Colombia. More than 300 air asbestos personal samples have been collected on 26 workers. Two articles reporting the results of this work have been published in peer-reviewed journals. Results and discussion: Highly polluted environments require the development of a sampling windows strategy to prevent overloaded samples. Sensitivity analysis can be used to determine the implication of different data analysis approaches to include samples below the limit of detection, overloaded samples, or samples collected for time windows below or above 8-hr. Detailed activity diaries can aid data analysis efforts. Validation of the results, even when working with certified laboratories, is also important. Voluntarily participation can be achieved by: a) assuring confidentiality to workers and owners; b) certifying academic affiliation of the researchers, and no association with occupational or environmental authorities; c) informing owners and workers about the campaign results; and d) conducting sampling campaigns at no cost for workers and owners.

Keywords: D-occupational, A-sampling methods, A-analytical methods, A-activity patterns, A-workplace

Tu-O-D2-05

European Chemical Industry council (CEFIC) Generic Exposure Scenario (GES) Worker Risk Assessment Tool

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Abstract: Under the EU Registration, Evaluation, and Authorization of Chemicals (REACH) regulation, the uses of classified substances require the development of exposure scenarios to describe safe use conditions of the substance and then communicate these conditions in the supply chain. Through the 2010 REACH activities, uses were found to be best described and communicated using Generic Exposure Scenarios (GES) for substances with wide dispersive use such as solvents. The European Chemical Industry council (CEFIC) has developed a GES Worker Risk Assessment Tool to meet the requirement of worker chemical safety assessment. This tool incorporated the European Centre for Ecotoxicology and Toxicology of Chemicals Targeted Risk Assessment (ECETOC TRA) worker module for exposure estimates and risk characterizations for both industrial and professional sector of uses. Special operational conditions and risk management measures can be applied with justifications in the tool. Extensible markup language (XML) transfer files were also created enabling data from each GES worker template to be migrated into the European Chemical Agency Chemical safety assessment and reporting tool (Chesar). The Chesar platform can interact with the International uniform chemical information database (IUCLID) to generate a full Chemical Safety Report for a REACH submission. When conducting health risk assessment in practice, the CEFIC tool, a scientifically based standardized tool, enables both sides (registrant and evaluator) to have a common system to ensure chemical safety.

Keywords: A-exposure models, A-risk assessment, REACH

Tu-S-E2: Thinking through Computational Exposure as an Evolving Paradigm Shift for Exposure Science: Development and Application of Predictive Models from Big Data

Tu-S-E2-01

Vision for Big Data and Computational Predictive Exposure Science

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Abstract: A new and compelling line of exposure science is emerging out of a combination of technological advances in measurement capability, modeling, computation, and internet enabled access to data descriptive of time, activity, behavior, and social condition. Advances in measurement technology have made it possible to collect simultaneous information for multiple agents with greater temporal resolution and reduced cost. Growth of computational technologies has eased data collection and storage issues, and expanded the capability to analyze large data sets. Systematic compilation of large data sets under a common set of terms (ontology) that facilitates compiling information from multiple studies in common formats have also been proposed. To date, these activities are largely occurring discretely. Information from each is useful but the full value of combined data from integrating information from these technologies has not yet been realized. We will discuss opportunities and provide examples for how this information may be used in an integrated manner to better understand exposures and their sources, and to be more predictive. Particularly, ways to incorporate available data sources and emerging technologies within current biomonitoring programs will be explored. Key considerations for integration include approaches for identifying a manageable subset of these technologies, defining consistent integration methods, and developing consistent terminology for data collection and reporting as well as useful metrics for evaluating utility of the integrated information. To be successful, the path forward will require the cooperative involvement of stakeholders, including research partnerships with industry and other information owners. The promise of these efforts for public health are enormous in combination with computational toxicology, providing an unprecedented opportunity to inform risk sciences via expanding data and enhancing predictive reliability.

Keywords: A-chemical prioritization

Tu-S-E2-02

The Importance of Commercial Data and Research and the Value it Brings to Public Health and Safety Communication

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Abstract: The science of measuring and understanding what types of products consumers purchase, and hence the potential associated chemical and biological exposures, as well as why they choose one product over another has grown more sophisticated with the rapid advances in data science. It is no longer enough to know what was bought, but rather to understand the entire "lifecycle" of the purchase decision, from interaction with advertising campaigns, to resonance of the campaign message, to the actual purchase behavior. The tools and data employed in this "big data" era are also complex, from analysis of millions of lines of purchase data to identification of advertising exposure across multiple media types including TV, radio, mobile devices, and websites visited, to the use of GPS on the ground and satellite information in the sky to monitor physical location and potential purchase locations. These approaches and insights have direct understanding of persons' exposures to commercially available forms of chemical and biological exposures -- in particular systemic and on-going exposures, but potential short-term outbreaks as well. It also has bearing on understanding how public safety message can shape behavior in these areas. Moreover, these efforts are taking place on a global scale, in both developed and emerging markets. This discussion focuses on some of the important commercial innovations and methodologies in commercial consumer research and demonstrates their utility for furthering insights in exposure science.

Keywords: A-behavior, C-consumer products

Tu-S-E2-03
Developing a Passive Time-Activity Triage System In support of Consumer Ingredient Exposure Prioritization
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Abstract: Chemical Hazard/toxicity assessment of chemicals relies on droves of chemical-biological data at the organism, tissue, cell, and biomolecular level of resolution. Big data in the context of exposure science relies on a comprehensive knowledge of societies' and community activity levels at time-scales that can span seasons, years, over disparate geographical distances, involving a diverse array of product and chemical ingredient exposures as a function of these activities. OpenHealth platforms (symptoms), aggregated search term volume (Google trends), Social Media (Twitter) and consumer exposure "ground-truthing" activities with aggregated national consumer marketing/purchasing data holds the key in prioritizing and defining the nature of personal chemical exposures, and their geospatial variability to put a real-time fly-on-the-wall for chemical exposure prioritization. We provide an overview of our workflow, demonstrate how these web technologies can be integrated into a tractable triage system to better inform chemical exposure related study design (product, timing and population selection) and elucidate meaningful near-field exposures from consumer products. [Disclaimer: The views expressed in this abstract are those of the authors and do not necessarily reflect the views or policies of the U.S. Environmental Protection Agency]

Keywords: A-analytical methods, A-exposure factors, A-activity patterns, A-geospatial analysis/GIS, A-exposure models

Tu-S-E2-04
Social Media to Augment Exposure Science: Current Applications and Future Possibilities
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Abstract: With the explosion of popularity of social media over the last decade, researchers are presented with a new and largely untapped data source that can augment exposure science in several ways. This opportunity comes at a time when traditional survey research methods are challenged with trends in communications and society making their processes less efficient and more difficult to obtain accurate, reliable results; these include the decline in landline telephone coverage and decreased public willingness to participate in research. We will present several of the opportunities for incorporating social media in exposure science, from the first stages of study design through the dissemination of research results. We include both original examples and those from other researchers. For example, at the time of an environmental disaster, social media can be used to identify a potentially exposed group through geolocation information. Topics of conversation can indicate immediate effects from the disaster or actions taken to mitigate those effects. At the same time, officials can broadcast important safety information using social media to benefit those exposed. Social media can be used to reach out directly to identified exposed individuals for study recruitment; capture co-occurring terms or conditions that might impact the degree of exposure for investigation in a follow-up study; and solicit and collect diary information over the course of a study to track reported exposure and behavior. In studies with a survey or mobile data capture component, the social media postings of willing participants can be appended to the data to provide additional characteristics, insights, and a longitudinal view. Finally, social media can be used as a means to stay in touch or locate participants between waves of a study and quickly disseminate the results of research to inform the public.

Keywords: A-sampling methods, A-epidemiology, social media

Tu-O-F2: Indoor Environments - II

Tu-O-F2-01
Effect of Temperature Stratification on Exposure to Non-Buoyant Gaseous Pollutants in Indoor Spaces
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Abstract: In approximately 500 indoor air quality investigations in the past decade, OSHA has found that 52% of indoor air quality problems stem from inadequate ventilation. Inadequate ventilation can be exacerbated by spatial differences in temperature as stratified layers decrease the effective mixing volume. Non-buoyant gaseous pollutants can thus collect in the breathing zone creating concentration spikes much higher than those

found near the floor/ceiling. To characterize this effect, 25 controlled experiments were conducted in two indoor spaces in northern California. Cigarette smoke was passed through a smoke actuator which was then cooled to create a non-buoyant fine particulate tracer source. PM2.5 monitors less than 1m away from the source point consisted of 4 sampling points in each cardinal direction so as to account for directionality. There were a total of 10 sampling monitors and 26 sampling points for each experiment. Temperature sensors were placed slightly above and below the floor and ceiling surfaces, respectively to garnish an accurate reading of temperature stratification. Stratification strength ranged from 0 to 10°F (-18 to -12°C). Level of stratification was found to have significant impact on the vertical concentration profile, with concentration levels in the breathing range of stratified spaces reaching roughly 3 times those of unstratified indoor spaces. Vertical mixing levels quantified using the turbulent diffusion coefficient show an increase of up to 75% with a stratification decrease of 3°C. Outdoor factors such as sunlight heating were also recorded and were found to have a significant impact on vertical concentration profiles.

Keywords: A-exposure factors, A-indoor environment, C-air

Tu-O-F2-02 – Withdrawn

Tu-O-F2-03
Fingers as Sampling Devices: Finger-wipe Sampling Discriminates Third hand Tobacco Smoke Contaminated Environments in Home and Hotel Studies
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Abstract: Thirdhand smoke (THS) is the residue present in environments after active smoking has taken place, and consists of tobacco smoke-related toxic compounds present on surfaces, found in house dust, or re-emitted into air. Compounds measured in thirdhand smoke environments include nicotine in air, dust and surfaces, 3-ethenylpyridine in air and tobacco-specific nitrosamines in dust and surfaces. Collecting such samples often involves expensive equipment such as the cyclone vacuum or requires multiple visits such as needed for air samples. Here we present data on finger-wipe samples for nicotine taken from subjects (adults and children) in environments with extensive air, dust and surface wipe measures of THS contamination. These environments include homes of former smokers and hotel rooms. The finger wipe samples were correlated with other THS measures (e.g. correlation coefficient of 0.43, $p < 0.05$, for air nicotine and finger-wipe nicotine in guests staying overnight in hotel rooms of varying smoking status). Human fingers may be efficient samplers of their surrounding environments and finger-wipe measures may well reflect environmental contamination by THS and other environmental chemicals. Studies on finger chemical contamination may also help to elucidate risk pathways, especially to infants and children with frequent hand to mouth behaviors.

Keywords: A-activity patterns, A-second-hand smoke, A-behavior, D-children, Thirdhand smoke

Tu-O-F2-04
Filter Capture Efficiency Testing for the Biological Glove Box in the International Space Station
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Abstract: In the Threshold Acceleration for Gravisensing-2 (Gravi-2) experiment lentil seedling roots will be used to study the mechanisms by which a plant responds to the changing direction of a gravity field. These tests will be carried out in the International Space Station in 2014. This research project requires improvements of the biological glove box (BGB) filters to allow safe use of hazardous chemicals for fixation of the tested plant roots. The objective of this project was to test the filter capture efficiency of the BGB filters for aqueous solutions of formaldehyde, glutaraldehyde and ethanol in a simulated spill scenario. Finely dispersed aerosols of the aqueous solutions of formaldehyde, glutaraldehyde and ethanol were captured on the test filter at a flow of 75 L/min. The concentration downstream of the tested filter was monitored using a photoacoustic gas monitor. For quantification of the filter capture efficiency, membrane filters were impregnated with 2,4-dinitrophenylhydrazine (DNPH) for analysis of the aldehydes. These substances were analysed by HPLC-UV. Air was passed through activated coal for subsequent analysis of ethanol by GC-FID. The new design of the BGB filter unit showed that a challenge with 10.0 mL aliquot of test solution leads to average downstream air concentrations of 0.295±0.094 mg/m3 for a 3.0% formaldehyde solution and 0.018± 0.015 mg/m3 for a 4.0% glutaraldehyde solutions,

corresponding to a filter capture efficiencies of 99.54% for formaldehyde and 99.97% for glutaraldehyde. For a filter load of 5.0 mL of 70:30 ethanol:water (v/v), the concentration of ethanol downstream of the test filter was 19.4±7.8 mg/m3, corresponding to a filter capture efficiency of 97.54%. These remained below the space maximum allowable concentrations (SMAC) for these substances. A continued test showed that breakthrough occurred only after a exposing the BGB filter to a volume of test solution corresponding to tenfold the volume used in the spill scenario.

Keywords: A-analytical methods, A-indoor environment, B-VOCs, A-workplace, aerospace

Tu-O-F2-05
Combined Exposure to Health Stressors in Indoor Built Environments in Europe

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Abstract: The objective of this study was to undertake, summarize, and present a systematic review on multiple or combined exposure in indoor built environments. The review covered safety threats and injuries, indoor air pollution, use of household chemicals, noise, damp and mould, thermal conditions, crowding, inadequate hygiene standards, and harmful building and equipment/furnishing materials, relevant to residential buildings and day care and school settings. The key findings were as follows: - The most frequent combinations of risk exposure in indoor environments, pertain to chemical mixtures of pollutants that are almost ubiquitous in this setting, including carbonyls, volatile organic compounds, particulate matter and polyaromatic hydrocarbons. - The second most frequent combination of stressors includes the simultaneous and multiple exposure to air pollutant mixtures and biological stressors (mould/dampness and mite allergens) or physical stressors such as noise and thermal (dis)comfort. - The third most frequent stressor combination concerns to the multiple presence and interaction between physical and biological stressors, such as noise, thermal conditions and/or mould, and adverse indoor conditions such as crowding or substandard hygiene. Socioeconomic differences play an important role in determining the actual exposure to the above stressor combinations and, thus, to the consequent adverse health effects. In the light of the current financial crisis and the increasing immigration pressure in Europe, the connection between socioeconomic status of households and combined exposure to health stressors in the indoor environment is likely to escalate. From the methodological point of view, aside from simple additivity of effects and some specific cases of exposure to at most two simultaneous stressors, which may enhance the activity or counteract each other, currently there is limited actual evidence available on health effects of co-exposure to multiple stressors.

Keywords: A-built environment, A-cumulative exposure, A-indoor environment, A-environmental justice, D-vulnerable

Tu-O-G2: Traffic-Related Exposures - II

Tu-O-G2-01
International Airport Emissions Result in Freeway-like Ultrafine Particle Concentrations and Size Distributions up to 10 km Downwind

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Abstract: An instrumented vehicle measured the spatial pattern of air pollution impacts from Los Angeles International Airport (LAX) emissions and found an adverse impact on air quality up to 16 km downwind, much farther than previously reported. Measurements conducted over long durations (up to 6.5 hours) at different times for 29 days across two seasons consistently showed that maximum ambient ultrafine particle (UFP) number concentrations were aligned to the jet landing trajectories east of LAX during the prevailing westerly winds with concentrations exceeding 100,000 particles/cm3 up to 10 km downwind. During most of the day, UFP number concentration were at least double the local ambient concentrations up to 16 km downwind and over about 60 km2 of a mostly residential area. Similar spatial patterns for increased oxides of nitrogen, black carbon and particle-bound polycyclic aromatic hydrocarbons concentrations were also observed. Additional measurements of size distribution were later undertaken. Impacted areas up to 10 km downwind from LAX showed a number concentration mode in the 20-40 nm range, small sizes typically associated with fresh fuel combustion emissions and similar to that on Los Angeles freeways. In comparison, much larger modes (e.g., 80 to 150 nm) were measured for both coastal and ambient aerosol in the un-impacted areas. These results suggest that airport emissions have resulted in previously undiscovered UFP exposures for a significant section

of the local population that is similar in scope and freeway-like in its concentrations and size distributions. When area and concentration weighted total impact was compared against typical UFP concentration elevation from freeway emissions, the equivalent freeway length required for a comparable impact rivaled the urban freeway network in Los Angeles.

Keywords: B-nanoparticles, B-particulate matter, D-community, Airports, Ultrafines, Airports, Ultrafines

Tu-O-G2-02
Spatial and Temporal Distribution of Near-Highway Air Pollution in Three Urban Neighborhoods in Metropolitan Boston (USA)

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Abstract: While exposures to components of air pollution vary both within and between neighborhoods, it is unknown to what extent multi-pollutant concentration patterns are generalizable across near-highway neighborhoods in a metropolitan area. The goal of this work was to determine the extent of inter-neighborhood differences that can be explained by different sources, geography, and meteorology in three neighborhoods (Somerville, Dorchester, and Chinatown) along Interstate 93 (I-93) in the metropolitan Boston area (USA). The objectives were to characterize spatial gradients from I-93 and temporally-varying predictors of seven traffic-related air pollutants (PNC, PAH, NO, NO_X, BC, CO, $PM_{2.5}$) to (1) determine whether spatial patterns in concentrations and inter-pollutant correlations among pollutants differ across neighborhoods; and (2) determine whether variation across neighborhoods can be explained by local sources or meteorology. One year of mobile monitoring (36-55 days per neighborhood) was performed in near-highway (<400 m) and paired urban background (>1000 m) neighborhoods. Effects of temperature, wind speed and direction, and highway traffic volume were estimated using mixed effects models. Pollutant levels generally increased with highway proximity, consistent with I-93 as a major source of traffic-related pollution; however, distance-decay gradients varied by pollutant, neighborhood, time of day, and season. Correlations among pollutants differed across neighborhoods (e.g., ρ = 0.35-0.80 between UFP and NO_X and ρ = 0.11-0.60 between UFP and BC) and were generally lower in Dorchester than in the other neighborhoods. Examination of concentration patterns indicated contributions from major surface roads that were comparable in magnitude to contributions from I-93. The differences in near-highway pollutant distributions in a single metropolitan area suggest that caution should be used when assuming similarity of near-highway areas for epidemiology studies.

Keywords: A-epidemiology, B-particulate matter, C-air, D-community

Tu-O-G2-03
Air Pollution, Traffic and Socio-Economic Status

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Abstract: Living near traffic has been shown in many studies to affect a number of health outcomes adversely. This relationship between traffic and health has been explored using various approaches. We developed several metrics for exposure to air pollution and traffic and health risks resulting from these exposures at a very dense spatial resolution. The metrics include traffic density and output from the MNRiskS model, a comprehensive statewide model of air pollution emissions, concentrations, exposure, and risk. The metrics were compiled by census block groups so that they could be compared with census socio-economic and demographic data. The results show that the measures of environmental impairment, air pollution and traffic, are highly correlated. Furthermore, in the Minneapolis-St Paul metropolitan area these measures of environmental hazard were all significantly positively correlated with poverty, the fraction nonwhite population, the fraction of specific minorities, less than high school education, and population density. They were significantly negatively correlated with home ownership, median home value, the number of vehicles per household, driving alone, and median household income. These relationships also held, although less strongly, statewide and in rural areas. Principal component and regression analyses confirmed the correlations and contributed to full interpretation of the data and understanding of nuances in the relationships. We interpret the results as indicating that people living in areas with high minority populations and on the lower end of the socio-economic spectrum appear to be disproportionately exposed to traffic and air pollution and in consequence are estimated to bear disproportionately high health risks.

Tu-O-G2-04
Investigating Air Pollution Exposures in a Cohort of Traffic Police in Kathmandu, Nepal

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Abstract: Exposure to traffic pollution has been generally accepted to be deleterious to human health. Much of our understanding of this stems from studies performed in developed nations, where emissions controls are reasonable and overall pollutant loading is relatively low. However, much of the world is subjected to substantially different aerosol conditions, particularly in developing nations. Six Nepali traffic police officers at six different locations (total cohort size: 36 unique individuals) were monitored for 6 consecutive days each with a suite of monitors including a personal scattering nephelometer, a micro aethalometer, a GPS record, and an accelerometer measure of activity. 24 hour integrated filters were also collected for chemical speciation, including trace metals, organic and elemental carbon, and ions. Five-minute averaged levels observed in Kathmandu were varied with typical exposure levels during their work shifts between 1000-2000 µg m-3, which were sustained for 6-10 hours; background concentrations rarely dropped below 20-25 µg m-3. Black carbon levels were equally variable, with observed five-minute averaged concentrations typically between 5 and 300 µgC m-3. Passive sampling of gas phase species was also performed. A number of health endpoints were measured in individuals including pre and post shift blood pressure and spirometry, 96 hours of electrocardiogram, and 3 and 4 samples, respectively, of blood and urine biomarkers for measures of inflammation and oxidative stress. An intervention was included in the study design which provided N95 personal face masks for participants to wear for part of their work week to reduce occupational exposures to traffic generated particulate matter.

Tu-O-G2-05
Exposure Assessment and Misclassification for Traffic-Related Air Pollutants Using Census Information: Spatial Resolution Needs

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Abstract: Health surveillance and demographic data are typically collected at the census block or tract level. Is this spatial resolution sufficient for traffic-related pollutants, the most important air pollution source in urban areas? We evaluates the spatial resolution and zonal systems needed to estimate traffic-related air pollutants using the detailed information assembled for the 800 km2 area encompassing Detroit, Michigan, USA. Concentrations of nitrogen oxides (NOx) due to vehicles are predicted using hourly traffic flows on 9,700 links representing all but the smallest roads, the MOVES2010 emission model, the RLINE dispersion model, local meteorology data, a temporal resolution of 1 hr, and a spatial resolution as low as 10 m. Concentration at 30,000 model receptors were joined with shape files to estimate residential exposures for 700,000 individuals at property parcel, census block, tract, and ZIP code levels. We determined the resolution needed to meet specific error criteria, and quantify exposure misclassification for each zonal systems as shown using maps, distributions, contingency tables, and other statistics. To portray traffic-related air pollutant exposure, interpolations between receptors and points of interest should not exceed 40 m for areas within 60-80 m of major roads, and 100 m at larger distances. In census tracts and ZIP codes, average exposures tend to be overestimated since few individuals live very near major roads, the range of concentrations among zones is compressed, most exposures are misclassified, and the high levels near roads are entirely omitted. The use of smaller zones improves performance, but even block-level data will misclassify a substantial number of individuals. These results are robust in being based on a very comprehensive model. Exposure, health surveillance and demographic data should be geocoded or collected at the highest spatial resolution to estimate exposures and impacts of traffic-related pollutants.

Tu-S-A3: Pesticide Exposure and Risk Assessment - II

Tu-S-A3-01
Pesticide Exposure in Ireland: Rapid Response Models and Reporting Annual Exposure
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Abstract: Each year in Ireland, the Pesticide Control Division generate an annual report detailing exposure to pesticides in Irish consumers. Both probabilistic and deterministic assessments of dietary exposure are calculated, by linking residue data measured in the national sampling plan to national dietary surveys. Assessments are carried out using the dietary exposure system Creme Crop Sciences, a cloud-based software service incorporating both cumulative and aggregate probabilistic assessments of exposure to pesticides. The acute and chronic exposure models in Creme Crop Sciences are described, as well as a number of variability models, limit analyses based on toxicological endpoints, and the handling of residue data. Where non-compliant residues were detected, rapid risk assessments based on the residue level found and national food consumption data are carried out to estimate the risk to consumers and to guide the follow-up action to be taken. This is carried out using a specially developed feature called the "MRL Breach Wizard", which can be used as a rapid-response type model to estimate if action is required should an MRL be exceeded.

Keywords: A-aggregate exposure, A-cumulative exposure, B-pesticides, C-food, A-exposure models

Tu--A3-02
Application of the MCR to the assessment of exposure to multiple pesticide residues from the consumption of fruits and vegetables
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Abstract: Concern has been raised by a number of organizations over the potential for underestimating risks by not considering the toxicity of combined exposures to multiple pesticide residues on food items. To investigate this issue, the Maximum Cumulative Ratio (MCR) approach was applied to monitoring data on multiple residues of pesticides in samples of strawberries, lettuce, grapes, apples, and pears from the UK reported by Defra Expert Committee on Pesticide Residues in Food and multiple organophosphorus pesticide residues on lettuce from the EU reported by EFSA. MCR is a measure of the toxicity-weighted exposures (Hazard Indices or HI) when considering concurrent exposures from a sample of a food item separately. These datasets included samples of crops with large numbers of detected residues. The values of MCR for the individual samples of the five UK crops range from 1.0 to 4.0 and the average MCR value for the samples was 1.6. This value indicates that >60% of the HI value for the average sample was driven by the contribution from a single compound. MCR values were also lower for samples with larger values of HI, indicating that samples of the greatest concern were due to individual pesticides occurring at high levels and not combined exposures to multiple pesticides. These findings support the current pesticide-by-pesticide approach to exposure assessment in identifying samples with the greatest risks from both individual and combined pesticide residues.

Keywords: A-risk assessment, C-food, C-food, A-cumulative exposure

Tu-S-A3-03
Application of the Maximum Cumulative Ratio (MCR) Approach Using Residue Data from Pesticide Data Program and the Cumulative and Aggregate Risk Evaluation System (CARES) Model
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Abstract: The US Environmental Protection Agency and European Food Safety Authority define cumulative dietary risk as concurrent exposure from the consumption of foods that contain multiple residues of pesticides which have a common mechanism of toxicity. Many organizations have expressed concern over this approach for not considering the impact of combined exposures to residues of all pesticides in diet independent of mechanism. To investigate this issue, the Maximum Cumulative Ratio (MCR) approach was applied to estimates of dietary exposure developed using the Cumulative and Aggregate Risk Evaluation System (CARES) model based on the CSFII consumption data and monitoring data on multiple residues of pesticides in samples of various commodities reported by the USDA Pesticide Data Program (PDP). MCR is defined as the ratio of cumulative toxicity from exposure to multiple chemicals to the largest toxicity from a single chemical. This approach provides a quantitative measure of difference in an individual's toxicity using a chemical by chemical approach versus that using a cumulative model of combined toxicity. The USDA Pesticide Data Program is a residue monitoring program using multi-residue methodology to determine co-occurrence of multiple pesticides

on give food item. The CARES probabilistic model generates a temporal exposure pattern assigning co-occurring residues to consumption data. The doses of two age groups (adults and 2 year olds) will be investigated over a single day and multiple days. The results of this pilot project should provide an indication of whether cumulative exposure is primarily driven by a one or two pesticides or the result of the smaller contributions from multiple pesticides. This work will also explore the potential impact of contributions from non-detected values and of grouping exposures based on mechanism of action.

Keywords: A-cumulative exposure, B-pesticides, C-food

Tu-S-A3-04
Community Exposures to Pesticide Drift
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Abstract: The off-target movement of pesticides during and after agricultural pest control treatments is an ongoing public health concern. Worker illnesses associated with pesticide drift continue to be reported, and risks for vulnerable populations such as the elderly, small children and women during pregnancy are not well characterized. This presentation examines the study designs, methods and models used in evaluating pesticide drift in agricultural communities. Air monitoring programs require careful consideration of spatial and temporal aspects of spraying and need to be linked to local meteorological data. Biological monitoring of populations can be useful if sufficient information is available regarding exposure sources. Global positioning system technology can determine time-location patterns for community residents. Two community air monitoring studies were conducted in Washington State agricultural regions to coincide with the use of the organophosphorus insecticides chlorpyrifos and azinphos methyl. Preliminary findings indicated that air concentrations were below regulatory guidelines throughout the sampling periods. However, follow up studies found that the more toxic oxygen analogs of these compounds were present in community air, raising questions as to whether current guidelines are adequate. Results from pesticide drift studies from both airblast orchard spraying and fixed-wing aircraft applications are used to evaluate the accuracy and precision of current exposure assessments.

Keywords: B-pesticides, A-exposure models, C-air, D-community, D-children
Tu-S-A3-05
Applying Comparative Risk Methods to the Changing Occupational Risks of Pesticide Handlers
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Abstract: Product substitution is a common approach to reducing occupational hazards. A chemical substitution in the agricultural workplace normally involves change from a higher to a lower toxicity compound, but it also may lead to changes in the volume of chemical used, application techniques, and the level of personal protection required of workers. This study employs comparative risk methods to evaluate the recent replacement of azinphos methyl as a pest control agent for codling moth in the tree fruit industry. Comparative risk analysis provides a means of integrating changes in exposure, toxicity and other factors to identify risk tradeoffs that result from such chemical substitution. This presentation examines the comparative risks for agricultural pesticide handlers during an azinphos methyl application scenario and scenarios for acetamiprid, chlorantraniliprole, spinetoram, and thiacloprid. Probabilistic exposure assessments for these scenarios were performed using a combination of personal samples collected from pesticide handlers and generic exposure measurements from the Agricultural Handlers Exposure Database (AHED). The potential risks associated with these application scenarios are presented, together with an analysis of strengths and weaknesses of comparative probabilistic health risk assessment methods.

Keywords: B-pesticides, A-risk assessment, D-occupational

Tu-S-B3: Direct Reading Methods and Sensors in the Workplace

Tu-S-B3-01
Occupational Exposure Assessment in Carbon Nanotube and Nanofiber Primary and Secondary Manufacturers: Mobile Direct-Reading Sampling

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Abstract: Toxicological evidence suggests the potential for a wide range of health effects from exposure to carbon nanotubes (CNTs) and carbon nanofibers (CNFs). To date, there has been much focus on the use of direct reading instruments (DRIs) to assess multiple exposure metrics for potential exposures to CNTs and CNFs due to their ability to provide instantaneous results. Still, uncertainty exists in the usefulness and interpretation of the data. To address this gap, air-monitoring and statistical analysis of the data was conducted at six sites identified as CNT and CNF manufacturers or users and results were compared to filter-based metrics. Particle number, respirable mass, and active surface area were monitored with a condensation particle counter, a photometer, and a diffusion charger, respectively. The instruments were placed on a mobile cart and used as area monitors in parallel with filter-based elemental carbon and electron microscopy samples. All instruments in this study are portable and routinely used for industrial hygiene sampling. Significant variability was seen with the DRI data between common processes as well as the indoor and outdoor backgrounds. However, no clear pattern emerged linking the DRI results to the elemental carbon or the microscopy data (CNT/CNF structure counts). Overall, no consistent trends were seen among similar processes at the various sites. The DRI instruments employed were limited in their usefulness in assessing potential exposures at the sampled sites but were helpful for hypothesis generation, control technology evaluations, and other air quality issues. The DRIs employed are non-specific, aerosol monitors and therefore subject to interferences. As such, it is necessary to collect samples for analysis by more selective, laboratory-based methods to confirm and quantify exposures.

Keywords: A-nanotechnology, A-workplace, D-occupational, A-sampling methods

Tu-S-B3-02
UV Native Fluorescence Based Monitor for Workplace Exposures

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Abstract: Direct reading instruments are valuable tools for workplace exposure assessment. NIOSH, the US Army Research Institute of Environmental Medicine, Army Corps of Engineers and Photon Systems are developing and evaluating a personal monitor (PM) to determine naphthalene exposures in military personnel exposed to jet fuels. The naphthalene-PM, developed by Photon Systems with Army SBIR Program-funding utilizes native fluorescence of molecules excited by deep ultraviolet (UV) light to perform qualitative and quantitative analysis. Because the strength of the emitted signal corresponds to the amount of the chemical present, concentration can be determined. This single sensor platform can be adapted for air, surface or liquid matrices. To measure contaminants in air, the sampling chamber concentrates the contaminants for identification and measurement. For measurements in water, a flow-cell or cuvette can be used and for measurements of surface contamination the instrument can be used in a "point and shoot mode". Current research is proceeding in two phases: the laboratory validation of the instrument and an exposure assessment study /field evaluation of the monitor at Department of Defense facilities in the continental United States. The project objectives are to 1) validate sensor technology to measure, in near real-time, environmental contaminants and potential personal exposures to chemical hazards during routine activities, 2) evaluate the capability of the naphthalene-PM to reliably operate under a range of environmental conditions, 3) validate the naphthalene-PM as a practical and efficient technology to assess contaminants levels and personnel exposures in an operational setting. Findings from laboratory and field validation studies indicate the prototype monitor is capable of determining airborne concentrations of select polycyclic aromatic hydrocarbons at levels much lower than conventional industrial hygiene methods and can do so in three minutes or less.

Keywords: A-analytical methods, B-VOCs, D-occupational, A-sampling methods, B-SVOCs

Tu-S-B3-03

Direct Reading Chemical Exposure Assessment Method with Real Time Location System, DREAM-RTLS

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Abstract: Instrumental analytical chemistry has evolved with the advances in microcomputers, Wi-Fi, and internet protocol. As a result of this evolution, an exposure assessment method was developed that provided real time wireless personal chemical exposure monitoring measurements (in parts per million) with their corresponding real-time location coordinates (x, y, and z). NIOSH funded a project under their Direct Reading Exposure Assessment Methods (DREAM) initiative to create a Chemical Exposure Monitoring with Indoor Positioning or CEMWIP method. A commercially available Real-Time Location System (RTLS) was combined with a custom-built photoionization detector (PID) to develop the CEMWIP method. This CEMWIP method was evaluated for accuracy and precision in the measurement of VOC concentration, location, temperature, and humidity over time. A simulated release of VOCs was monitored under laboratory conditions to provide data for a hazard dose map of controlled releases. The DREAM-RTLS used indoor antennas mounted on the walls of the work area to detect RF pulses emitted by a personal chemical sensor and its RF beacon. The antennas are connected by data cable to a computer with a program that calculates the beacon's location and plots it on a floor plan in real time. Simultaneously, the personal chemical sensor with additional associated circuits also provides VOC, humidity, and temperature data to a server. Measurements are taken every second, displayed in real time through a remote web interface, and stored for later analysis. Exposure alarm levels are programmed in software to signal the user of the remote laptop of exceeded limits. For the first time, precision indoor positioning coordinates have been combined with real-time exposure measurements to allow immediate alarm to hazardous exposure, but more importantly, 3-dimensional hazard mapping of a work area that can associate elevated worker exposure to specific work tasks.

Keywords: A-analytical methods, A-indoor environment, A-sensor technology, A-workplace, B-VOCs

Tu-S-B3-04

Field-portable, Direct-reading Sensors for Personal Exposure Measurement of Aerosol

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Abstract: Field-portable, real-time sensors for aerosols, sensors that can provide information about chemical and physical properties of the aerosol, are valuable tools for near real-time personal exposure monitoring and can promote effective epidemiology and surveillance, and on-site hazard identification and mitigation. We describe our recent efforts on the development of compact, direct-reading instruments for aerosol exposure. A Portable Mobility Aerosol Size Spectrometer has been developed for size distribution measurement of nanoparticle and ultrafine aerosols. The instrument uses a miniature bipolar charger, differential mobility analyzer, and a condensation particle counter to obtain number-weighted mobility size distribution of the airborne particles in the diameter range of 10-1000 nm. The battery-operated stand-alone prototype measures about 9x9x6 inch, weighs about 10 lbs, and allows mobile and personal exposure measurement. Aerosol Multielement Spectrometer, an instrument designed for simultaneous measurement of airborne concentration of several particulate metals, is also under development. The instrument employs microscopic concentration of sampled aerosol and allows in-situ, direct microanalysis using microplasma emission spectroscopy. Several metals of interest to environmental and occupational health at detection limits on the order of few ng/m3, at time resolution of few seconds to minutes can be measured with this hand-portable instrument. Principle of operation, key challenges, and the results from the laboratory and field testing of both these instruments will be presented, and the unique applications of these sensors will be discussed.

Keywords: A-sampling methods, A-analytical methods, A-nanotechnology, C-air, A-sensor technology

Tu-O-C3: Biomarkers of Exposures to Environmental Chemicals - I

Tu-O-C3-01

Human Biomonitoring of Plasticizers: Time Trends of Exposures in the US and Germany

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Abstract: Certain phthalates have been under intensive scrutiny because of their proven or suspected endocrine disruptive activity. In consequence, phthalate production and consumption changed considerably over the last decades. We investigate trends of phthalate exposure analyzing urinary biomonitoring data from the US National Health and Nutrition Examination Survey (NHANES) and the German Environmental Specimen Bank (ESBhum). For NHANES we investigated the sampling years 2000 - 2010 and for ESBhum the years 1988-2008 on the basis of urinary metabolites of di-iso-butylphthalate (DiBP), di-n-butylphthalate (DnBP), Butylbenzylphthalate (BBzP), di-ethylhexylphthalate (DEHP) and di-iso-nonylphthalate (DiNP). In Germany, DnBP exposures (via mono-n-butylphthalate) decreased considerably from 174 µg/l (1988) to 19.6 µg/l (2008) reaching levels comparable to those in the US after a less pronounced decrease there. In contrast, DiBP exposure (via mono-iso-butylphthalate) seems rather constant in Germany (25.5 µg/L in 2008) and surpassing DnBP exposures in 2006. DiBP exposure in the US nearly tripled from 2002 (2.7 µg/L) to 2010 (7.7 µg/L). BBzP exposure (mono-benzylphthalate), decreased in Germany from 6.8 µg/l (1988) to 3.8 µg/l (2008), paralleling the decrease in the US (11 µg/l in 2000, 6.5 µg/l in 2010). Similar to DnBP, DEHP exposure (via 5-OH-mono-ethylhexylphthalate) significantly decreased in Germany from 25.3 µg/l (1988) to 9.6 µg/l (2008), in the US exposures decreased from 20 µg/L (2002) to 12.9 µg/l (2010). Following the opposite trend, DiNP exposure (via mono-carboxy-octylphthalate), increased both in the US from 5.4 µg/l (2006) to 12.6 µg/l (2010) and in Germany from 1.2 µg/l (1988) to 3.6 µg/l (2008). Considerable changes in body burdens over time are obvious, depending on the phthalate, but also depending on location (US vs. Germany) and can be partially explained by changing regulations and production/consumption numbers of the phthalates in question.

Keywords: B-phthalates, A-biomonitoring

Tu-O-C3-02

Assessment of Exposure to Multiple Phthalates in the General Canadian Population

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Abstract: Phthalate are ubiquitous environmental chemicals and human exposure to phthalates occurs through multiple routes and pathways. We have estimated daily intake rates for several phthalates in the general Canadian population by age and sex using urinary phthalate metabolites concentrations measured in the Canadian Health Measures Survey (CHMS) Cycle 1 (2007-2009) and Cycle 2 (2009-2011). We have used the creatinine correction approach as well as the urine volume approach in a simple one compartment model to calculate daily intake rates for diethyl phthalate (DEP) in individual survey participants. Both approaches yielded similar daily intake estimates for DEP. Subsequently, we have used the creatinine correction approach to estimate daily intakes for di-n-butyl phthalate (DnBP), di-isobutyl phthalate (DiBP), butylbenzyl phthalate (BBzP), and diethylhexyl phthalate (DEHP) in individual survey participants. Descriptive statistics on the daily intake estimates (µg/kg-bw/day) were derived for the general Canadian population. The geometric mean of daily intake rates in Canadians for DEP, DnBP, DiBP, BBzP and DEHP based on CHMS 2009-2011 data were 1.3, 0.64, 0.43, 0.22, and 0.41 respectively. The corresponding intake estimates (µg/kg-bw/day) based on the CHMS 2007-2009 dataset for DEP, DnBP, BBzP and DEHP were 2.1, 0.93, 0.43 and 0.96. Our data suggest that the exposure to these phthalates in Canadians have decreased between 2007 and 2011. We have also observed that about 70 % of the Canadian population has daily intake estimates for two or more phthalates, among DEP, DnBP, DiBP, BBzP and DEHP, at or above the geometric mean of daily intake rates of respective phthalates.

Keywords: A-biomonitoring, B-phthalates, Daily intake estimates, A-risk assessment

Tu-O-C3-03

DPHP Metabolites in Urine Samples of the German Environmental Specimen Bank from 1999 to 2012

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Abstract: The aim of this study was to investigate a possible time trend and status quo of dipropylheptylphthalate (DPHP) exposure. DPHP is used as a substitute of other high molecular weight phthalates in high temperature applications (e.g cable wires, roofing membranes, etc.). DPHP was selected in the cooperation project between the German Federal Ministry for Environment (BMU) and the German Chemical Industry Association (VCI) due to its listing as High Production Volume (HPV) chemical in the European Union. The BMU-VCI project establishes new human biomonitoring methods and biomarkers for fifty emerging substances. 300 urine samples (24-hour voids) from the German Environmental Specimen Bank were analyzed for three specific, secondary oxidized DPHP metabolites (with hydroxyl, oxo and carboxy modifications of the alkyl side chain). Urine samples were collected in the years 1999, 2003, 2006, 2009 and 2012, 60 samples per year, from 30 male and 30 female volunteers (age: 21-29 years). The samples were analyzed by liquid/liquid extraction followed by GC-HRMS, which enabled us to distinguish between DPHP and Di-iso-decyl phthalate (DiDP) metabolites. The limit of quantification was between 0.15 µg/l and 0.3 µg/l, depending on the metabolite. All samples were blinded before analysis. DPHP metabolites were not detected in the years 1999-2006. Thereafter, detection rates increased from 3.3% in 2009 to 21.7% in 2012. As expected, mono-oxo-propylheptyl phthalate (oxo-MPHP) was the most abundant metabolite, with concentrations between <LOQ and 0.96 µg/l. The daily DPHP intake was calculated via oxo-MPHP with a maximum of 0.32 µg/kg bodyweight/day. Our results show that DPHP exposure has reached the general German population. However, exposure to DPHP is considerably lower than for other high molecular weight phthalates. Future measurements will enable us to monitor the development of DPHP exposure and advise risk management steps, if warranted.

Keywords: A-biomonitoring, B-phthalates

Tu-O-C3-04

Biomonitoring of the industrial alkyl pyrrolidone solvents NMP and NEP: specific metabolites in 24-hour urine samples from the German Environmental Specimen Bank (1996/2012)

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Abstract: N-Methyl-2-pyrrolidone (NMP) and N-ethyl-2-pyrrolidone (NEP) are multi-purpose organic solvents in industry. Both are developmental and teratogenic toxicants in rodents. NMP is classified as a REACh substance of very high concern. Because of their toxicological profile and their broad application resulting in a possible exposure of the general population, NMP and NEP were chosen as target substances for the cooperation project between the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) and the German Chemical Industry Association (VCI) aiming to establish human biomonitoring (HBM) methods for "new" substances of interest. NMP and NEP are metabolized to 5-hydroxy-N-alkyl-2-pyrrolidones (5-HNMP, 5-HNEP) and 2-hydroxy-N-alkylsuccinimides (2-HMSI, 2-HESI). We analyzed these specific metabolites in 24-hour urine samples from the German Environmental Specimen Bank. For this purpose, 20 randomly selected samples collected in 1996 and in 2012, respectively, were analyzed by a sensitive and specific GC-MS/MS method with isotope dilution quantification. We detected NMP metabolites in 100% and NEP metabolites in 95% of all samples. Despite the considerable differences in the elimination half-times of the alkyl pyrrolidone metabolites, the correlations between the metabolites were rather strong (NMP: r=0.51; NEP: r=0.67). An exposure determined through one metabolite is thus confirmed by the other metabolite. Median NMP metabolite levels were comparable between 1996 (5-HNMP 50 µg/L, 2-HMSI 46 µg/L) and 2012 (5-HNMP 39 µg/L, 2-HMSI 41 µg/L). Surprisingly, urinary levels of NEP metabolites were approx. 10 times higher in 1996 (5-HNEP 14 µg/L, 2-HESI 42 µg/L) as compared to 2012 (5-HNEP ~1 µg/L, 2-HESI 5 µg/L). We would have expected a reverse trend for NEP since NEP has only recently been introduced into the market as a substitute for NMP. The sources of past and present exposures to NMP and NEP warrant further investigations.

Keywords: A-biomarkers, A-biomonitoring, A-chemical prioritization, B-VOCs, C-multimedia

Tu-O-C3-05

Urinary Organophosphate Flame Retardants in California Adults

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Abstract: Organophosphate flame retardants (OPFRs) are abundant and found at the highest concentrations relative to other flame retardant chemicals in house dust. Despite their widespread use, little is known about their biological levels and their relationships with house dust concentrations, which provide insight into exposure pathways and potential health risks. We analyzed urine samples from 16 California residents in 2011 for 6 dialkyl phosphates (DAPs), the expected major metabolites of the most prominent OPFRs, and qualitatively screened for 18 other metabolites predicted from in vitro metabolism studies. We detected all 6 DAPs within the range of previously reported levels. We found weakly positive correlations between urine and dust concentrations. The homes with the highest dust concentrations of tris(1,3-dichloro-isopropyl) phosphate (TDCIPP) and tris(2-chloroethyl) phosphate (TCEP) had the highest urinary levels of bis(1,3-dichloro-2-propyl) phosphate (BDCIPP)and bis(2-chloroethyl) phosphate (BCEP), respectively. Metabolite levels of OPFRs were correlated for many OPFR combinations, suggesting they commonly co-occur. To our knowledge, this is the first study to measure these 6 DAP metabolites simultaneously and to detect other OPFR metabolites in US urine samples. We recommend biomonitoring studies include these 6 DAPs as well as several additional compounds detected through qualitative screening and previous ADME studies. OPFRs represent a class of poorly-studied commercial chemicals with widespread exposure, and raise concerns for health effects including carcinogenicity, endocrine disruption, and neurotoxicity.

Keywords: A-biomonitoring, B-flame retardants, A-indoor environment

Tu-S-D3: Hydraulic Fracturing and Its Potential Impact on Environment and Public Health

Tu-S-D3-01

Technology and Policy Impediments to Monitoring for the Potential Health Impact of Unconventional Gas Development

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Abstract: The dramatic increase in unconventional gas drilling (UGD) for natural gas tightly bound to deep underground shale layers has led to public concern for health and the environment, and to numerous individuals who believe that their health has been adversely affected. Exposure assessment is key to determining whether there is a causal linkage. But there are a wide array of challenges to effective exposure assessment. These include the diversity and rapid evolution of technical approaches to UGD, including the hydraulic fracturing compounds used; the many potential failure points at the drilling sites as well as upstream and downstream that could lead to exposure; the diversity of the safety culture of the companies involved and their willingness to cooperate with exposure studies; the enormous temporal variability in potential air and water releases; the relative paucity of regulatory oversight tools; and the perhaps intentional lack of engagement in many jurisdictions of health professionals in deliberations concerning UGD.

Keywords: shale gas, A-environmental policy, A-environmental regulation

Tu-S-D3-02

Exposures and Environmental Effects from Hydraulic Fracturing in Colorado

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Abstract: Oil and gas development using unconventional methods, i.e., directional drilling and hydraulic fracturing, has expanded dramatically across the US in recent years. Well pads and associated infrastructure are increasingly in close proximity to communities, thereby raising public concern about exposure to a wide range of stressors and their related health impacts. This presentation explores the use of both Public Health and Ecosystem Services approaches to address the complex trade-offs that accompany fossil fuel development using this technology by exploring impacts to air water, soil on a range of spatial scales and their implications for exposure science and health assessments.

Keywords: A-aggregate exposure

Tu-S-D3-03

Assessing Potential Unconventional Natural Gas Drilling-Related Residential Exposures

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Abstract: Unconventional natural gas drilling (UNGD), an industry currently impacting areas all over the U.S., often occurs close to residential areas. Few studies regarding the potential for chemical exposure and health impacts on people living near UNGD have been conducted. We monitored air and water from 14 residences in 4 different counties of southwest PA in the summer of 2013. Inclusion criteria were non-smoking households that utilized ground water as their primary water source. UNGD-proximate residences (n=11) were located < 0.5 miles of a UNGD facility, and control homes (n=3) were located > 3 miles from any drilling-related facility. Half of the UNGD-proximate homes had previously self-reported adverse health complaints, which residents attributed to UNGD. Questionnaires assessing demographics, household activities related to air quality, and perceived stress levels were administered at time of monitoring. Indoor and outdoor $PM_{2.5}$ in UNGD-proximate homes ranged from 5.1 - 21.5 and 9.3 - 19.8 $\mu g/m^3$, respectively. $PM_{2.5}$ levels were comparable to those observed in control homes and none exceeded 35 $\mu g/m^3$, our "criteria of concern". Indoor NO_2 (13.2 $\pm$ 4.0 ppb, mean $\pm$ SEM), outdoor NO_2 (7.1 $\pm$ 0.5 ppb), and outdoor O_3 (25.5 $\pm$ 2.8 ppb) at UNGD homes were below our criteria of concern. Thirty-five percent of all the sampled homes contained at least one VOC > than the 90th percentile seen in previous EPA studies. Twenty-two percent of UNGD-proximate homes and 33% of control homes revealed concentrations of benzene, toluene, ethylbenzene, and xylenes > 90th percentile value reported. Water tests showed a wide variation in metal content, but none exceeded a primary minimum containment level (MCL) for any metal and no UNDG-dependent differences between homes were apparent. Methane, ethane, and ethylene in water from all homes were below the U.S. Dept.of Interior Federal Standard (10-28 µg/L). Our pilot results will guide and inform future exposure assessment strategies.

Keywords: A-indoor environment, A-risk assessment, B-VOCs, A-environmental policy, unconventional natural gas drilling

Tu-S-D3-04

Cytotoxicity and Epigenetic Effects of Post-hydraulic Fracturing Flow back Waters in the Marcellus Shale from Pennsylvania

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Abstract: The rapid development of high-volume horizontal hydraulic fracturing (HVHHF) for mining natural gas from shale has posed potentially serious impacts on human health and biodiversity. The produced flowback waters after hydraulic stimulation is known to carry high levels of saline and total dissolved solids (TDS). To understand the toxicity and epigenetic effects of these waste waters, we analyzed produced/flowback water from 5 Marcellus wells from Pennsylvania. We characterized the composition of these samples by inductively coupled plasma mass spectrometry (ICP-MS) and scanning electron microscopy (SEM)/ energy dispersive X-ray spectroscopy (EDX). ICP-MS indicated barium (3776.58±609.01 ppm) and strontium (2309.6±881.68 ppm) are most abundant metals in these samples. The G12 system was used to analyze the mutagenesis and epigenetic gene silencing effect of flowback samples. A cytotoxicity study using colony formation assay was carried out to decide LC50 of these samples on the human bronchial epithelial cells (Beas-2B) with 7 days repetitive treatment. The LC50 was calculated to be ~2.7 %(v/v). A concentration dependant colony formation in soft agar was observed in cells treated by flowback waters for 6 weeks. Studies of the flowback water transformed cells show a slightly faster growth rate and better migration capability when compared to control cells. Our study will help understand the potential health effect of post-hydraulic fracturing flowback waters in the Marcellus shale. (Supported by a supplement to NIEHS Center grant #ES 000260)

Keywords: C-water

Tu-S-D3-05

Public Perceptions of Shale Gas Drilling in Eastern Pennsylvania

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Abstract: While shale gas drilling has occurred for many years in Texas and other places, it has increased dramatically in the northeast, particularly in Pennsylvania. The technology, which has changed somewhat over

the last decades, has resulted in information gaps and health concerns for both humans and ecological receptors. We explore public perceptions and concerns about shale gas drilling with a framework of energy alternatives and environmental health. Surveys were conducted in areas with gas drilling, and in nearby New York and New Jersey where no gas drilling occurs. The survey results from homes located in the areas with and without fracking sites are compared and contrasted. As expected, there were significant differences within these populations with respect to overall concern, health concerns, and information sources. This information is useful for a range of public policy makers, health professionals, and the public.

Keywords: Public Perception

Tu-S-E3: The ExpoDat Initiative: Exposure-Informed Chemical Safety Assessment for High Throughput Prioritization - I

Tu-S-E3-01
The ExpoDat Initiative: Exposure-Informed Chemical Safety Assessment for High Throughput Prioritization

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Abstract: This presentation will serve as an introduction to the ExpoDat Initiative and set the stage for the Symposium. In 2012, the ExpoDat Initiative was begun to evaluate approaches to consider exposure for targeted testing and risk assessment across a broad range of chemicals. A June 2012 workshop gathered international experts in exposure science from governmental agencies, academia, and industry to explore exposure determinants in high-throughput exposure assessment. The workshop objectives were two-fold: (1) identify and prioritize determinants for near-field and far-field exposures of the general population to chemicals; and (2) consider near-term priorities for assimilation and/or development of relevant data to inform these determinants. A case study approach was used to address the immediate needs for rapid exposure assessment, i.e., approaches that maximize use of available information to efficiently provide estimates of exposure potential. The case study was specifically designed to evaluate a tiered approach for generating exposure estimates for a large group of chemicals that have little or no exposure measurement data and to test this approach using oral equivalent dose data for a subset of the ToxCast™ Phase II chemicals. The workshop results were presented at the 2012 ISES meeting. A November 2013 working meeting among exposure experts reviewed results from ongoing work on the case study that used exposure modeling approaches from three researchers funded by the Long-Range Research Initiative of the American Chemistry Council. Other tools for estimating exposures that could be incorporated into a tiered approach were discussed. This symposium will 1) highlight the results from the recent ExpoDat efforts, 2) present other related high-throughput exposure prediction methods, and 3) discuss priority data needs that support the various high-throughput approaches.

Keywords: A-exposure models, A-risk assessment

Tu-S-E3-02
The Long-Range Initiative (LRI) ExpoDat Modeling Case Study

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Abstract: This series of presentations will provide a summary of the methods and initial results of a case study for high-throughput risk assessment and prioritization of 229 chemicals. Exposure estimates, calculated as daily chemical intake rates (iR; mg/kg/day), were compared with effect estimates known as oral equivalent doses (OED; mg/kg/day), calculated from in vitro bioactivity data that has been adjusted for chemical dosimetry. It is emphasized that chemical exposures meeting or exceeding OED values do not necessarily infer the potential for adverse effects. Exposures were calculated for all relevant use categories for each compound. For each chemical and use category, physical-chemical properties and mass balance models were first used to calculate the intake fraction (iFs; mass taken in by an individual or the population per mass emitted to the environment), or the product intake fraction (PiFs: mass taken in by an individual or the population per mass of chemical in product) in the case of personal care product applications. The iF is then multiplied by the estimated quantity emitted, applied, or ingested (Q; e.g., mg/day) to determine exposures, where essentially iR = Q × iF. The

values for Q are estimated from the total production volume of the compound and, for consumer products, an estimate of the size of the user population. Overall, the Tier I approach leads to results that are useful as a preliminary high-throughput estimate of exposure and may help identify chemicals of concern. Results may be improved if there were more (and accurate) input data available related to use categorization and the mass of chemical allocated to various uses. Sales volume data and concentration of chemical in products for food or cosmetic items, for example, would help enable more accurate modeling of exposure. It is emphasized that in terms of their chemical properties these 229 chemicals are not fully representative of the more diverse universe of chemicals used by society.

Keywords: A-exposure models

Tu-S-E3-03
The Long-Range Initiative (LRI) ExpoDat Modeling Case Study
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Keywords: A-exposure models

Tu-S-E3-04
The Long-Range Initiative (LRI) ExpoDat Modeling Case Study
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estimate of the size of the user population. Overall, the Tier I approach leads to results that are useful as a preliminary high-throughput estimate of exposure and may help identify chemicals of concern. Results may be improved if there were more (and accurate) input data available related to use categorization and the mass of chemical allocated to various uses. Sales volume data and concentration of chemical in products for food or cosmetic items, for example, would help enable more accurate modeling of exposure. It is emphasized that in terms of their chemical properties these 229 chemicals are not fully representative of the more diverse universe of chemicals used by society.

Keywords: A-exposure models

Tu-S-E3-05
The Long-Range Initiative (LRI) ExpoDat Modeling Case Study
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Abstract: This series of presentations will provide a summary of the methods and initial results of a case study for high-throughput risk assessment and prioritization of 229 chemicals. Exposure estimates, calculated as daily chemical intake rates (iR; mg/kg/day), were compared with effect estimates known as oral equivalent doses (OED; mg/kg/day), calculated from in vitro bioactivity data that has been adjusted for chemical dosimetry. It is emphasized that chemical exposures meeting or exceeding OED values do not necessarily infer the potential for adverse effects. Exposures were calculated for all relevant use categories for each compound. For each chemical and use category, physical-chemical properties and mass balance models were first used to calculate the intake fraction (iFs; mass taken in by an individual or the population per mass emitted to the environment), or the product intake fraction (PiFs: mass taken in by an individual or the population per mass of chemical in product) in the case of personal care product applications. The iF is then multiplied by the estimated quantity emitted, applied, or ingested (Q; e.g., mg/day) to determine exposures, where essentially iR = Q × iF. The values for Q are estimated from the total production volume of the compound and, for consumer products, an estimate of the size of the user population. Overall, the Tier I approach leads to results that are useful as a preliminary high-throughput estimate of exposure and may help identify chemicals of concern. Results may be improved if there were more (and accurate) input data available related to use categorization and the mass of chemical allocated to various uses. Sales volume data and concentration of chemical in products for food or cosmetic items, for example, would help enable more accurate modeling of exposure. It is emphasized that in terms of their chemical properties these 229 chemicals are not fully representative of the more diverse universe of chemicals used by society.

Keywords: A-exposure models

Tu-O-F3: Indoor Environments - III

Tu-O-F3-01
Noise Monitoring in Children's Home Environments
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Abstract: Background: Noise exposure has been associated with negative birth outcomes, reduced cognitive function, and increased blood pressure in children. However, research about environmental noise exposures is sparse and often the measure of exposure is simply proximity to a noise source. In particular, noise in homes and other public environments has not been well characterized, but is known to be generally lower (but potentially more variable) than workplaces. Initial testing of available monitors to evaluate location and duration of sampling in homes will identify suitable candidate measures/monitor(s) and sampling procedure for scale up. Methods: Three candidate noise monitor types were selected for a pilot test of home environments: sound level meter (SLM), dosimeter (DM), and an iPod with AudioTools/SPL Graph application. One of each monitor was placed in two rooms in nine volunteer homes with a young child (age 2-4 years) for 7 days. A noise questionnaire was administered at setup. A daily noise source log was also completed by the participant. Results: The monitors were successfully deployed in all homes, with all noise source logs completed. The homes varied by type, by area (rural/suburban), distance from an airport or highway, and number of residents.

Comparison of peak and average sound pressure level as well as 1/1 octave band measurements, across and between monitors, room types, and homes to evaluate accuracy of the monitors and suitability for a week long measurement period showed good comparability between SLM and DM. In most homes the noise patterns in the different rooms mirror each other and the sound pressure levels at night are lower in the bedroom than in the most used room; the hourly average varied from 20 to 80 dBA. Conclusions: Test results were used to recommend a monitor for 36-month old study visits in the National Children's Study. Results can be used by other researchers to select noise monitoring devices and configurations.

Keywords: Noise, D-children, A-indoor environment

Tu-O-F3-02
Assessing Exposure to Mixtures and their Effects
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Abstract: Epidemiology and toxicology studies typically examine the health effects of one exposure at a time, while in the real world we are exposed to a multitude of substances. Exposure scientists often measure numerous compounds at once, depending on the type of sample and analytical chemistry methods. We face two general, interconnected problems: 1) what are the patterns of co-exposure and how do they depend on factors such as demographics? 2) What are the effects of exposure to mixtures and how should they be analyzed? This paper will review methods for both problems, focusing on the second. Both epidemiology and toxicology define "synergism" and "antagonism" with respect to a null model of no interaction. But the two differ dramatically with respect to the definition of the latter. Epidemiologists define interaction as deviation from additivity as measured on a linear scale. Mixtures toxicologists reject this definition because it has the logical consequence of a compound interacting with itself if it has a non-linear dose-response curve. Instead, they use the null models of concentration addition for compounds that act by similar mechanisms and independent action for compounds that act by different mechanisms. Concentration addition is perhaps most familiar through its special case of toxic equivalent factors (TEFs), as are used for dioxin-like compounds. Concentration addition has recently been generalized to allow examination of mixtures of full and partial agonists, both of which are common for important cellular receptors. Progress on both mathematical/statistical analysis of mixtures and the analytical chemistry of non-targeted analysis imply that exposure sensors based on reporter assays may be able to measure certain aspects of the exposome while integrating their biological effect. This technique may be particularly well suited to analyzing endocrine disruptors.

Keywords: A-aggregate exposure, A-cumulative exposure, A-epidemiology, A-statistical methods, endocrine disiruptors

Tu-O-F3-03
Combined exposure to harmful indoor air pollutants in Europe
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Abstract: Exposure to air pollutants occurs mainly within the indoor built environment, considering the significant amount of time spent daily indoors. Exposure may vary significantly depending on the proximity to traffic sources (PM, NO2) the presence of indoor emissions from combustion sources such as biomass for space heating (PM, PAHs) and smoking (PM, PAHs, VOCs, carbonyls), building materials (VOCs), furnishing (carbonyls and phthalates) and consumer products (phthalates, flame retardants, PCBs and pesticides). In order to provide a comprehensive assessment of the cumulative exposure and the associated risks, a systematic review of existing indoor levels for all the compounds mentioned above was carried out and a well-established methodology for exposure and risk assessment/characterization was applied on the data collated. Data on concentrations were clustered according to the chemical family, the indoor setting and the country. Occupants are continuously exposed to a cocktail of carcinogens (benzene, formaldehyde, PAHs) endocrine disruptors (phthalates, PCBs and flame retardants) and allergens (PM, VOCs and biological allergens). Based on average country/setting concentration data, cumulative exposure and the associated risks for several endpoints from plausible exposure combinations were estimated. The combined effects of these chemicals are still not sufficiently elucidated, since their physico-chemical and biochemical properties would favour multiple ways of interaction upon human uptake; there might be synergies in effect (e.g. PAHs and nitrosamines of second hand smoke, both causing lung cancer), or they might inhibit each other's metabolism - this is the case for the almost ubiquitous indoors BTEX mixture. However, notable effect modifications to asthma exacerbation were identified

even at low levels of exposure to different combinations of individual VOCs or higher susceptibility to low VOCs and formaldehyde levels after sensitization by biological allergens.

Keywords: A-built environment, A-activity patterns, A-cumulative exposure, A-epidemiology, A-risk assessment

Tu-O-F3-04
Evaluation of the Influence of a Combined Dust Reducing Carpet and Air Filtration Intervention on the Indoor Air Quality in a Primary School

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Abstract: Schools in neighbourhoods with poor ambient air quality and/or high noise levels cannot rely on natural ventilation to improve indoor air quality (IAQ). Since many primary schools do not have a ventilation and filtration system, there is interest in alternative solutions. Laboratory tests show promising results for dust reducing carpets and compact air filtration systems but there is no information on the field performance of such interventions. The objective of this study was to evaluate the combined effect of a dust reducing carpet and a compact air filtration system on the IAQ in a classroom in a real life setting. IAQ measurements were performed in two classrooms, each occupied by 27 children. Measurements of PM-10 and PM-2.5 were performed by filter sampling and aerosol spectrometry. Other parameters included black smoke (BS), volatile organic compounds (VOC), NO_2 and formaldehyde. Both interventions were introduced in one classroom during one week, using the other classroom as a reference. In a second week the interventions were moved to the other classroom. In three additional weeks the class rooms were compared without interventions. An evaluation of the interventions in an unoccupied classroom was conducted over the weekend. In the weekends the interventions resulted in reductions of PM-10 and PM-2.5 and their derived respective BS values, ranging from 70 % to > 90 %. During the lessons these reductions were 33-42 %. Levels of VOC, NO_2 and formaldehyde were rather low and showed much variability within and between the classrooms. Because of this a contribution of the interventions to the reduction of gas-phase compounds remained inconclusive A field test of a dust reducing carpet and a compact air filtration system yielded a consistent reduction of all PM-parameters in both filter measurements and aerosol spectrometry. Much higher reductions were observed over the weekend, suggesting an interaction of occupancy with the effectiveness of the interventions.

Keywords: A-indoor environment, D-children, B-VOCs, B-particulate matter, C-air

Tu-O-G3: Traffic-Related Exposures - III

Tu-O-G3-01
A Modeling System to Examine Near-Road and Near-Source Air Toxics for Community-Scale Cumulative Assessments

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Abstract: Cumulative assessments consider a range of potential stressors that might impact the health of a receptor, such as a local neighborhood or wetland area. When receptors are located near pollution sources such as highways or ports (within 500-1,000 m), then they could be at risk of increased exposure due to greater pollutant concentrations. We developed a near-road and near-source modeling system to estimate outdoor air toxic concentration gradients near these sources. The system is currently called C-Line, the Community Line-Source Modeling System. C-Line uses various types of publicly available input parameters, such as traffic counts and emission volumes, within a user-friendly interface. The term "system" is based on the ability to easily download publicly-available input datasets (or upload specific, locally-collected datasets), to vary input parameters and examine differences in scenarios (e.g., increase traffic or diesel on a given roadway), and visualize results and differences between results for different scenarios. Various geographic areas will be presented as case studies, along with the role of the near-source pollution within the context of other chemical and non-chemical stressors to which these communities are potentially exposed, including other pollution sources and perceived stressors. C-Line results can be used to inform decisions about citizen science campaigns, educate users on relative risks in their community, or to support research on near-source air toxics exposures.

Keywords: A-cumulative exposure, A-environmental justice, A-exposure models, D-vulnerable, D-susceptible

Tu-O-G3-02

Mitigating Commuter Exposure to Air Pollution: How Does Choice of Route and Mode Influence Exposure?

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Abstract: Road traffic is one of the largest sources of air pollution in almost every city in the world. Commuters are at particular risk of exposure because of their daily proximity to road traffic throughout their working lifetimes. Whether a commuter can act to mitigate their exposure, such as through their choice of route and transport mode, is an important question to answer, if mitigation strategies are to be developed to reduce exposures. The Fort Collins Commuter Study is a 5 year study investigating personal exposure to air pollution, using a variety of measurement and modelling approaches. The study collected personal exposure measurements during ~800 real commutes between September 2012 and February 2014. The study used a repeated measures panel design, whereby 46 individual commuters travelled by different modes (car, bicycle) and routes multiple times. The study design enabled assessment of whether an individual's choice of route and mode impacted their exposure to a range of pollutants. Exposure to black carbon, carbon monoxide, particulate mass, particle number, volatile organic compounds, nitrogen dioxide and noise intensity were measured at 10 second resolution alongside environmental variables. The commuter's routes were tracked using GPS, thus enabling detailed spatial and temporal analysis of their exposure. Initial results indicate that cyclists can substantially reduce their exposure by taking alternative routes. Car drivers have more difficulty reducing their exposure, partly because longer routes are needed to avoid heavily-trafficked roads. Cyclists tended to experience higher levels of exposure to particulate pollutants, whereas drivers were exposed to higher levels of gas-phase pollutants.

Keywords: A-exposure factors, Commuting, Transport, Commuting, Transport, A-epidemiology, B-particulate matter

Tu-O-G3-03

Evaluation of Traffic Density Parameters as an Indicator of Near-road Black Carbon Pollution: A Case Study with NEXUS Measurement Data

J. Xue, J. Burke, S. Liu, F. Chen; EPA, Durham, NC

Abstract: Near-road exposure to traffic-related air pollutants has become a focus of health risk studies. Some studies have shown effects of traffic density on the respiratory diseases. Traffic density is parameter integrating major road and traffic count. To better understand the correlation between the traffic density parameters and actual air pollutant concentrations we used measurement data from the US Environmental Protection Agency (US EPA)-sponsored Near-road EXposures and effects of Urban air pollutants Study (NEXUS) collected at about 30 locations across Detroit at various distances from major roadways with different traffic characteristics during two seasons (Fall 2010 and Spring 2011). For the correlation assessment we compared black carbon (BC) concentrations against different traffic density parameters. The average BC concentrations during a day showed variations consistent with the change in traffic volume which was classified into three categories of low, medium, and high for detailed studies. We found mean BC concentrations for the low, medium, and high traffic hours are 0.45, 0.64, and 0.94 ug/m3 respectively for the fall season and 0.35, 0.44, and 0.59 ug/m3 respectively for the spring season. Major-Road Density (MRD), All-Traffic Density (ATD) and Heavy-Traffic Density (HTD) gave an average correlation coefficient of 0.26, 0.18 and 0.48, respectively for the combined BC concentrations of all seasons and all distances from the major road. HTD, which includes only heavy duty diesel vehicles in the traffic count, gives statistically significant correlation coefficients for all near road distances (50, 100, 150, 200, 250, and 300 m) analyzed. Generalized linear model (GLM) analyses show that season, traffic volume, HTD and distance from major roads are highly related to BC measurements. Our analyses indicate that traffic density parameters may be useful indicators of near-road BC concentrations for health risk studies.

Keywords: A-geospatial analysis/GIS, C-air, near-road pollution, traffic density

Tu-S-A4: Pesticide Exposure and Risk Assessment - III

Tu-S-A4-01
The Role of Pesticide Incident Databases in EPA Risk Assessments and Regulations
E. E. Evans; US EPA, Washington, DC

Abstract: The EPA's Office of Pesticide Programs' (OPP) mission is to protect human health and the environment from unreasonable effects of pesticide use. Prior to registering a pesticide, OPP conducts human health risk assessments to determine the conditions under which a pesticide can be used without resulting in adverse effects. OPP uses information from a variety of sources to understand better whether registered pesticides are causing unanticipated adverse acute and chronic effects on human health. Pesticide incident data can be an important source of information for risk assessments. EPA collects incident data, which primarily represent acute health effects, through Section 6(a)(2) of the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) which mandates registrants to submit information about adverse outcomes resulting from exposure a pesticide for which they hold a registration. These submissions are collected into OPP's Incident Data System (IDS). The Sentinel Event Notification System for Occupational Risk (SENSOR)-Pesticides data is now routinely incorporated into the incident scoping work as well. The Tier I reports makes recommendations on whether there is a need for a more in-depth Tier II analysis. A recommendation for further in-depth analyses across a broader set of available incident data sets and an additional review of available epidemiological studies and human toxicology and medical case reports are made based on high frequency and/or severity of incidents in IDS and SENSOR-Pesticides or the preliminary Agricultural Health Study results for a particular active ingredient. These detailed Tier II reviews include data analyses from: IDS, SENSOR-Pesticides, the California Department of Pesticide Regulation (CDPR) Pesticide Illness Surveillance Program (PISP), the National Pesticide Information Center (NPIC), and American Association of Poison Control (AAPCC) annual reports. EPA/OPP also collaborates with Health Canada's pesticide incident data team.

Keywords: B-pesticides

Tu-S-A4-02
An Overview of the SENSOR-Pesticides Program
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Abstract: It is important to conduct public health surveillance to promptly identify any adverse effects to humans from pesticide exposures. Data gathered through surveillance efforts can guide prevention activities, including enforcement, and/or regulatory interventions. Recognizing the importance of pesticide poisoning surveillance, the National Institute for Occupational Safety and Health (NIOSH) provides funding and technical support to state health departments through the Sentinel Event Notification System for Occupational Risk (SENSOR)-Pesticides program. The SENSOR-Pesticides program is also partially funded by the EPA. A total of 12 states participate in the SENSOR-Pesticides program. These health departments obtain case reports from many different sources. The three leading report sources are other government agencies (e.g. the state department of agriculture), poison control centers, and workers' compensation. All cases conform to a standardized case definition. Detailed information on each case is collected by the state agencies in a standardized manner, using standardized variables and a severity index. Between 1998 and 2010, a total 8,342 cases of acute occupational pesticide-related illness were identified. The industries that accounted for the highest proportion of cases were Services (30%) and Agriculture (27%). The incidence rate was highest in the agricultural industry, and was an order of magnitude higher than the rate in all other industries combined. Most illnesses were of low severity (80%). Severity was moderate in 19% of cases, and high in 1%. The SENSOR-pesticides program has also identified many emerging pesticide problems. Emerging problems recently identified include acute high severity illness caused by acrolein exposure, a two-fold increased risk of pesticide poisoning among female agricultural workers compared to males, and illnesses related to pyrethrin and pyrethroid exposures.

Keywords: A-workplace, B-pesticides, D-occupational

Tu-S-A4-03
How SENSOR-Pesticides Data is used to Inform Risk Assessments and Worker Safety Regulations
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Abstract: Pesticide incident data can be an important source of feedback for human health risk assessments. Chemical-specific incident scoping is conducted routinely using FIFRA "6a2" data, submitted by pesticide registrants under the statutory requirement. These submissions are collected into OPP's Incident Data System (IDS). SENSOR-Pesticides data is now routinely incorporated into the incident scoping work as well. The incident team within OPP's Health Effects Division systematically looks at human pesticide incident information. This incident team routinely conducts "Tier I" incident analysis in which we describe and summarize incidents reports in terms of quantity and severity of incidents. If there are deaths or incidents classified as of "major" severity, a more detailed review of narrative reports on these incidents is performed. The Tier I report makes recommendations on whether there is a need for a more in-depth Tier II analysis. The SENSOR-Pesticides dataset provides detailed case narratives, reflects circumstances of occupational exposures occurring in agricultural and other industries and applies a rigorous case certainty index. SENSOR-Pesticides data is also useful in helping OPP to provide acute benefit information needed to justify regulatory amendments to improve pesticide worker protections required by the worker safety regulations (40 CFR 170 and 171). Specific applications of SENSOR-Pesticides in recent incident data reviews, and SENSOR-Pesticides data used to inform the Worker Protection Standard (WPS) proposal will be included.

Keywords: B-pesticides

Tu-S-A4-04
Contributing Factors of Acute Paraquat and Diquat-Related Illnesses and Injuries in the United States, 1998 -2010
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Abstract: Herbicides are the most widely used type of pesticide in agricultural and commercial market sectors. Paraquat is one of the most commonly used herbicides in the world while diquat is used less widely. Paraquat and diquat are synthetic, non-selective contact herbicides that cause desiccation and act as defoliants. Data collected between 1998-2010 will be obtained from 11 states that conduct acute occupational pesticide-related illness surveillance as part of the National Institute for Occupational Safety and Health (NIOSH)'s Sentinel Event Notification System for Occupational Risks (SENSOR)-Pesticides Program. Additional data will be obtained from the California Department of Pesticide Regulation (CDPR)'s Pesticide Illness Surveillance Program (PISP) from 1998 - 2010. Persons were considered cases in this analysis if they became ill or injured after exposure to paraquat or diquat, or pesticide mixtures that included paraquat and/or diquat. Contributing factor information will be gathered from several sources: from SENSOR-Pesticides state partners, CDPR, and a NIOSH review of narrative descriptions, documentation of violations identified during investigation, and usage requirements on pesticide labels. The magnitude and trend of acute paraquat and diquat-related illnesses from work-related and non-work-related exposures during 1998 - 2010 will be presented. Characteristics and contributing factors will be determined for acute paraquat and diquat-related illness/injury cases. Because of the high toxicity and widespread use of paraquat, it is important to understand the factors of paraquat/diquat exposure that led to illness/injury.

Keywords: B-pesticides, Surveillance

Tu-S-B4: Exposure Assessment Approaches for Epidemiological Studies and Risk Assessment Applications

Tu-S-B4-01
Evaluating Uncertainty due to Exposure Assessment in Epidemiological Studies
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Abstract: Exposure assessment aims to ascertain the magnitude, duration, frequency and routes of exposure to enable estimation of individual- or population-level exposures. Exposure assessment approaches can be qualitative or quantitative in nature and can reflect indirect or more direct estimates of exposure or dose (internal or bioavailable). Exposure assessment limitations in epidemiological studies can result in varying degrees of measurement error and misclassification bias. Regardless of the complexity of the exposure metrics that are

used, key considerations include approaches to reduce exposure uncertainty such as proper characterization of the primary routes of exposure and different environmental media being considered, consideration of different critical periods of exposure, and examination of the most relevant exposure metrics (e.g. specific biological matrices or monitoring data) for the outcomes being examined. This presentation will address some of the exposure assessment challenges in environmental and occupational epidemiological studies in characterizing specific chemical and non-chemical exposures including the utility of different exposure assessment approaches to inform cumulative risk assessment efforts. This presentation will also include a brief discussion of techniques to reduce and correct for measurement error in exposure estimates.

Keywords: A-epidemiology, A-risk assessment, A-cumulative exposure, A-aggregate exposure

Tu-S-B4-02
Evaluation of Exposure Measurement Error and its Implications for Bias in Occupational Epidemiology Studies
C. Johnson, B. Grajewski; National Institute for Occupational Safety and Health, Cincinnati, OH

Abstract: Exposure measurement error and misclassification are important sources of information bias in epidemiologic studies, including occupational health studies. However, it can be difficult to quantitatively estimate the impact of these biases on study results when validation studies or other detailed information about the nature of biases are unavailable. This presentation will describe qualitative and quantitative methods to evaluate potential for bias from exposure measurement error and misclassification, including generalizable rules regarding the direction of bias and formal quantitative bias analyses. The advantages and disadvantages of each method will also be presented. Additionally, these concepts will be illustrated using a case study of work hours and preterm birth among flight attendants. Hours worked during the first trimester of pregnancy was obtained by self-report and by abstracting individual flight records from the flight attendants' airlines. Flight attendants tended to over-report the number of hours worked compared to hours recorded by the airline. However, flight attendants whose infants were born preterm over-reported the number of hours worked to a greater extent than flight attendants whose infants were born at term. Using self-reported hours and hours from flight records resulted in different conclusions regarding the association between hours and preterm birth. This example demonstrates how exposure measurement error and misclassification have the potential to substantially affect the results of epidemiologic studies and the interpretation of the state of the evidence when conducting risk assessments.

Keywords: A-epidemiology, A-workplace

Tu-S-B4-03
Exposure Assessment for Intraurban Air Pollution: From Models to Sensors
P. Ryan; Cincinnati Children's Hospital Medical Center, Cincinnati, OH

Abstract: Air pollution epidemiology plays an integral role in quantitative risk assessment by providing estimates of association between air pollutants and adverse health effects. Subsequent appraisals of regulatory actions often rely on these estimates of association to gauge their impact on public health. However, sources of error and bias in studies of air pollution epidemiology are rarely considered in risk assessment. For example, current regulations are typically based on aggregate exposure data from central site monitoring stations without consideration or quantification of their potential misclassification of individual-level exposure. This issue is of particular importance for risk assessment of traffic-related air pollutants (TRAP), including elemental carbon and ultrafine particles, which have been consistently linked to adverse health outcomes. Despite advances in air pollution exposure assessment, including increasingly sophisticated dispersion and land-use regression models, imprecise estimates of exposure remain due to the high spatial and temporal variability of these pollutants and individuals' time-activity patterns which may increase or decrease personal exposure. These sources of uncertainty may impact the ability of risk assessors to characterize and quantify human health risks related to these pollutants. The goal of this presentation is to initiate a dialogue between risk assessors and epidemiologists regarding 1) the strengths and limitations of existing model methodologies to estimate individual-level TRAP exposure and 2) the potential benefit of improved measures of exposure, including personal monitoring, to improve estimates of associated health effects and the implication of these in subsequent risk assessment.

Keywords: A-epidemiology, C-air

Tu-S-B4-04
Incorporating Ecological and Epidemiological Data using Linked Micromaps
M. McManus; U.S. Environmental Protection Agency, Cincinnati, OH

Abstract: Ecological monitoring studies have led to the development of spatially balanced probabilistic surveys used to assess the condition of aquatic resources, such as rivers and streams. Results from such surveys can effectively be summarized using linked micromaps to display, for example, the statistical and spatial distributions of stream chemistry conditions among many different watersheds as a series of small maps. Such survey designs can also be used to assess relative risks to stream conditions with respect to several environmental indicators of land use. However, how might linked micromaps be used to integrate more disparate types of ecological and/or human health data? One means of integration is that linked micromaps can simultaneously display multiple variables, with measures of variation, over the same areal units, which is an advantage over traditional choropleth maps. Such a display can assess if similar statistical summaries occur in areal units that are in close proximity to one another. However, a challenge to incorporating ecological and epidemiological data is that the sample frame developed for ecological surveys, and areal units of inferences such as watersheds or ecoregions, are typically different from epidemiological studies focusing on census tract, neighborhood or political boundaries. A cumulative or integrative risk assessment incorporating both ecological and human data will need to integrate and analyze multiple sources of data with different areal units. This presentation will explore how more interplay between the ecological and epidemiological exposure sciences might occur if the use of linked micromaps becomes more standard in assessments of human health and the environment.

Keywords: A-geospatial analysis/GIS, C-streams, A-ecological exposure

Tu-S-B4-05
Evaluating Exposures to Chemical and Non-Chemical Stressors in a Cumulative Risk Assessment
A. Evans[1], J. Wright[2], G. Rice[2]; [1]Oak Ridge Institute for Science and Education, Cincinnati, OH, [2]U.S. Environmental Protection Agency, Cincinnati, OH

Abstract: Toxicological and epidemiological studies involving chemical mixtures (e.g., multi-pollutant exposures) have been increasing. Human health assessment of chemical and nonchemical mixture risk remains rare. Recently, there has been an increased emphasis on integrating nonchemicals (e.g., noise, microorganisms, psychosocial stress) into cumulative risk assessment (CRA). Due to limited evidence regarding the toxicity of and co-exposure to multiple chemical and nonchemical stressors, integration of chemical and nonchemical stressors is difficult. Another focus of CRA is on the identification of vulnerable populations. Some examples of why populations may be vulnerable include: higher exposures to one or more chemical stressor, differential toxicity due to nonchemical stressor exposure, and differential ability to recover from chemical or nonchemical stressor exposure due to genetics, lifestyle, or pre-existing disease. This presentation will illustrate how existing data can be used to 1) evaluate co-exposures to chemical and nonchemical stressors and 2) identify potentially vulnerable populations. It will also include a discussion of the uncertainties associated with CRAs of chemical and nonchemical stressors specifically regarding those related to combining data from various sources (e.g., national and local surveys) and situations with limited data on joint toxicity and/or exposure to these mixtures. Multiple case studies involving exposures to various chemical and nonchemical stressors will be used to aid this discussion. * The views expressed herein are those of the authors and do not necessarily reflect of the views or policies of the U.S. EPA.

Keywords: A-risk assessment, A-cumulative exposure, A-biomonitoring, D-vulnerable, A-environmental justice

Tu-O-C4-01
Disaggregating Source Inputs to Compute Population-Scale Human Exposure: Merging Models and Biomonitoring Data

H. Shin[1], T. E. McKone[2], D. Bennett[1]; [1]University of California, Davis, Davis, CA, [2]University of California, Berkeley, Berkeley, CA

Abstract: Background/Aims: Information about the distribution of chemical-production mass with respect to use and release is a major and unavailable input for calculating population-scale exposure estimates. The objective of this study is to understand the importance of chemical properties and the distribution of total production volumes among different use and release categories on the magnitude of resulting human exposures. Methods: We assumed that the total production volumes are distributed to direct dermal application (e.g., fragrance, cosmetics), indoor residential consumer use resulting in indoor emissions (e.g., couch, vinyl flooring), and outdoor emissions. We used Bayesian approaches that take the total intake from our exposure models as the prior intake distribution and the intake inferred from measured biomarker concentrations in the NHANES survey as the basis for updating. By carrying out a generalized sensitivity analysis, we separated the input parameters for which the modeled range of total intake is within a factor of 2 of the intake inferred from biomonitoring data and those that result in a range greater than a factor of 2 of the intake. This analysis allows us to find the most sensitive (or important) parameters and the likelihood of emission rates for various source emission categories. Results: Chemical properties are a primary determinant of the relative contribution of each exposure pathway within a given class of compounds. For DEHP, pyrene, PBDE-47, and PBDE-153, all low volatility compounds, more than two thirds of exposure derives from outdoor food ingestion. In contrast, for DEP, DiBP, DnBP, BBP, and naphthalene, all relatively volatile compounds, either inhalation (indoor and outdoor) or dermal uptake from direct consumer use is the dominant exposure pathway. Conclusion: The approach from this study provides insights on confronting data gaps to improve population-scale exposure estimates used for high-throughput chemical prioritization.

Keywords: A-chemical prioritization, A-exposure models, B-SVOCs, A-statistical methods, A-biomonitoring

Tu-O-C4-02
Quantifying the Effect of Permanent Dietary Transitions in the North on Human Exposure to Persistent Organic Pollutants

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Abstract: For aboriginal human populations in the Arctic, the main route of persistent organic pollutant (POP) exposure is via traditional food consumption. Previous work by our group indicated that an ongoing dietary transition away from traditional foods and toward imported foods contributes to decreasing POP exposures observed in these populations. To further explore this issue, we expanded the human food chain bioaccumulation model ACC-Human Arctic by including models for organisms deemed to be important elements of a traditional Northern diet (beluga whale, narwhal, caribou). We then parameterized the expanded model to simulate POP intake in two specific aboriginal populations in Canada's North (from the Inuvik region, Northwest Territories and Baffin Island region, Nunavut). Using dietary survey information from initial and follow-up biomonitoring campaigns in both communities, we simulated POP exposures for each individual study participant. We found that the amounts and frequencies of traditional food consumption were the most important predictors of POP exposure. Further, both declining Arctic environmental POP contamination and reduced traditional food consumption contributed significantly to the decrease in human POP concentrations between the initial and follow-up study. Ultimately, our model approach allowed us to characterize the roles of POP emission reductions and dietary transitions in influencing historical POP exposures among two specific Northern communities, and further underscored the importance of accounting for dietary transition behavior in future POP biomonitoring within these populations.

Keywords: A-biomonitoring, A-epidemiology, A-exposure models, B-pesticides, persistent organic pollutants

Tu-O-C4-03
Urinary Flow Rates and Body Mass Index in NHANES: Potential Confounding in Assessments of Obesity and Other Health Outcomes Related to Urinary Biomarker Concentrations

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Abstract: Urinary analyte concentrations are affected both by exposure level and by urinary flow rate (UFR). Systematic variations in UFR with body mass index (BMI) could confound associations between BMI or other health outcomes and biomarker concentrations. We assessed patterns of UFR across age, sex, race/ethnicity, and BMI category in the NHANES 2009-2012 datasets. Geometric mean (GM) UFRs (ml/hr-kg BW) were compared across age-stratified (6 -11, 12-19, and 20+ years) demographic subgroups (sex, race/ethnicity categories, and BMI category). Patterns across BMI category or race/ethnicity based on either urinary concentration or mass excretion rates (ng/hr-kg BW) were assessed in example age groups for three case study chemicals: bisphenol A (BPA), 2,5-dichlorophenol (2,5-DCP), and methyl paraben (MP). GM UFR varied significantly across age groups, from 1.01 ml/hr-kg in ages 6 to 11 to 0.62 ml/hr-kg in adults ages 20+ (p<0.0001). UFR differed significantly among categories of race/ethnicity but not by sex, and varied inversely with BMI category in all age groups by up to three-fold, and also varied inversely with waist circumference. BPA and 2,5-DCP concentrations were positively associated with BMI category; associations were null or reversed based on analyte mass excretion rate. Observed differences in MP concentrations among race/ethnicity were reduced, but not nullified, using urinary excretion rate. Conventional hydration status adjustments did not fully address the effect of flow rate variations. UFR varies systematically with age and BMI category and can confound assessments of exposure-health outcome associations based on urinary analyte concentration or creatinine-corrected concentration.

Keywords: A-biomonitoring, A-epidemiology, A-exposure factors, A-statistical methods

Tu-O-C4-04
Tracking Contributions to Human Body Burden of Environmental Chemicals by Correlating Environmental Measurements with Biomarkers

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Abstract: Background/Aims: The work addresses current knowledge gaps regarding causes for correlations between environmental and biomarker measurements and explores the underappreciated role of variability in disaggregating exposure attributes that contribute to biomarker levels. The objective of this study is to understand the contribution of home-based exposure to human body burden from a simulation study. Methods: Our simulation-based study considers variability in environmental and food measurements, the relative contribution of various exposure sources (indoors and food), and the biological half-life of a compound, on the resulting correlations between biomarker and environment. For two hypothetical compounds with respective half-lives are on the order of days for one and years for the other, we generate synthetic daily environmental concentrations and food exposures with different day-to-day and population variability as well as different amounts of home- and food-based exposure. Assuming that the total intake results only from home-based exposure and food ingestion, we estimate time-dependent biomarker concentrations using a one-compartment pharmacokinetic model. Results: The R2 between wipe and serum concentrations increases with the increasing contribution of home exposure. Although the R2 between wipe and serum measurements is within the same range for the two compounds, the relative contribution of the home exposure to the total exposure could differ by 20%, thus providing the relative indication of their contribution to body burden. Conclusion: The novel method introduced in this paper provides insights for evaluating scenarios or experiments where sample, exposure, and compound variability must be weighed in order to interpret associations between exposure data.

Keywords: A-biomonitoring, A-exposure factors, A-indoor environment, C-food, A-aggregate exposure

Tu-O-C4-05
Urinary Polycyclic Aromatic Hydrocarbons and Neurodevelopmental Outcomes in Children from the National Health and Nutrition Examination Survey, 2001-2004
S. S. Kim, A. Askey, A. Richter, H. Zhang, K. N. Dietrich, A. Chen; University of Cincinnati, Cincinnati, OH

Abstract: Prenatal exposure to polycyclic aromatic hydrocarbons (PAHs) has recently been associated with increased anxiety, depression, attention deficits, and decreased cognitive function in children, but the research on postnatal PAH exposure is scarce. We analyzed data from 1,484 children aged 6-15 years from the U.S. National Health and Nutrition Examination Survey (NHANES) 2001-2004. We used two indicators for exposure: the sum of the low molecular weight PAH metabolites (SUMLMWPAHs, including 1- and 2-hydroxynaphthalene, 2- and 3-hydroxyfluorene, 1- and 2- and 3-hydroxyphenanthrene) and the high molecular weight PAH metabolite (1-hydroxypyrene). We examined the associations between urinary PAH metabolite concentrations and self-reported diagnosis of attention deficit hyperactivity disorder (ADHD), learning disability (LD), and receiving special education. We calculated weighted odds ratios (ORs) and 95% confidence intervals (CIs) of PAH metabolites after adjustment for survey year, age, race, sex, US born status, maternal age at birth, education of reference person in the household, poverty income ratio, maternal smoking during pregnancy, environmental tobacco smoke, and blood Pb levels. About 9% of the children had ADHD, 12.2% had LD, and 10.8% received special education. The median for urinary SUMLMWPAHs and 1-hydroxypyrene was 4223 and 73 ng/g creatinine, respectively. For a unit increase in natural log-transformed SUMLMWPAHs, the adjusted ORs were 0.85 (95% CI 0.66, 1.11) for ADHD, 1.05 (95% CI 0.76, 1.44) for LD, and 1.20 (95% CI 0.90, 1.58) for receiving special education. Analogously for 1-hydroxypyrene, the adjusted ORs were 0.91(95% CI 0.70, 1.19) for ADHD, 0.85 (95% CI 0.62, 1.15) for LD, and 1.02 (95% CI 0.75, 1.39) for receiving special education. We observed no significant associations between urinary PAH metabolites and ADHD, LD, and special education in children, probably due to very short half-life of PAHs in urinary samples.

Keywords: B-SVOCs, D-children

Tu-S-D4: Unique Exposures in a Post-disaster Environment

Tu-S-D4-01
Mold and Other Allergen Concentrations in the Homes of Children with Asthma after Hurricane Katrina in the Head-Off Environmental Asthma in Louisiana (HEAL) Study
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Abstract: The city of New Orleans, LA was severely impacted by flooding and wind damage following landfall of Hurricane Katrina in August 2005. Thousands of homes were water-damaged resulting in the rapid growth of microbial agents. In response to mold exposure and health effects concerns, we evaluated mold and other allergen exposures and asthma morbidity in Post- Katrina New Orleans children from the Head-off Environmental Asthma in Louisiana Study (HEAL). The children (N=182) were aged 4-12 years, had moderate-to-severe asthma, and underwent clinical evaluations to determine asthma morbidity. From March 2007 to April 2009, dust was collected from the children's bedrooms at baseline, 6- and 12- months and evaluated for dust mite, cockroach, mouse, and Alternaria by immunoassay. Air samples were collected from indoors and outdoors of their homes and evaluated for mold spore concentrations. Overall, average fungal concentrations at baseline were 501 spores/m3 for indoor and 3958 spores/m3 for outdoor air samples. The 5 most common indoor air fungi were Basidiospores Cladosporium, Ascospores, Penicillium-Aspergillus, and Curvularia. Indoor air mold levels were 627 for flooded versus 438 spores/m3 for non-flooded homes (p =0.07). Percent allergen levels detected in dust were: Alternaria (98%), mouse (60%), dust mite (35%) and cockroach (20%). In conclusion, the results indicate non-mold allergens were at low levels compared to other studies within and without the region; however, airborne levels of indoor mold tended to be higher in flood-damaged homes.

Keywords: D-children, A-indoor environment, B-microbial agents, A-epidemiology, Asthma, Mold, Katrina

Tu-S-D4-02

Exposure Metrics for the Children's Health after the Storms (CHATS) Study Cohort

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Abstract: Children's Health After the Storms (CHATS) is an environmental health study of children in Louisiana and Mississippi who had lived in areas affected by Hurricanes Katrina and Rita conducted during 2012-2013. As part of CHATS, a substudy was designed to examine how indoor and outdoor air pollutant measurements compare with personal measures to determine if there is a relationship between these exposure measurements. We conducted two 7-day environmental exposure assessments on 104 children enrolled in CHATS. Particulate matter (PM10), second-hand smoke (SHS), and gaseous pollutants were sampled in the current residences. The personal measurements of PM10 and SHS (mean: 38 µg/m3, 20 µg/m3, respectively) were highly correlated with indoor concentrations ($r > 0.8$), but not with outdoor measurements ($r < 0.2$). Benzene and formaldehyde showed a similar pattern. The strong correlations between personal and indoor measurements suggest that a large portion of personal exposure to these pollutants occurs inside the home. Compliance in wearing the personal monitor may have also influenced the measurements. However, among the subgroup with higher personal monitor wearing compliance, personal exposure measurements deviated up to 300% for SHS and 50% for PM10 from corresponding indoor concentrations, also suggesting that SHS exposures are significantly increased by proximity to smokers in indoor homes. This study demonstrates the need for personal monitoring to accurately measure contaminant exposures. The accuracy of the personal exposure measurements is influenced by the participants compliance with study protocols. These findings will enable researchers to design exposure assessment strategies that can be rapidly implemented and provide the highest quality exposure data in the event of an environmental catastrophe.

Keywords: D-children, C-air, A-epidemiology, A-sampling methods, A-emergency response

Tu-S-D4-03

An Asessment of Microbial Diversity Inside Homes Affected by Superstorm Sandy

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Abstract: In New York City (NYC), domestic mold contamination has been one of the greatest concerns for public health officials and most common complaints of residents in the aftermath of Hurricane Sandy. In urban settings, asthmatic children could be particularly susceptible to adverse health effects related to fungal exposures following catastrophic water damage. A 2004 Institute of Medicine report and several meta-analyses have concluded that mold and home dampness factors are associated with asthma symptoms. However, a majority of this evidence is based on report of dampness or visible mold and not on measured fungal exposure, limiting these studies from demonstrating 1) that fungal exposure was the causative agent, 2) which species of fungi were associated with the health outcomes and 3) whether specific allergic sensitization is an etiological pathway to the asthma-related morbidity. Recently, advances in molecular-based methodologies (polymerase chain reaction and illumina sequencing) will allow for characterization of fungal profiles associated with water damage, enable monitoring the efficacy of remediation efforts and long-term changes in domestic fungal profiles, and may aid in elucidating the association between fungal exposure and poor respiratory health. With a recent grant from the Centers for Disease Control and Prevention (CDC) we will test the hypotheses that NYC homes with Hurricane Sandy-related water damage will have different fungal species profiles both pre- and post-remediation as compared with NYC homes that were not impacted and that fungal concentrations in homes will be associated with asthma symptoms, airflow obstruction and airway inflammation among asthmatic children. The opportunity to identify fungal species profiles that may serve as tools by other communities in the aftermath of weather events is important for the field and will be the next steps in research.

Keywords: A-epidemiology, D-children, A-biomarkers, A-indoor environment, D-community

Tu-S-D4-04
Air Pollution Exposures During the 2012 High Park Fire

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Abstract: The High Park Wildfire burned over 87,000 acres (353 km2) of forest in Northern Colorado from June 9 to June 30th 2012. The fire was considered the third most destructive in Colorado history, destroying over 250 homes and resulting in one fatality. Smoke from the fire created plumes that stretched from Colorado to Nebraska and Kansas, with severe local impacts to the Front Range communities of Northern Colorado. Ambient fine particle concentrations measured in Fort Collins, CO exceeded several hundred micrograms per cubic meter on several occasions during the fire, with visibility reduced to only a few hundred meters at times. Researchers at Colorado State University conducted a suite of personal exposure measurements for PM10 and PM2.5, in addition to plume dispersion modeling, remote sensing, and community-wide exposure assessment. Personal exposure data were also characterized in terms of aerosol oxidative load using a novel, paper-based microfluidic assay. These data indicate that aerosol reactivity levels measured at the personal level during the fire met or exceed the worst days reported in cities like Beijing or Mexico City over the past decade. Although public health agencies issued several advisories for residents to stay indoors, shut windows, and avoid exercise, there was little that many community members could do to prevent elevated pollutant exposures during the event. Massive biogenic air pollution episodes poses a particular problem for public health messaging and behavioral adaptation for affected communities. In addition, PM produced during peak fire seasons may coincide with other pollutants harmful to health.

Keywords: B-particulate matter, A-sensor technology, D-wildlife, C-air

Tu-S-E4: The ExpoDat Initiative: Exposure-Informed Chemical Safety Assessment for High Throughput Prioritization - II

Tu-S-E4-01
Other Perspectives for Developing Exposure Estimates: "SHEDS-Lite: Rapid Scenario-Based Exposure Predictions for Chemicals with Near-Field and Dietary Pathways"

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Abstract: Creative advances in exposure science are needed to support efficient and effective evaluation and management of chemical risks, particularly for chemicals in consumer products. This presentation will describe the development of EPA's screening-level, probabilistic SHEDS-Lite human exposure model. Using as inputs information on consumer product chemical ingredients, consumer product usage, human activities, chemical properties, and chemical residues in food and drinking water, the model predicts quantitative distributions of chemical exposures resulting from residential near-field or dietary pathways. The exposure scenarios relevant for each chemical are based on the types of consumer products in which the chemical is found. In an initial high-throughput case study, exposure and intake dose results for over 2000 chemicals were summarized by exposure pathway, consumer product category, exposure route (dermal, inhalation, non-dietary ingestion, dietary) and age/gender cohort. The ability of the SHEDS-Lite model to predict human exposures inferred from available NHANES biomarker data (including the identification of critical exposure pathways) was examined. Future efforts will focus on expanding the chemical domain of the model beyond that covered by this initial case study application.

Keywords: A-exposure models, A-chemical prioritization, A-indoor environment, A-aggregate exposure, C-consumer products

Tu-S-E4-02
Other Perspectives for Developing Exposure Estimates: "ExpoCast Framework for Rapid Exposure Forecasts"
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Abstract: The U.S. E.P.A. continues to use high throughput exposure models (simulation) and any easily-obtained exposure heuristics to generate forward predictions of potential exposures from chemical properties. By comparison with exposures inferred via reverse pharmacokinetic modeling from monitoring data in NHANES and other sources, we translate the specific predictions of the forward models into probabilistic forecasts of human exposure. This goal of this ExpoCast framework is to minimize the well-known pitfalls of mathematical modeling by both integrating the predictions of multiple models and empirically evaluating performance over as many chemicals as possible. For the thousands of chemicals with no other data on human exposure, the glass could be considered half full since easily obtained heuristics of exposure can explain more than half the variability in parent chemical exposures inferred from CDC NHANES biomonitoring data. However, the glass is also half empty in that the remaining variance appears to be associated with the well documented differences in exposures between various demographic groups. Additional biomonitoring is needed to develop empirical exposure heuristics for these chemicals. Ultimately, the ability to apply knowledge gained from the extant monitoring data to thousands of chemicals with no other source of information is critical information for determining the human health risk posed by environmental chemicals.

Keywords: A-exposure models

Tu-S-E4-03
Additional Perspectives for Developing Consumer Exposure Estimates: Consumer Exposure Models and Public Data
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Abstract: Within the context of the ExpoDat program, multimedia models have been used to develop screening level consumer exposure estimates. Applying multimedia modeling approaches to consumer exposure assessment (nearfield exposure) is a fairly recent development in Exposure Sciences, and represents one of many approaches that can be used. A number of models specific to developing consumer exposure estimates from direct product use are also available, ranging from screening level to higher tier tools. Available models include ones that cover multiple types of consumer products as well as ones that are focused on a specific product type. The scientific underpinnings of two of the screening level models used in developing submissions under the EU Registration Evaluation and Authorization of Chemicals (REACH) regulation will be discussed: the European Center for Ecotoxicology and Toxicology Targeted Risk Assessment tool and the European Solvent Industry Group's Generic Exposure Scenario Risk and Exposure Tool. To better understand how different modeling approaches compare, results from the REACH screening models, the higher tier ConsExpo model, and available exposure measurements will be compared with ExpoDat multimedia model-based predictions.

Keywords: A-exposure models, C-consumer products, C-multimedia

Tu-S-E4-04
Tiered Testing and Assessment Strategies: Next Steps for Exposure
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Abstract: In response to continually increasing requirements to more efficiently assess and manage larger numbers of chemical substances, pragmatic data-driven frameworks that invoke successive tiers of testing based on consideration of margins of exposure have been proposed. And while the suggested increasingly data informed tiers for hazard are relatively well evolved, development of those for exposure lags well behind, though increasing experience confirms that iterative consideration of exposure contributes significantly to efficient discrimination of priorities. Efforts to date in considering potential for exposure in lower tiers include modeling of simple surrogates or "determinants" of potential for exposure. Though fate and transport models relevant to estimation of environmental (or far field) exposure which rely heavily on physical chemical properties, environmental half-lives, and release rates have potential to contribute, they don't address the most important sources of human exposure (namely, indoor and consumer uses). As a result, the importance of early use

profiling is increasingly being recognized, with efforts for improvement focusing on data mining and inclusion of use-related determinants in proposed early tiers of consideration of exposure. These developments are considered in the context of potential next steps to evolve tiered approaches to the consideration of exposure, which are essential to implementation of tiered testing and assessment strategies.

Keywords: A-risk assessment

Tu-S-E4-05
The ExpoDat Initiative: Operationalizing a Tiered Approach to Exposure Assessments
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Abstract: This presentation will provide concluding remarks for the Symposium. Over the last two years, the ExpoDat Initiative has focused on developing and testing a framework for operationalizing a working tiered approach to high through-put exposure assessments using exposure modeling approaches. While the case study used models developed by three researchers funded by the Long-Range Research Initiative of the American Chemistry Council, the effort is mindful that there are various alternative approaches and is inclusive of these. These additional approaches expand the tools available for estimating exposures that could be incorporated into a working tiered approach. As important, they help further the discussion on how exposure science can be fortified to meet the demands of 21st century exposure assessments beyond the needs of prioritization. From the onset, the value of identifying additional information that could reduce uncertainty in exposure estimates was recognized as a key focus for the ExpoDat Initiative. Recommendations developed during the 2012 workshop will continue to be explored through additional case studies and other approaches.

Keywords: A-exposure models, A-risk assessment

Tu-S-F4: INTEGRA: Integrated Modeling to Predict Internal Exposure to Chemicals

Tu-S-F4-01
INTEGRAted Exposure Assessment - Needs and Perspectives
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Abstract: The INTEGRA project aims to introduce an integrated methodological approach and the respective computational tools for assessing the source-to-dose continuum developed for the entire life cycle of substances covering an extensive chemical space. The major component of INTEGRA will be a unified computational platform that integrates environmental fate, exposure and internal dose dynamically in time and across different spatial resolutions (from local to global). This description requires the use of multimedia and micro-environmental modelling, exposure analysis incorporating multiple pathways and routes of exposure, and Physiology Based ToxicoKinetic (PBTK) modelling. Exposure analysis up to internal dose, will allow the interpretation of actual dosimetry to target tissues to in vitro assay results. This is expected to enhance the overall risk assessment process by fine tuning the dosage used in vitro to the actual internal dose at the target tissue. Biomonitoring data interpretation is another challenge for INTEGRA, through "reverse modeling" calculations for exposure reconstruction. Following this, and based on the amount and quality of prior information, quantitative predictions, ranging from the overall exposure burden up to pathway/route specific information could be made. Another important issue is the applicability domain of such a comprehensive methodology/platform. The aim is to expand the chemical space covered by INTEGRA through automated links to QSAR models for the prediction of physical and biochemical parameters such as partition coefficients. Clearance/elimination kinetics is retrieved from PopGen and the publicly available data from Simcyp. The platform applicability is being extensively validated using human biomonitoring data from Europe and the USA. Overall INTEGRA aims to provide the necessary methodology/computational tool for the transition to next level of risk characterization, shifting from hazard to exposure based risk assessment.

Keywords: A-aggregate exposure, A-environmental policy, A-exposure models, A-biomonitoring, A-life cycle analysis

Tu-S-F4-02
A Methodological Framework for Occupational Exposure Assessment

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Abstract: This presentation will outline the occupational exposure models selected for the INTEGRA project, and discuss the issues involved in combining data from different tools and different exposure pathways. A range of model tools currently exist to estimate occupational inhalation exposure and to a lesser extent dermal and inadvertent ingestion exposure. The Advanced REACH Tool (ART), which is based on a calibrated mechanistic model and Bayesian updating system to incorporate available measurement data, probably represents the best approach to estimate inhalation exposure. The ART model is based on estimating exposure for tasks using a near-field / far-field source-receptor paradigm. The mechanistic model was calibrated using a comprehensive set of measurements. The Bayesian update allows users to enter their own data to allow the model estimates to be refined. Developments on extending the ART to cover dermal exposure have begun, but this tool (DART) is unavailable and we have therefore included an updated version of the DREAM tool to assess dermal exposure. This model includes elements to account for dermal exposure by immersion, surface transfer and deposition. In the INTEGRA platform both the ART and DREAM model tools will allow the effect of personal protective equipment to taken into account. Since the current models for inadvertent ingestion are likely relatively inaccurate and imprecise, and because ingestion exposure is most probably closely associated with hand dermal exposure, we have excluded inadvertent ingestion exposure from detailed consideration.

Keywords: A-exposure models, D-occupational, C-multimedia

Tu-S-F4-03
Internal Dosimetry and Exposure Reconstruction

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Abstract: Exposure reconstruction from biomonitoring (BM) data using reverse dosimetry and physiologically based toxicokinetic (PBTK) models should in theory reduce uncertainty and variability by constraining variability to within physiologically feasible ranges. However, the utility of the PBTK approach depends on the accuracy of the model used to describe the biological system it represents. In this presentation the results from a study will be presented where a range of PBTK models, with increasing levels of biological detail, were used to simulate data generated from laboratory based human volunteer studies where both the BM outputs and the exposure are known. Comparisons were made between predicted and actual data to assess the ability of the models to reconstruct exposure. A workflow will be described where global sensitivity analysis (SA) of the models was used to identify; 1) the most important parameters that determine uncertainty and variability in BM data, 2) how the information was used to reduce the number of model parameters with minimal loss of precision in the estimation of exposure 3) how this significantly reduces the computational cost of these simulations and, 4) how this type of analysis has the potential to inform the prioritization of resources in BM field studies.

Keywords: A-aggregate exposure, A-biomarkers, A-biomonitoring, A-exposure models, A-risk assessment

Tu-S-F4-04
Methodological Issues and Implications for INTEGRA Model Validation: Environmental Exposure Modeling and Human Biomonitoring

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Abstract: Some of the primary challenges that the integrated multi-media and multi-route exposure model in the INTEGRA project tackles, can be sub-divided into two major components: (i) developing a unified computational platform that integrates environmental fate, exposure and internal dose dynamically in time and across different spatial resolutions, and (ii) extensive validation of model outcomes, among others through comparison with actual human biomonitoring data. In the presentation, we will address several of the advances that the INTEGRA project offers in both components mentioned above. Topics that will explicitly be discussed in the presentation are: (i) Refinement of the external computational platform by improving the implementation of several specific exposure pathways in the project platform: a. Improvements for exposure mechanisms/pathways for dermal exposure b. Improvements for object mouthing behavior exposure modelling c. A detailed food consumption pattern, country-, age-, and gender differentiated; (ii) Collection of HBM data for

model validation: a. Identify and collect sources of information that reflect spatial and temporal variability in biomarker data across a large portion of the chemical spectrum (in terms of half-life, exposure frequency, single and aggregate exposure pathways,…). These data will typically be used for forward model validation; b. Relate measured HBM data to different exposure patterns. This issue will typically address aspects of inter- versus intra-individual variability of biomarker data and the value of e.g. spot versus composite urine samples. These data are expected to be very relevant for the backward model validation foreseen in the INTEGRA project. Through specific illustrations, the presentation will show the advances made by the INTEGRA project compared to the existing frameworks, and will additionally outline some of the future directions for the remainder of the project.

Keywords: A-biomonitoring, A-exposure models, C-food, A-exposure factors

Tu-S-F4-05
A Methodological Framework for Occupational Exposure Assessment

A. Sleeuwenhoek[1], K. Jones[2], N. Warren[2], K. Galea[1], D. A. Sarigiannis[3], J. W. Cherrie[1]; [1]Institute of Occupational Medicine, Edinburgh, United Kingdom, [2]Health & Safety Laboratory, Buxton, United Kingdom,[3]Aristotle University of Thessaloniki, Thessaloniki, Greece

Abstract: This presentation will outline the occupational exposure models selected for the INTEGRA project, and discuss the issues involved in combining data from different tools and different exposure pathways. A range of model tools currently exist to estimate occupational inhalation exposure and to a lesser extent dermal exposure and inadvertent ingestion exposure. The Advanced REACH Tool (ART), which is based on a calibrated mechanistic model and Bayesian updating system to incorporate available measurement data, probably represents the best approach to estimate inhalation exposure. Developments on extending the ART to cover dermal exposure have begun, but this tool (DART) will not be available for some time. In the interim, an updated version of the DREAM tool has been judged to offer the best solution. Models to estimate inadvertent occupational ingestion exposure from hand-to-mouth contacts are only just being developed and there is only a screening tool available (iEAT). Since it is likely relatively inaccurate and imprecise, and because ingestion exposure is most probably closely associated with hand dermal exposure, we have excluded inadvertent ingestion exposure from detailed consideration in the project.

Keywords: A-aggregate exposure, A-exposure factors, A-exposure models, A-workplace, D-occupational

Tu-S-G4: Identifying Chemical Hazards in Meat, Poultry, and Egg Products: USDA/FSIS's Integrated and Collaborative Approach

Tu-S-G4-01
FSIS Chemical Hazard Identification, Prioritization, and Management: An Overview

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Abstract: The Food Safety and Inspection Service (FSIS) is responsible for ensuring that the commercial supply of meat, poultry, and egg products is safe, wholesome, and properly labeled. For more than 40 years, FSIS has monitored the levels of certain chemicals in FSIS-regulated products as part of its National Residue Program (NRP). Historically, the Agency has focused on agricultural chemicals, such as veterinary drug and pesticide residues. These chemicals are well-regulated by U.S. FDA or U.S. EPA, who set acceptable levels, called tolerance levels, for these chemicals in edible tissue. Recently, FSIS has redesigned the NRP to become more effective at detecting a greater number of chemicals, including chemical hazards beyond veterinary drugs and pesticides. These changes have included development of a tiered sampling structure and adoption of new, multi-residue analytical methods that allow FSIS to analyze an individual tissue sample for many more chemicals than before. To complement the Agency's increased testing capabilities, FSIS is also strengthening its ability to identify emerging chemical hazards and to prioritize these chemicals for eventual testing under the three-tier NRP. Chemical hazard identification activities are integrated across the Agency's laboratories and headquarters functions and will be discussed in more detail throughout this symposium. FSIS is also implementing a transparent and reproducible approach for addressing chemical hazards in FSIS-regulated products that do not have official "tolerances" set by FDA or EPA. FSIS is particularly interested in collaborating and exchanging data with the International Society of Exposure Science and other similar groups of academics and stakeholders with the goal of improving the mutual understanding of chemicals of concern in meat, poultry,

and egg products. This presentation and the symposium as a whole is a first step toward a fruitful and effective collaboration.

Keywords: A-chemical prioritization, A-environmental regulation, B-metals, C-food, B-pesticides

Tu-S-G4-02
FSIS Laboratory Testing Programs for Chemical Hazard Identification
J. Hill; USDA FSIS, Athens, GA

Abstract: FSIS implemented two exploratory pilot programs during 2013-2014 that attempt to identify unexpected hazards or multiple concurrent hazards in FSIS regulated products. Starting in October 2013 reserves from approximately 30 ground poultry microbiology samples were analyzed each quarter at the FSIS Eastern Laboratory with several chemistry residue methods. The methods include a veterinary drug residue method (LC/MS/MS), an aminoglycoside method (LC/MS/MS), a metals method (ICP-MS), and the TOX 1 method (GC-MS), which are all published in the Chemistry Laboratory Guidebook on the FSIS website. Additionally Food Emergency Response Network (FERN) Cooperative Agreement Program Labs analyzed approximately 300 samples of retail ground beef by the TOX 1 method. The method instrument (GC-MS) was operated in full scan mode and internal standards were included for each sample. Recurring unknown peaks (signal to noise ratio of 10 or better) and/ or the 20 tallest peaks were identified and compared to peaks in the library of known chemicals. Peaks of chemicals not identified in the library were reported initially as "unknown," and will be further analyzed to attempt identification. This program will assist FSIS in measuring the effectiveness of merging the microbiology and chemistry sampling programs by performing both types of analyses on a single sample. It also will assess the potential for monitoring FSIS regulated commodities for unexpected contaminants and establish a data-driven identification and hazard/risk prioritization process for compounds other than veterinary drugs and pesticides. Findings from the two testing programs will be discussed along with next steps.

Keywords: C-food, A-chemical prioritization, A-analytical methods, A-epidemiology, A-exposure models

Tu-S-G4-03
Scanning the Horizon through Information-Based Hazard Identification: New Advances and Opportunities to Get Involved
P. Bennett, M. O'Keefe, J. Muniz-Ortiz; Food Safety & Inspection Service, Washington, DC

Abstract: FSIS has several ongoing initiatives to create information exchange networks between government and non-government experts on chemical hazards in the food chain, with a focus on meat, poultry, and egg products. Developing formal and informal exchanges with scientists in the public and private sectors who have experience in exposure science, environmental contaminants, toxicology, chemistry, and feed technology, is a central pillar of this process. Experts, such as those who are members of ISES, could provide valuable feedback to FSIS regarding its hazard identification program. In addition to building channels of communication between FSIS and external scientists, the Agency also relies heavily on its partnerships with other federal agencies, including the Environmental Protection Agency and the Food and Drug Administration. FSIS has strong ties with the EPA and FDA and is looking to strengthen these relationships by identifying experts within these Agencies to improve further the intelligence on chemical hazards that FSIS already receives. FSIS also intends to lay the groundwork for the formation of a chemical advisory committee, which would complement what FSIS has in place currently to advise on microbiological hazards. Finally, FSIS intends to contract with a food safety expert to assist FSIS in developing this more robust intelligence network. The goal of these collaborative efforts is to enable FSIS to reconsider how chemical hazards are identified for testing within the NRP for meat, poultry, and egg products.

Keywords: A-chemical prioritization, Chemical Hazards

Tu-S-G4-04
EPA/OPPT's Current Activity on Chemical Hazards: Work Plan Chemicals Program
A. Kim; U.S. Environmental Protection Agency, Washington, DC

Abstract: The mission of the Office of Pollution Prevention and Toxics (OPPT) of the EPA is to protect you, your family, and the environment from potential risks from toxic industrial chemicals. The Toxic Substances Control Act (TSCA) of 1976 provides EPA with authority to require reporting, record-keeping and testing, and to establish restrictions relating to chemical substances and mixtures. Certain substances are generally excluded from the TSCA, including, but not limited to, food, drugs, cosmetics, and pesticides. Under this law, OPPT evaluates potential health risks of new and existing chemicals (~84,000 chemicals currently on the TSCA Inventory). In September 2011, EPA conducted an online discussion forum and webinar to gather stakeholder input on proposed criteria and data sources to be used to identify a subset of existing chemicals that would be further assessed. The process EPA adopted focused on chemicals that met one or more of the following indicators of potential hazard and/or exposure: (1) Potential concern for children's health (i.e., reproductive or developmental effects); (2) Neurotoxic effects; (3) Probable or known carcinogens; (4) Persistent, Bioaccumulative, and Toxic (PBT); (5) Used in children's products; and (6) Detected in biomonitoring programs. Using this process, in March 2012, the Agency identified a work plan to further assess 83 chemicals under the TSCA for risk assessment in the coming years. These chemicals had high scores in this screening process based on their combined hazard, exposure, persistence and bioaccumulation characteristics. For more information, please visit: http://www.epa.gov/oppt/existingchemicals/pubs/workplans.html#select Disclaimer: The views of the authors of this abstract are those of the authors and do not represent Agency policy or endorsement.

Keywords: Work Plan Chemicals, A-risk assessment

Posters
TP: Poster Viewing

Tu-P-01
Human metabolism and excretion kinetics of methyl, n- and iso-butyl parabens after oral dosage
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Abstract: Parabens are widely used as antimicrobial preservatives in cosmetics, pharmaceuticals and food. In vitro studies have shown increasing estrogenic activity with increasing alkyl chain length. Human biomonitoring studies have described ubiquitous exposure of the general population to parabens using the parent compounds in urine as biomarkers of internal exposure. However, information on human metabolism of parabens is sparse. The aim of this study was to investigate human metabolism and elimination kinetics of parabens and their metabolites to establish urinary conversion factors. This information is needed to extrapolate from urinary paraben levels to actual paraben doses taken up. We orally dosed three volunteers with 10 mg ring labeled methyl-, iso- and n-butyl paraben and collected their urines over 48h. Administration of the different parabens followed at least a week apart to avoid interferences resulting from shared metabolites. We postulated and measured p-hydroxybenzoic acid (PHBA) and p-hydroxyhippuric acid (PHHA) as shared and the parabens themselves as specific urinary biomarkers. Metabolites were determined using online LC-MS/MS with quantification by isotope dilution. Methyl paraben in urine represented 17% (16-19%) of the dose, while iso-butyl paraben represented only 6.4% (5.4-7.9%) and n-butyl paraben 5.6% (5.2-6.4%). Thus,the butyl parabens are excreted to a significantly lower portion as parent compounds in urine than methyl paraben. For all parabens PHHA was the major metabolite representing approx. 60% of the dose. PHBA accounted for about 3% of methyl paraben and 6% of iso- and n-butyl paraben. Altogether, these metabolites accounted for approx. 84% of the oral methyl paraben dose and for about 68% of n- and iso-butyl paraben. Elimination was fast and took place mainly during the first 24h. With this study we provide essential data on the human metabolism including urinary metabolite conversion factors to be used for exposure and risk assessment.

Keywords: A-biomonitoring, C-personal care products, A-biomarkers

Tu-P-02

The Application of City Specific Data for Health Impact Assessments of Reduced Ozone

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Abstract: Health impact assessments of air pollution reductions are performed at the national-scale to assess regulatory policy and public health benefits. The EPA often relies on national endpoints, despite substantial research establishing spatial variability of exposure factors (e.g. concentration-response function and background concentrations). The goal of this project is to re-examine health impact assessments by utilizing regionally and spatially specific data compared to the current nation-wide approach and to assess the influence on estimates of health benefits. A health impact assessment of avoided premature mortality was performed for 44 U.S. cities under a stricter hypothetical ozone air quality standard of 70ppb. Analyses were run using typical national endpoints, plus combinations of varying city-specific data for three components: 1) concentration-response (C-R) functions, 2) policy relevant background concentrations, 3) and conversion factors to go from 24hr-mean estimates to 8-hr maximum estimates. Analysis was performed using the BenMAP software (version 4.04) Initial results demonstrate that of the city-specific variables, the C-R function substantially drives estimates of avoided mortality. The conversion factor affects a few cities (Los Angeles, Washington DC, Baton Rouge), while the policy relevant ozone background shows little impact on overall estimates with the exception of Las Vegas. Of the 44 cities examined, city-specific conversion factors reduced avoided mortality estimates in 26 cities, while city-specific C-R functions result in equal gains and losses in avoided mortality estimates among locations. A health impact assessment using the national level data estimates 342 avoided annual mortalities for the 44 cities combined, while applying city-specific data estimates 316 avoided mortalities. This study demonstrates the sensitivity of health benefit estimations when incorporating regionally specific data, as opposed to national values.

Keywords: A-exposure models, A-risk assessment, A-exposure factors, A-environmental regulation

Tu-P-03 - Withdrawn

Tu-P-04 - Withdrawn

Tu-P-05

Cadmium Mobilization during Pregnancy and Lactation in Highly Exposed Populations

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Abstract: Exposure to cadmium has been associated with adverse neurobehavioral outcomes and nephrotoxic effects in both animal and human studies. Cadmium has a biological half-life on the order of decades and is stored in the liver, kidneys and bone. Consequently, breast milk may be a source of infant exposure, particularly in mothers with high cumulative lifetime exposures. We conducted a literature review of studies measuring cadmium in breast milk and of physiologically-based pharmacokinetic (PBPK) models describing cadmium mobilization during pregnancy and lactation. Few studies reported breast milk cadmium concentrations, one in a population living near a metallurgic complex, and the remaining in populations exposed through diet and smoking. The median cadmium concentration in breast milk among these studies ranged from 0.06-0.67 µg/l, and in blood it ranged from 0.54-1.54 µg/l. In a separate study, mean urinary cadmium excretion in smelter community residents was twice that of the reference population, indicating that populations with high cumulative lifetime exposures have a comparatively higher cadmium body burden. Published cadmium PBPK models do not include pregnancy or lactation as excretion pathways for mothers, or breast milk as an exposure pathway for infants. Available PBPK models consider diet and smoking as the primary routes of exposure, and do not account for exposures via dust, soil, or ambient air. Our review of the literature showed that 1) breast milk is an understudied cadmium exposure pathway for infants whose mothers have high cadmium body burden, 2) current PBPK models do not consider pregnancy or lactation as cadmium excretion pathways, and only take into account smoking and diet exposures. Studies monitoring cadmium biomarkers during pregnancy and lactation are necessary in order to estimate prenatal and infant cadmium exposure, and to parameterize PBPK models that incorporate cadmium mobilization during pregnancy and lactation.

Keywords: B-metals, A-biomarkers, A-exposure models, A-cumulative exposure

Tu-P-06

Fine Particulate Matter and Black Carbon Land Use Regression Modeling and Source Apportionment across Downtown Pittsburgh, PA, USA

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Abstract: Intra-urban variability in sources of fine particulate matter (PM2.5) can result in differing exposures to public health, as certain areas have periods of heavy traffic congestion, frequent bus routes, and density of trucks. Land use regression (LUR) models and source apportionment can be used to help disentangle the complexity of pollution across a city. A saturation monitoring campaign was designed to capture spatial variability in PM2.5 and black carbon (BC) within the downtown Pittsburgh core, with an emphasis on diesel-related sources. Geographic information system-based (GIS) methods were used to characterize spatial distributions in local pollution sources, such as traffic density, truck density, and bus route frequency. PM2.5 and constituents (BC and metals) were sampled during winter and summer 2013 from 7AM to 7PM Monday through Friday to capture work-week exposures. Sampling locations (n=40) were systematically allocated to capture multiple pollution source profiles across downtown Pittsburgh. Four reference sites were used to capture long-range transport and meteorological drivers of local concentrations. Mean PM2.5 concentrations were 13.22 (SD=2.33 µg/m3) for winter and 13.28 (SD=1.99 µg/m3) for summer, and mean BC was 3.57 (SD=1.39 abs) for winter and 4.11 (SD=1.93 abs) for summer. For source apportionment, factors such as motor vehicle emissions, brake/tire wear, fuel/oil, and diesel were identified in the small domain. We are currently developing season- and pollutant-specific LUR models, and fine-scale concentration estimates. This spatial saturation monitoring campaign explored fine-scale variability in PM2.5, BC, and trace metal constituents across downtown Pittsburgh during winter and summer 2013. Intra-urban sampling within a small city allowed us to further understand and refine exposure assignment of source contributions to public health.

Keywords: B-particulate matter, A-exposure models, A-exposure factors, A-geospatial analysis/GIS

Tu-P-07

Derivation of Biomonitoring Equivalents for Chlorpyrifos Using a Pharmacokinetic/Pharmacodynamic Model of Oral Exposures

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Abstract: Blood chlorpyrifos (CPF) and its main urinary metabolite (3,5,6-trichloro-2-pyridinol, TCPy) are often included in general population-based biomonitoring data. Methods that put human internal dose measurements in a health-risk context have been lacking. The concept of Biomonitoring Equivalents (BEs) seeks to address this shortfall. BEs incorporate pharmacokinetic models to calculate biomarker levels consistent with the underlying toxicological endpoints used in setting the guidance values (e.g. RfDs). These models convert the external doses associated with the toxicological endpoint to a measure of internal dose. The models also provide an opportunity to use smaller uncertainty factors (UFs) since pharmacokinetic differences can be modeled directly. Here, we calculate BE values for blood CPF and urinary TCPy using a PBPK/PD model. The model allows the direct determination of CPF blood concentration associated with a 10% inhibition in red blood cell cholinesterase (RBC ChE), the USEPA regulated endpoint, for oral exposures. This model also predicts age-specific individual human variability of blood levels associated with a 10% inhibition in RBC ChE using Monte Carlo analysis, which allows determination of blood levels protective of sensitive humans. Thus, no additional UFs are required to derive the BE. The blood BE value for CPF in adults is 4,500 pg/g. This level is about 4,000 fold higher than geometric mean blood levels (1.1 pg/g) reported in US pregnant women. The urinary BE for TCPy is 1,300 µg/L. The median urinary TCPy in the general US adult population was 2.2 µg/L (CDC exposure years 2001-2002). Assuming that 20% of the reported levels occur from CPF exposure (the remainder is assumed direct exposure to environmental TCPy in non-worker populations), then the BE for TCPy will be about 3,000 fold larger than current levels. These findings suggest that current US adult dietary exposures to CPF are well below levels that could cause 10% inhibition of RBC ChE.

Keywords: A-biomonitoring, A-risk assessment, B-pesticides

Tu-P-08

Comparison of Low-Cost Portable Particle Monitors: PM Measurements from Roadways and Residential Cooking

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Abstract: Ambient fine particulate matter (PM2.5) has been known as a risk factor for mortality and morbidity due to cardiorespiratory causes. Owing to increased interest in personal exposures to PM2.5 in various daily activities in general environments, a number of low-cost portable direct reading instruments have been developed. To evaluate the feasibility of such low-cost portable directing reading equipment for personal air PM2.5 exposure, three direct-reading instruments were simultaneously used at two different environments in Houston TX, freeways and indoor homes where cooking activities were involved. The 1-minute averages of responses from a DC1700, Dylos Corporation, and a P311, Airy Technology, were compared with the 1-minute average of PM2.5 mass from a DustTrak II, the TSI Inc. The average PM2.5 mass concentrations were 39.9 ± 13.6 ug/m3 on freeways (n=5) and 104 ± 107 ug/m3 at homes with cooking activities (n=5). The results showed that the responses from the DC1700 and the P311 correlated well with the DustTrak II, ranging from r2= 0.738 to r2=0.978. The correlations between the P311 and the DustTrak II were better (r2 > 0.906) than the correlations between the DC1700 and the DustTrak II (r2 < 0.884). The correlations among the equipment were higher at the indoor homes than the freeways. Linear regression models showed that the responses from the P311 and the DC1700 significantly predicted the DustTrak PM2.5 mass concentrations, respectively (p<0.001). The results from this study suggested that the responses from the P311 and the DC1700 can be used to measure PM2.5 mass concentrations from the DustTrak in urban air and indoor homes.

Keywords: C-air

Tu-P-09

Comparison of Free and Total Malondialdehyde as a Biomarker of Oxidative Stress

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Abstract: Malondialdehyde (MDA) is generated as a product of lipid peroxidation caused by reactive oxygen species (ROS). MDA has been long recognized as a biomarker of oxidative stress; but controversies remain as to whether MDA can accurately reflect ROS activity. One of the reasons for this stems from its analytical methods. Due to its reactivity, MDA can react with other constituents (e.g., proteins) of the biological media, However, few studies have considered the confounding effect of protein on MDA concentrations. In our preliminary study, we analyzed both "free" MDA and total MDA (the sum of free MDA and MDA-protein adducts) concentrations in bronchoalveolar lavage fluid (BALF) of Brown-Norway rats exposed to polyvinylpyrrolidone and citrate coated silver nanoparticles. On the first day after exposure, the exposure groups were higher than the control group in both total MDA and free MDA: mean percentage changes comparing the exposure group to the control group ranged from 106% to 148% for total MDA and 86% to 355% for free MDA. On the seventh day after exposure, while the mean concentrations of total MDA for the exposure group were still higher than those for the control group (by 92% to 227%), free MDA concentrations were similar for both groups. This was concurrent with a remarkably low level of protein in the control group. It is possible that with low level of protein, little fraction of the free MDA in BALF of the control group was sequestered, thus leaving the level of free MDA 'abnormally' high compared to the exposure groups. The findings support the hypothesis that concentrations of free MDA in biological media are affected by protein concentrations. Additional comparisons of free versus total MDA are under way using other biological specimens (serum and urine). We expect that in biological media where proteins are present, the concentration of total MDA is a more appropriate biomarker than free MDA in reflecting lipid damage caused by oxidative stress.

Keywords: A-biomarkers, B-nanoparticles

Tu-P-10

Characterization of Exposure to Household Air Pollution among Pregnant Women in Ayacucho, Peru

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Abstract: Exposure of 110 pregnant women who used biomass fuel for cooking to particulate matter (PM2.5) and carbon monoxide (CO) was assessed as part of a pilot study investigating the exposure-response relationship between household air pollution (HAP) and birth weight in Ayacucho Region, Peru between March and May 2013. Forty-eight hour real time CO and PM2.5 were measured using PAC III single gas monitor (Draeger Safety Inc., Pittsburgh, PA) and MicroPEM v 3.2 (RTI International, Research Triangle Park, NC) respectively. The on-board filters in the MicroPEM samplers were used to determine PM2.5 concentrations gravimetrically. Personal exposures to and kitchen concentrations of both pollutants were measured for each subject during the third trimester of pregnancy. Information on household and behavioral factors that could affect exposure was collected using questionnaire. Average kitchen concentrations of CO and PM2.5 were 8.7 ppm (95% confidence limits: 4.5, 13.0 ppm) and 377 µg/m3 (271, 482 µg/m3) respectively, and as expected were higher than the corresponding average personal exposures - 1.6 ppm (1.2, 2.0 ppm) and 177 µg/m3 (85, 150 µg/m3) respectively. Correlation between both pollutants were relatively high in the kitchens (ρ=0.81) and for personal exposures (ρ=0.79). However, correlation between kitchen and personal measures for both CO (ρ=0.21) and PM2.5 (ρ=0.30) was only moderate. The types of cookstove and firewood used for cooking were associated with exposure in univariate analyses. Kitchen concentrations of and personal exposure to both pollutants tended to be higher for women cooking with open fire or exclusively with eucalyptus wood. Consistent with other studies, kitchen concentration of HAP components may not be a good measure of personal exposures in this study setting. However, both time-integrated CO and PM2.5 are relatively correlated and their measurements may be reasonable estimates of each other for personal exposure or kitchen concentrations.

Keywords: A-indoor environment, C-air, B-particulate matter, Pregnant women, carbon monoxide

Tu-P-11

Residential Outdoor Air Pollution and Brain Morphology in the Adult Health and Behavior (AHAB II) Cohort and Pittsburgh

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Abstract: Background: Air pollution exposure is associated with increased inflammatory risk, and may adversely impact brain morphology through systemic inflammation, disruption of the blood-brain barrier, or translocation via olfactory mucosa. Currently, little is known about the relationship between air pollutants (particulate matter ($PM_{2.5}$), black carbon (BC), trace metal constituents) and brain morphology. The AHAB-II cohort is a community-based registry to identify neural and biobehavioral predictors of physical and mental health in midlife. We combine individual brain morphology indicators with fine-scale air pollution exposure estimates to explore their associations. Aims: Geographic information system (GIS) was used to geocode participant addresses and assign individual air pollution exposure estimates. We developed models to examine associations between outdoor air pollution and brain morphology. Methods: Air pollution data were obtained from a monitoring campaign with 36 sites across the Pittsburgh region. Land use regression (LUR) models were developed for $PM_{2.5}$, BC, and lead. We assigned mean pollutant concentrations within a 300 m buffer of each participant's residential location (n=306; mean age = 43 yrs; 45% men). Structural neuroimaging methods were used to determine indicators of brain morphology. Results: Preliminary results suggest that a 1 µg/m^3 increase in summer $PM_{2.5}$ exposure is associated with a -0.019 mm (p ≤ .05) decrease in cortical thickness after controlling for intracranial volume and age. Future analyses will examine other outcomes, and potentially mediating factors related to inflammation. Conclusions: This is among the first studies to examine associations between residence-specific air pollution exposures and brain morphology. Observed associations may have implications for pollution effects on brain-based functional outcomes (e.g., early cognitive declines).

Keywords: B-particulate matter, A-epidemiology, A-geospatial analysis/GIS

Tu-P-12

Deterministic and Probabilistic Exposure Modeling of Data Generated from a Randomized Clinical Study Investigating Dentifrice Ingestion in Children

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Abstract: Objectives: A clinical trial was conducted to investigate dentifrice ingestion in children. Directions included use of a "pea-sized" amount for children under 6 years-old (y/o) per marketed product instructions. Deterministic and Probabilistic Monte Carlo modeling were performed to examine the resulting exposure potential for children age 2-6 y/o. Methods: Data were generated from a randomized, 3-treatment, 3-period, crossover clinical trial enrolling 90 children 2-12 y/o. Deterministic modeling was applied to dentifrice use and ingestion values. Probabilistic Monte Carlo modeling was applied to the ingestion values for children 2-6 y/o (54 subjects) in order to extrapolate exposure potential. Results: Clinical results showed a reduction in the amount of dentifrice used per brushing in younger ages with implementation of the "pea-sized" direction. For 2-4 y/o, the most sensitive population, Deterministic modeling indicated an average of 0.524 g dentifrice used per brushing (95% = 1.107 g); and an average of 30.2 mg dentifrice ingested per kg body weight (BW) per day (95% = 85.9 mg/kg BW). Fully Probabilistic modeling for 2-6 y/o with 3 variable input parameters was executed in two ways, i.e. a 'general population' versus a 'subject oriented' approach. This indicated an average of 23.1 mg dentifrice ingested per kg BW/day (95% = 69.7 mg/kg BW) for the general population approach and 22.3 mg dentifrice ingested per kg BW/day (95% = 64.6 mg/kg BW) for subject oriented approach. Results from the subject oriented approach are considered more realistic, as data were only sampled within a single age group and combined thereafter, as compared to the general population approach which sampled the entire dataset across ages. Conclusions: Probabilistic modeling utilizes the entire dataset and provides a refinement to extrapolated exposure as compared to Deterministic modeling. More realistic exposure values can be derived to provide for improved safety assessment.

Keywords: A-exposure models, D-children, Dentifrice, Probabilistic modeling, C-personal care products, Dentifrice, Probabilistic modeling

Tu-P-13

Transects Modeling from Bisecting Roadways for Particulate Matter 2.5 (PM$_{2.5}$), Elemental Carbon (EC), and Nitrogen Dioxide (NO$_2$) in Homewood, PA

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Abstract: While large scale monitoring can quantify exposure to pollutants for cities or regions, more specific variations in pollutant levels at a community level require more saturated sampling or sampling on a smaller scale. Monitoring directly at points of interest may not fully capture the spatial variability of pollutants, therefore a spatial saturation model using transects may provide a more reliable estimate of for the entire sampling domain. We partnered with the Homewood Children's Village, a community organization concerned with their neighborhood air quality in areas where children spend a significant amount of time outdoors. Using transect modeling across the entire community, we aimed to establish a gradient or exposure map for PM$_{2.5}$, NO$_2$ and EC. Two main roads identified by the heaviest traffic patterns bisect the community lengthwise. Considering only roads within the community, a transect model was developed with 22 sites sampled at varying distances, relative to the main roads. A reference site from within the community was used to adjust for temporal variation. PM$_{2.5}$ was collected via active filters and NO$_2$ via passive badges on stationary monitors for 4, 7-day periods in Oct.-Nov. 2013. PM$_{2.5}$ ranged from 3.1-9.8 µg/m^3 (mean = 7.1) and NO$_2$ ranged from 11.9-16.7 ppb (mean = 13.7) once temporally adjusted to the reference site. Elemental carbon (EC) was also measured from the filters and ranged from 1.7-6.5 absorbance units (mean = 4.0). Considering the main bisecting roads as the source of pollutants for the transect sampling pattern, NO$_2$ showed a significant (α = 0.05) trend and no pattern was observed in PM$_{2.5}$ or EC. While transects from the main roads showed no trends for PM$_{2.5}$ and EC, NO$_2$ demonstrates a trend of decreasing concentration with increasing distance. External bordering roads with higher traffic density did show a pattern of decreasing all measured pollutants concentrations with increased distance.

Keywords: B-particulate matter, C-air, A-exposure models

Tu-P-14
DRAGON: A Suite of Tools to Support Exposure and Risk Assessment
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Abstract: Exposure and risk assessments require careful scrutiny of scientific literature and numerous decisions. Each decision about the appropriateness of a given data source must be made in a systematic way, and the decisions must be transparent to all stakeholders when the assessment is released. For this reason, exposure and risk assessment benefit from systematic literature review. In this review, risk assessors perform literature searches and evaluate the resulting literature for quality and applicability to the assessment. They also document the final decisions and the rationale behind those decisions. In many cases, this process takes place in a series of Excel and Word documents, and decisions can become lost across different members of the risk assessment team or across multiple organizations. DRAGON provides a framework to collect and organize all the data and decisions for an assessment. Drawing on experience with human health and ecological exposure assessments for new and existing chemicals, ICF has developed modules that allow the user to complete human health and ecological risk assessments from literature review all the way to risk estimation and documentation. In this poster, the DRAGON tool is applied to the question of current human and ecological risk due to exposure to environmental and household lead. The risk assessment is broken down into the following steps: - Literature categorization based on user-defined key words, - Data extraction from animal toxicology studies, human epidemiology studies, and ecotoxicity studies, - Study quality review, - Exposure conceptual model development, - Exposure scenario development, - Toxicity benchmark development, - Risk estimation, and - Overall assessment management, including automatic report generation The outcome is a framework that is tailored for a lead risk assessment that clearly describes all assessment decisions.

Keywords: A-risk assessment

Tu-P-15

High Performance Environmental Profiling of House Dust to Support Computational Exposure Science

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Abstract: Only a relatively small subset of chemicals has been sufficiently characterized for potential risks to public health. The desire to increase the pace of risk assessment has led to the development of robust modeling approaches for screening of exposure potential to complement emergent toxicity screening efforts. Models that integrate chemical properties, consumer product information, and modeled human behavior are now being used to evaluate the exposure potential of large numbers of chemicals. Actual measurements of chemicals in exposure-related media are necessary to evaluate the reliability of these models, but data are readily available for only a small number of chemicals, typically those previously identified as possibly posing a hazard to human health. Non-targeted analysis of environmental samples using high resolution mass spectroscopy allows large numbers of chemicals to be measured. We applied liquid chromatography time-of-flight/mass spectrometry (LC-TOF/MS) methods to rapidly screen dust samples from the American Healthy Homes Survey (AHHS). We observed 100-1000 peaks in each sample. Using chemical property information from EPA's Distributed Structure-Searchable Toxicity (DSSTox) database, we were able tentatively to characterize many of these as manufactured chemicals. Comparison to EPA's Consumer Product Chemical Profiling database enabled us to link dozens of compounds with consumer products. A preliminary analysis of a subset of samples found that the majority of the identified compounds were associated with "beauty" personal care products. High performance environmental profiling of house dust holds great promise for the evaluation and calibration of high-throughput exposure models; moreover, further development and application of the technique to a wider range of environmental media will facilitate the integration of emerging analytical and computational technologies to assess exposure potential on a scale far more grand than previously attainable.

Keywords: A-chemical prioritization, A-analytical methods, C-consumer products, A-risk assessment, C-personal care products

Tu-P-16

A Method of Creating Exposure Indicators for Examining the Potential Human Health Effects of Climate Change

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Abstract: Impact assessments of climate change on chronic diseases are less understood and existing assessments cover limited geographies showing mostly local, rather than national comparisons. Current knowledge gaps exist because metrics that capture individual level exposures to climate change with spatial and temporal consistency are lacking. We describe and evaluate a generic metric that captures exposure to climate variability and change with temporal and spatial resolutions that match the scale of routinely available national and state health data (county level) in the United States (US). Meteorological data was used to identify the number of county-specific temperature anomalies using location- and time-specific climatology. The metric, referred to as "exceedence days" (EDs), was defined as the number of days that exceeded the 95%-ile of the distribution of the observed daily maximum temperatures over a 1960-1989 baseline period and was calculated for a 51-year time period (1960-2010). We used negative binomial regression to investigate EDs across divisions, time and county-level urbanization. We then evaluated the ability of this approach to capture natural climate modes by incorporating La Niña (LN) and El Niño (EN) periods into the models. We observed significant increases in the annual mean number of EDs during the 1990s (16.4 EDs) and 2000s (18 EDs) compared to the reference period, 1960-1989, (15.2 EDs). Continentally, EN periods were associated with as much as a 24% decrease in EDs, while LN periods were associated with as much as a 29% increase in EDs, compared to neutral periods; and, both season and county-level urbanization were associated with EDs occurrences. The findings suggest that the ED metric captures long-term variability in temperature anomalies and subtle spatial and temporal variability with sensitivity to the natural climate modes. And, we have identified differences in EDs among different areas of the country, seasons, and over time.

Keywords: Exposure Assessment, Extreme Temperature, Climate Variability, Climate Change, ENSO

Exposure to PM2.5, Ultrafine and Black Carbon Particles in Green vs. Non-Green Homes

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Abstract: Environmental concerns for improved energy consumption are driving a green building/remodeling movement. Energy conservation efforts have resulted in tighter buildings, which have led to a reduction in the air exchange rates between indoor and outdoor environments. Poor air exchange rates could lead to an increase in particles that often originate from indoor sources (tobacco smoke, cooking), but decrease particles from outdoor sources (traffic, combustion). We assessed the concentration of particles alongside air exchange rates (AER) in 30 non-green and 27 green homes. Particles ≤ 2.5 µm (PM2.5) were sampled on 37 mm, 2.0 µm pore-size PTFE membrane filters using single-stage Personal Modular Impactors (SKC, Inc.) and analyzed gravimetrically. In addition, real-time number concentrations of ultrafine particles and mass concentrations of black carbon were assessed using a P-Trak condensation nuclei counter (TSI Inc.) and microAeth® monitors (AethLabs), respectively. Capillary adsorption tubes (CAT) and sources were placed in different locations of the homes to determine the AER. Information on home characteristics was collected by questionnaires. At baseline (immediately post renovation) the AER was significantly higher (p=0.02) in non-green homes (median=3.1 h-1) as compared to green homes (median=1.1 h-1). The geometric mean of PM2.5 was 80 µg.m-3 in green homes and 56 µg.m-3 in non-green homes (p=0.1) and the geometric mean of the number concentration of ultrafine particles was 26087 cm-3 in green homes and 32535 cm-3 in non-green homes (p=0.2). Preliminary data show a higher concentration of ultrafine particles in green homes at 6 months (p=0.05) and at 12 months (p=0.3). Black carbon, which was measured only at 12 months, showed an increasing trend (p=0.06) in non-green homes. Further data analysis will tease out the influence of human activity versus the renovation status of homes.

Keywords: A-built environment, A-indoor environment

Development and Application of New Human Biomonitoring Methods for Substances of Interest - the German BMU-VCI Cooperation Project

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Abstract: Introduction The German initiative to develop new human biomonitoring (HBM) methods for substances of interest is a cooperation of the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) and the German Chemical Industry Association (VCI) which started in 2010. Emphasis is placed on substances either with potential health relevance or for which an exposure of the general population can be assumed. Methods After identification of relevant chemicals by an expert panel HBM methods are developed and first applied to about 40 non occupationally exposed persons. The analytical methods are cross-validated by the working group 'Analyses in biological Materials' of the German Research Foundation (DFG) and published together with pilot-test results in international, peer-reviewed journals. Results New HBM methods for methylenediphenyl diisocyanate (MDI), used in polyurethane and adhesives, the vulcanization accelerator 2-mercaptobenzothiazole (2-MBT), the plasticizer alternatives Hexamoll® DINCH and di-2-propylheptyl phthalate (DPHP), the alkylphenols 4-tert-octylphenol and 4-nonylphenol and the technical solvents N-methyl- and N-ethyl-2-pyrrolidone (NMP/NEP) have already been developed and applied. For some of these chemicals a considerable background exposure seems to be unlikely (e.g. MDI), for other substances (e.g. NMP/NEP) a ubiquitous background was detected. For DINCH and DPHP, trends of increasing exposure were observed in urine samples from the German Environmental Specimen Bank, mirroring the market introduction of the substances. The relevance of the findings needs to be assessed by toxicologically derived Human Biomonitoring Values (Biomonitoring Equivalents) and by population representative studies. Consequently, we plan to include these substances in the 5th German Environmental Survey. The results will contribute to a realistic exposure and risk assessment for these "new" chemicals in German children.

Keywords: A-biomonitoring, A-biomarkers, A-chemical prioritization, B-phthalates, C-consumer products

Tu-P-19

Human Exposure Assessment for Textiles: Proposal for a Standard Test for Migration of Chemicals from Textiles into Artificial Sweat under Physical Stress

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Abstract: Functional textiles are very important in our daily life. They contain a number of different chemicals that support the functionality and are often worn in direct contact with the skin, thus implying a large potential for consumer exposure. Meanwhile, no standardized tests exist for the assessment of chemical migration from textiles into sweat, which latter can be supposed to be the relevant transport medium from textiles to human skin. In order to design a setup for simulating wearing of textiles, we adapted the experimental setup of two ISO methods that are used for the assessment of color fastness for dyes used in textiles. The advantage of this design over static migration into sweat, which can be assessed by simply submersing the textile for a defined time, is that it also simulates the physical stress that textiles experience during wearing (friction and stretching). A case study was carried out with two engineered nanoparticles (ENP) that are frequently added to textiles, for antimicrobial activity or UV protection, i.e. silver (Ag) and titania (TiO2). We used 9 different commercially available textiles, four of which contained silver and 6 contained titania, presumably as TiO2 (one textile contained both metals). The textiles are shirts, trousers, underwear and socks. For the migration experiment the textiles were washed in model washing machines at room temperature. As "washing solution" artificial sweat of either pH 5.5 or pH 8.0 was used. The textile samples were exposed to sweat inside the rotating washing machines for 30 min at 40°C. Two of the four textiles released Ag in dissolved and particulate form (mainly <450 nm, here referred to as nanoparticulate Ag); TiO2 was only released by one textile. Human exposure modeling showed that external exposure from functionalized clothing thus may go up to 1.3 mg/d for total Ag, and 0.6 mg/d for nanoparticulate Ag. In comparison to migration experiments without physical stress we observed a larger migration.

Keywords: A-exposure models, C-consumer products, B-nanoparticles, textiles, experimental exposure assessment, textiles, experimental exposure assessment

Tu-P-20

Health Co-benefits of Traffic-related Greenhouse Gas (GHG) Mitigation Policies in Cities

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Abstract: The objective of this work is the investigation of the co-benefits in urban air quality and public health in the area of Thessaloniki, after the introduction of greenhouse gas (GHG) emission reduction policies. The policies implemented include an underground rail network in the city centre and changes in the transportation mode and fleet composition. Hence, traffic pollution is estimated for the year 2010 and two future scenarios in year 2020, i.e., a business-as-usual and the GHG emission reduction scenario. The health impact is assessed, via an integrated methodological framework, incorporating a number of models i.e. a) SIBYL to project vehicle stock numbers, b) VISUM to compute traffic flows and velocities, c) COPERT IV, to compute pollutant emissions, d) OSPM, to model dispersion in traffic corridor, e) CAPLUFF to model the traffic dispersion from motorways and f) NMRB-2008 to compute noise from road transport. The computed health effects result from the exposure to Particulate Matter, NO2, benzene and noise to the same urban population. Results show significant benefits, especially for the municipality of Thessaloniki and its adjacent municipalities. For example, for the centre of Thessaloniki, the number of deaths attributed to PM, NO2, and Benzene exposure are reduced by 17%, 21% and 52% respectively, whereas for the adjacent municipalities, reductions range from 7% to 19%, 18% to 21% and 44% to 52% respectively. In addition, in the municipality of Thessaloniki, there is a 69% decrease in cases of myocardial infraction, due to the reduced noise level. These aforementioned policies are expected to further reduce health impact, especially due to the synergetic effect of the improved air quality and the reduced ambient noise. This is demonstrated, with the neurotoxic effects from the co-exposure of benzene and noise and cardiovascular disease caused by PM and noise.

Keywords: A-climate change, A-cumulative exposure, A-environmental policy, A-epidemiology

Tu-P-21

A New Metric of Fine and Ultrafine PM Exposure: the Region-specific Oxidative Stress Index (SOS)

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Abstract: The current study provides a methodological framework for introducing refined exposure information into environment and health associations, by deriving a composite exposure metric we call "region specific oxidative stress index SOS". The latter takes into account the size specific mass deposited to region of the Human Respiratory Tract (HRT) as well as the size specific Reactive Oxygen Species (ROS) generating potential of PM. Based on the PM size specific oxidative potential and the deposition across the HRT, the SOS index is calculated as the product of the size specific mass deposited to the HRT region, multiplied by the oxidative potential of this size specific PM thus, we surmise that it is a more relevant metric for PM health associations. To investigate the feasibility of using this approach an extensive measurement campaign was carried out in a large Metropolitan area in Greece. PM size and number distributions were recorded in four sites. PM10, PM2.5, PM1 and UFPs samples were analyzed for oxidative potential by measuring ROS using the DTT protocol. Results showed that the fine particle concentration is higher in the city center than in the suburbs. The same is true for the oxidative potential especially for the smaller particles. Thus, the difference between actual exposure in the different monitoring sites for endpoints related to lower respiratory tract deposition and possibly translocation within the systemic circulation (e.g. cardiovascular disease, adverse pregnancy outcomes) might be up to 4 times higher than the one estimated by the respective differences in mass concentration. The SOS index proposed herein, could serve as a starting point for translating environmental information (PM measurements and ROS analysis) into an enhanced exposure metric; this could provide an intermediate advancement between existing concentration-response functions and a fully mechanistic assessment of PM associated mortality and morbidity.

Keywords: A-activity patterns, A-epidemiology, A-exposure models, B-particulate matter, C-air

Tu-P-22

Refining Assessment of PAH Exposure and Potential Carcinogenic Risk Assessment from Biomass Burning Incorporating Internal Dosimetry Metrics

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Abstract: The current study deals with the assessment of the cancer risk attributable to exposure to PAHs associated to an increased use of biomass for space heating in Greece in the winter of 2012-2013. The study incorporated ambient air PM sampling in several sites in the city of Thessaloniki, as well as chemical analysis of PAHs and levoglucosan, used here as the most specific tracer of biomass combustion. Internal exposure to PAHs was estimated taking into account the deposition of the respective PM fractions across the human respiratory tract (HRT) and the respective PAHs concentration of the respective PM fractions. Deposition at different regions of the HRT was estimated using the Multiple-Path Particle Dosimetry (MPPD) model. Potential cancer risk due to exposure to the mixture of urban ambient air PAHs was calculated using the toxicity equivalence factor (TEF) approach using as basis the benzo(a)pyrene (B[a]P) cancer potency. The BaP-TEQ (Toxicity Equivalent Quotient) (carcinogenic equivalent expressed in ng/m3) was calculated by multiplying the concentrations of each compound in the PAH mixture with the respective TEF for cancer potency relative to BaP. Cancer risk was estimated by multiplying the TEQ of the respective fraction of particulate matter deposited daily across HRT by a slope-factor equal to 0.25 10-6 ng/kg_bw/day) function, initially derived by the B[a]P Inhalation Unit Risk (equal to 0.88 10-6 (ng/m3)-1). Significant variation in internal exposure to PAHs (and respectively to the estimated risk) was observed among different age groups, much larger than variation due to geospatial attributes. Bodyweight normalized uptake (and the attributed risk) for children is four times higher than for adults. Only limited difference was found between traffic and urban background sites in the winter; the latter indicates that biomass emitted PM are not significantly different in terms of carcinogenic potency compared to traffic ones.

Keywords: A-activity patterns, A-climate change, A-exposure models, C-air, D-children

Tu-P-23

INTEGRA: Advancing Exposure Continuum from Global Scale Contamination to Tissue Dose

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Abstract: The objective of the INTEGRA project is to bring together all information necessary for assessing the source-to-dose exposure continuum over the entire life cycle of substances covering an extensive chemical space through the use of QSARs. The major outcome of INTEGRA is a comprehensive computational platform that integrates multimedia environmental and micro-environmental fate, (external) exposure and internal dose within a dynamic framework in time. The platform allows multimedia interactions across different spatial scales, taking into account environmental releases and related processes at global, regional and local scale, up to the level of personal microenvironment. Coupling seamlessly exposure models with refined computational tools for internal dosimetry transforms exposure/risk assessment of environmental chemicals since it allows risk characterization to be based on internal dosimetry metrics. In this way high throughput system data such as the ones generated by Tox21 in vitro testing can be used, towards the nowadays need of "exposure based risk assessment". This opens the way towards a higher level of assessment that incorporates refined exposure (tissue dosimetry) and toxicity testing (Biological Pathway Altering Dose - BPAD) associated to environmental contamination at different scales. The applicability of INTEGRA was tested on bisphenol-A. Tier 1 assessment (environmental releases based on production volumes, worst case exposure estimates and Tolerable Daily Intake of 50µg/kg_bw/d) indicated that specific exposure scenarios (i.e. bottle fed neonates and premature infants hosted in intensive care units) are close to the legislative thresholds. The refined exposure assessment incorporating probabilistic analysis, actual environmental release data, detailed consumer exposure modelling and the use of BPAD as an internal exposure risk characterization metric, resulted in increased margins of safety compared to conventional exposure/risk characterization.

Keywords: A-aggregate exposure, A-biomonitoring, A-exposure models, C-multimedia, A-risk assessment

Tu-P-24 - Withdrawn

Tu-P-25

May the control banding risk management method be useful for exposure assessment in epidemiology of workers exposed to engineered nanomaterial (ENM)?

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Abstract: Control banding (CB) is a method to guide risk management whenever there is uncertainty concerning the input data needed for risk assessment (uncertainty about the hazards of nanomaterials and about exposure levels). It takes into account existing information, the available technical and scientific data, and is based on a number of assumptions. In the CB the risk is function of severity of hazard and the anticipated probability of exposure. Although it seems tempting to use some of CB methods for epidemiology, direct application of risk levels inconsistently reflects the workers' occupational exposure and may result in biased results of the dose-response analysis based on such an exposure proxy. Nevertheless, after appropriate transformation, some of CB methods may be useful for exposure assessment of nano-workers in epidemiological studies. Basically, it may consist of: a withdrawal from the CB matrix of the hazard determinants related to ENM's toxicological properties (which are subject to the greatest uncertainty and overlap with epidemiological purpose); an extracting of the ENM's physicochemical properties (shape, size, solubility) as determinants for a further ENM's uptake and resulting internal dose assessment; and a conservation of the exposure probability calculated based on the process and organisational information (amount of ENMs handled, its dustiness/mistiness, frequency and duration of operations and use of personal and collective protection equipment). A nanotechnology-company information field-based form and worker's individual questionnaire were developed within EpiNano project. The collected data will be used for assessing workers' individual potential exposure to ENM in a forthcoming epidemiologic study and, meanwhile, might be useful to provide basic information for the inner-company risk assessment using CB approach.

Keywords: nanotechnology, occupational exposure, risk assessment, industrial hygiene, epidemiology

Tu-P-26
Are Children in Buggies Exposed to Higher Fine Particulate Matter Levels than Adults?
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Abstract: The potential effects of air pollution on the health of children are of particular concern. There is evidence that children living close to busy roads have poorer respiratory health, and this has been attributed to long-term exposure to traffic-related air pollution. Short-term fluctuations in air pollution may result in reduced lung function in asthmatic children and an increase in asthma symptoms. Young children and infants in buggies (strollers) travel close to the height of vehicle exhaust emissions, and so they may be subjected to higher pollutant concentrations than adults. A mobile sampling system attached to an unoccupied child's buggy was used to sample real-time PM2.5 concentrations at two heights - the nominal breathing zones of a seated child and that of the adult pushing the buggy. Samples were collected during each monitoring period using two TSI SidePak AM510 direct reading monitors fitted with PM2.5 impactors. These were initially co-located at the child breathing zone height to allow any differences in the devices' performance to be identified. The inlet of one was then repositioned to the adult breathing zone with the inlet of the second remaining at the child breathing zone height. After a 30 minute monitoring period, the adult inlet was again co-located with the child inlet for at least ten minutes. Measurements were collected along three pre-defined routes in the city-centre of Edinburgh, UK, on six weekdays. On each day, sampling was completed once along each route, resulting in 18 sets of measurements, comprising in excess of 3240 individual adult v. child comparison data points. Data analysis is ongoing and results will be available at the end of March 2014. Based on our findings in this small-scale study we will report on whether children in buggies are likely to be exposed to higher PM2.5 concentrations than adults.

Keywords: D-children, C-air

Tu-P-27
CITI-SENSE:"Development of Sensor Based Citizen's Observatories for Better Life Quality in Cities" - Lessons Learned from Edinburgh Pilot Study
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Abstract: Atmospheric monitoring is benefiting from large growth in sensor technology methods, with devices capable of being deployed in greater quantities, therefore coverage and impact. This gives opportunity to empower citizens with user-friendly devices but also presents challenges for data collation and dissemination in citizen science. The CITI-SENSE project "Development of sensor based Citizen's Observatories for better life quality in cities", aims to develop useful environmental information products based on data generated by citizens using sensors (i.e. Citizen Observatories), supplemented with other environmental and personal information, linked through secure wireless communication and online platforms. In addition, the project aims to demonstrate the usefulness of these tools to empower citizens for effective environmental governance and as contributors to scientifically validate exposure information. Pilot studies are being carried out in nine European cities. In Edinburgh, UK, we report on a pilot study focussed on urban air quality being undertaken to evaluate some of the projects novel sensor technologies. Five GeoTech AQ Mesh pods (static devices) measuring CO, NO, NO2, O3 as well as temperature and relative humidity were co-located to assess inter-device reading variability. The pods were also co-located with air quality monitoring sites on the Scottish Automatic Urban Network and with other interested stakeholders to assess their comparability with standard benchmark measurement devices. Further, preliminary investigation of the usefulness of the technology to empower citizens as Citizen Observatories was investigated at a local school. Five Ateknea (custom-built) portable sensors capable of measuring CO, NO2, 03, temperature and humidity were also piloted, using a combination of co-location experiments and user trials. We will report on the lessons learned from the CITI-SENSE Edinburgh pilot study, as well as the wider implications for citizen science.

Keywords: A-sensor technology, C-air, D-community

Tu-P-28

Assessing the Improvement in Predicting Personal Exposure to Elements in PM2.5 by Including Indoor PM2.5 Measurements and Home Characteristics to Outdoor PM2.5 Measurements

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Abstract: The elemental composition of PM2.5 has been associated with adverse health outcomes. Most epidemiological studies use outdoor PM2.5 concentrations at central monitoring sites as a surrogate of personal exposure. Here, it was tested if the addition of indoor PM2.5 measurements or other home and personal characteristics increased the prediction accuracy of personal PM2.5. The mass concentrations of PM2.5 and 36 elements were measured during 48-hour parallel indoor, outdoor, and personal sampling in nonsmoking households in three urban areas as part of the Relationship of Indoor, Outdoor, and Personal Air (RIOPA) study. Random forests were used to predict personal exposure for elements in PM2.5. A total of three models were developed, differing only with respect to the predictors used. Model 1 included only outdoor elemental measurements. Model 2 included both outdoor and indoor concentrations of elements in PM2.5. Model 3 included indoor and outdoor PM2.5 measurements and also home characteristics. The mean absolute prediction error percentage (MAPE%) for all models were calculated based on bootstrapped cross-validation and then were quantitatively compared. The inclusion of indoor PM2.5 measurements significantly improved the prediction of personal exposure for 17 of the 24 elements (Al, As, Ba, Ca, Cl, Fe, K, Mn, S, Sb, Se, Sn, Sr, Ti, V, Zn, Zr) compared to the model with outdoor PM2.5 data alone. For the remaining elements (Br, Cr, Cu, Ni, Pb, Si), the inclusion of indoor PM2.5 elemental concentrations did not significantly improve the prediction of personal exposure. Inclusion of home characteristics did not significantly improve the prediction of personal exposure for any of the elements. Overall, using outdoor PM2.5 data is not a perfect surrogate for personal PM2.5 exposure. For most elements, supplementing outdoor PM2.5 data with indoor PM2.5 data decreases the MAPE% for personal PM2.5 exposure while the addition of home characteristics does not.

Keywords: A-statistical methods, A-exposure models, random forest

Tu-P-29

Prenatal Exposure to Polybrominated Diphenyl Ethers and Child Language Development

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Abstract: Background: Flame retardants polybrominated diphenyl ethers (PBDEs) can affect children's learning and memory and neurobehavior. This study investigates whether prenatal exposure to PBDEs was associated with adverse language development in children. Methods: We recruited 178 mother-child pairs in Cincinnati, OH between 2003 and 2006, measured maternal serum PBDEs levels at 16 weeks of gestation using gas chromatography/mass spectrometry and assessed children's language skills at age 5 years. We used the Woodcock-Johnson Tests of Achievement to assess children's abilities in basic reading, brief reading (reading concepts and readiness), letter-word identification (word identification skills), passage comprehension, and word attack (pronunciation of nonsense word). We measured Verbal IQ with the Wechsler Preschool and Primary Scale of Intelligence-Revised. We analyzed the association between prenatal PBDEs exposure and children's language abilities after adjusting for maternal age, race, education, household income, parity, marital status, smoking, depression, IQ, child sex, and Home Observation for Measurement of the Environment score for child rearing. Results: The maternal serum median (range) concentration was 32.50 (5.60, 2015.50) ng/g lipid for Sum4PBDEs (BDE-47, -99, -100, -153, with medians of 18.90, 4.30, 3.40, 4.20 ng/g lipid respectively). A ten-fold increase in Sum4PBDEs was associated with a -3.6 (95% confidence interval [CI]: -10.2, 3.0) point change for brief reading (composite score of word identification and passage comprehension) and a -3.3 (95% CI: -8.1, 1.5) point change of Verbal IQ at age 5 years. Of the PBDE congeners, maternal serum BDE-153 level was inversely associated with the brief reading and word attack, with an estimate of -5.2 (95% CI: -10.9, -0.5) and -5.0 (95% CI: -10.2, 0.3) for a ten-fold increase in exposure, respectively. Conclusion: Prenatal PBDEs exposure was negatively related to child language development at age 5 years.

Keywords: B-flame retardants, D-children, D-prenatal, A-epidemiology

Tu-P-30

A Modeling Framework for Improved Characterization of Near-Road Exposure at Fine Scale

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Abstract: Traffic-related air pollutants could cause adverse health impact to communities near roadways. To estimate the population risk and locate "hotspots" in the near-road environment, quantifying the exposure at a fine spatial resolution is essential. A new state-of-the-art research line source dispersion model (R-LINE) provides an opportunity to improve the characterization of near-road exposure at fine scales. We modeled concentrations from on-road sources using R-LINE at census block level by using traffic activity data from the FHWA's freight analysis framework (FAF3) in conjunction with pollutant and vehicle-specific Emissions Factors from Mobile Vehicle Emission Simulator (MOVES). An approach called the Annual Stability and Wind Clustering method (ASWIC) was used to select representative meteorological conditions for which we simulated hourly concentrations with R-LINE, which were then scaled based on weights to yield annual average concentrations. We estimated background concentrations using Spatio-Temporal Ordinary Kriging (STOK) technique that uses observations from the AQS network. The total ambient concentration was then calculated by summing up the background and on-road concentrations. We applied this framework over three regions of the U.S. - Portland, Maine, North Carolina's Piedmont region, and evaluated against data from a field study in Detroit near the I-96 highway. The difference between the modeled and observed CO concentration is within a factor of two at four monitoring sites near I-96 in Detroit, MI. The modeled concentration is approximately 25% lower than the observed data within 100 meter from the road. The concentration drops by 40 to 60% after 100 meters from the road in Portland, Maine and 20 to 40% in the North Carolina Piedmont. Background concentration dominates PM2.5 and benzene in most of the areas in the North Carolina Piedmont, but on-road source contributes more than 57% of the total within 50 meters from the interstate roadways.

Keywords: C-air, Traffic air pollution, Fine scale exposure assessment

Tu-P-31

A Comparison between Two Exposure Methods for Traffic Related Air Pollution (TRAP) and Their Ability to Predict Lung Function in Asthmatic Children

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Abstract: Land use regression (LUR) is frequently used in epidemiologic studies to estimate exposure to traffic related air pollution (TRAP), but its use can be limited by cost, time, and transferability. In contrast, weighted road density (WRD) may provide a simple, surrogate measure of TRAP exposure based on available road networks. We evaluated each method with regard to estimating TRAP exposure and their ability to predict lung function in a cohort of asthmatic children in Cincinnati, OH. Methods: Concentrations of elemental carbon attributable to traffic (ECAT) were obtained from 27 sampling sites previously used to construct a LUR model in Cincinnati, OH. A WRD model was developed by calculating the length of all roads within 400m of the sampling sites and dividing by the total area. Road densities were then weighted according to road type based on size and traffic flow, and the correlation between sampled ECAT and WRD was determined. LUR and WRD models were then applied to estimate TRAP exposure at the homes of 116 children with pulmonary function data. The association between estimated TRAP exposure from each model and forced expiratory volume in 1 second (FEV1) and % predicted FEV1 were examined by linear regression. Results: WRD was significantly associated with sampled ECAT concentrations (R2 = 0.64), though less so than the LUR model (R2 = 0.75). Residential ECAT estimates derived by LUR were significantly correlated with WRD (r = 0.71, p = <0.01), and both ECAT estimates and WRD were associated with reduced lung function. An inter-quartile range (IQR) increase in WRD resulted in a 40 ml reduction in FEV1 (p = 0.03). Likewise, a 70 ml decrease in FEV1 (p =0.01) and a 4.4% decrease in % predicted FEV1 was seen per IQR increase in ECAT (p = <0.01). Conclusions: WRD may be a suitable alternative for LUR under circumstances where a sampling network and other data are not available. Both WRD and LUR predicted decrements in lung function associated with TRAP exposure.

Keywords: traffic related air pollution, land use regression, road density, asthma, children, traffic related air pollution, land use regression, road density, asthma, children, traffic related air pollution, land use regression,

road density, asthma, children, traffic related air pollution, land use regression, road density, asthma, children, traffic related air pollution, land use regression, road density, asthma, children

Tu-P-32
Developing Land Use Regression Model using the Monte Carlo Method to Account for Measurement Uncertainties
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Abstract: Land use regression (LUR) models are widely used to map variability in air pollutant concentrations in urban areas. LUR models are built to match measurement data, and these data may have two sources of uncertainty: (1) all data have errors associated with instrument precision and accuracy, and (2) the measurements may not capture the true annual (or seasonal) average pollutant concentrations in a given area due to incomplete measurement. We demonstrate that LUR models developed from measurement data are subject to propagation of these errors. Small perturbations (up to +/-20%) in inputs can lead to different sets of variables in traditional LUR models. Therefore, we build a novel LUR model using the Monte Carlo method to explicitly consider the impact of measurement uncertainties. First, traditional LUR models using stepwise regression are developed against 10000 sets of randomly perturbed measurements. The applied perturbation is determined by the estimated sampling uncertainty. Then, the most frequently appearing variables are considered as significant and used for developing the final model using multivariate linear regression. The final model may have a lower capability to explain the observed variation in the measurements, but is still capable to predict the spatial pattern of pollutants. The major advantage of the final model is that it provides uncertainty ranges for regression coefficients. The uncertainty ranges would cover the true values of coefficients (i.e., the values of coefficients when true annual average concentrations are used in the model).

Keywords: A-exposure models, A-geospatial analysis/GIS, A-statistical methods, C-air, B-particulate matter

Tu-P-33
Non-occupational Pesticide Exposure Pathways for Agricultural Women
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Abstract: Women living in agricultural regions may be exposed to relatively high levels of pesticides due to their participation in and proximity to farming activities. Exposure pathways in these women are not well-characterized. We reviewed the evidence from the published literature for the contribution of non-occupational exposure pathways in women living in agricultural areas in North America. Non-occupational exposure pathways included para-occupational (take-home or bystander exposure), agricultural drift, residential pesticide use, and dietary ingestion. Among the 37 publications identified, there was strong evidence for the importance of the para-occupational and agricultural drift pathways, while evidence that residential use of pesticides contributed significantly to exposure was moderate. There was insufficient evidence to understand the contribution of diet to total pesticide exposure. Our review did not identify any hygiene factors commonly recommended in pesticide safety training, such as house cleaning practices, shoe/clothing removal, and separate laundering of contaminated clothes, which were consistently linked to exposure. Exposure metrics predominantly used in the literature, such as pesticide levels in residential dust and biomarkers, aggregated over multiple pathways; therefore disentangling contributions from each pathway was difficult. The strongest evidence for specific pathways came from residential dust measurements. Results based on dust samples and biomarkers were inconsistent, possibly reflecting different exposure time windows and routes, or differences in activity-related contact rates. Our review highlights the need to better understand the relationship between pesticide levels in residential dust and biomarker levels in adults. Moreover, an improved understanding of the important pathways of pesticide exposure in women living in agricultural areas is critical for epidemiologic studies and for designing effective risk mitigation strategies.

Keywords: B-pesticides, A-aggregate exposure

Tu-P-34

APPLICATION OF EPIDEMIOLOGICAL STUDIES RESULTS FOR SUBSTANTIATION OF ANNUAL AMBIENT AIR STANDARD FOR NICKEL IN RUSSIAN FEDERATION

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Abstract: Background/Aims: To derive ambient air nickel BMC for justification of average annual nickel level in ambient air for Russian Federation using epidemiological studies. Methods: In cross-sectional study 382 children aged 3-7 years chronically exposed to low levels of environmental air nickel were examined. Exposure assessment for each child was conducted; nickel concentrations vary from 0.0000067 mg/m3 to 0.000073 mg/m3. We have considered a number of assumptions concerning the relation between exposure to different nickel levels and health effects. Children exposed to lower than under study nickel concentrations regarded as control group, to higher than under study nickel concentrations - as cases. Every assumption was verified by odds ratio that was used to build mathematical models of the «nickel ambient air concentration - odd ratio» relation. As a benchmark level of ambient air nickel, we used a value corresponding to the upper 95% confidence boundary of the obtained model. We have built mathematical models of the relation «ambient air nickel concentration - odds ratio» for several nosologic units from II, III, VI, X, XII chapters of ICD-10 selected in accordance with target organs for chronic inhalation nickel exposure; and for several laboratory tests. Results: The obtained benchmark levels were 0.00002 mg/m3 for asthma, 0.00003 mg/m3 for vasomotor rhinitis, 0.00002 mg/m3 for chronic tonsillitis, 0.00002 mg/m3 for percent of phagocytosis increase, 0.00002 mg/m for phagocytic number increase, 0.00002 mg/m3 for superoxide dismutase blood level decrease, 0.00004 mg/m3 for serotonine blood level decrease. Conclusion: Nickel BMC 0.00002 mg/m3 could be used for substantiation of annual nickel ambient air standard in Russian Federation.

Keywords: A-epidemiology, A-risk assessment, C-air

Tu-P-35

Modeling for Infection Risk during a Disease Outbreak

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Abstract: Quantitative microbial risk assessment (QMRA) aims to characterize risk of contracting an infectious disease. Various dose-response models have been developed for risk assessment purposes, but the infection risks may not be well characterized due to difficulties in exposure assessment. Conventional models are especially problematic in case of an emerging outbreak, during which the exposure scenarios may change over time. In this study, the infection risk of shigellosis was evaluated using outbreak investigation studies. A simple probabilistic model was constructed to estimate the probability of infection during an outbreak. Various assumptions were made with the model, e.g., infection and disease are direct results of pathogen exposure, only the same group of people were exposed to the pathogen, and outbreak ends when all susceptible individuals are infected. Reports of disease outbreaks were selected from the literature and reanalyzed for risk of infection. The number of disease cases was used as an indicator of infection, and the total cases was used as the total susceptible population. During an outbreak, the number of new cases increased as a result of elevated contact risk, causing the risk of infection to increase. As the size of susceptible population decreased and the risk of infection increases over time, the number of new case would also decrease with time towards the end of an outbreak. Twenty one outbreak studies were selected for model construction, and a simple exponential model was constructed to describe the change of infection risk during an outbreak. By adjusting for outbreak duration, the risk of infection could be described as $p(\tau) = 0.016\exp(4.16\tau)$, where τ represents relative time in the outbreak. Two additional studies were tested using the model, and the results closely followed the outbreak profile. Further studies are desirable to examine the applicability in outbreak prediction.

Keywords: A-risk assessment, B-microbial agents, A-Infectious disease

Tu-P-36 - Withdrawn

Tu-P-37

Environmental Exposures to PM and Resultant Metabolomic Perturbations in Humans

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Abstract: Studies have shown the adverse pulmonary and cardiovascular impacts of human exposures to airborne particulate matter (PM2.5). Epidemiological studies, primarily the cardiovascular studies, drive much of the risk assessment for ambient PM standards. Although PM concentration is the most common metric of exposure and risk, this measure fails to define the chemical variations that underlie potential differences in toxicity. Chemical species in PM, measured by EC/OC, ions, elements, and extractable organics, clearly demonstrate source-dependent variability in the chemical composition of PM. Such chemical variability would be expected to result in different biochemical perturbations in those people exposed, as assessed through a broad-spectrum metabolomics analysis. This study draws on PM filters and associated biological samples (urine, plasma, exhaled breath condensate or EBC) archived from two earlier PM exposure studies. One study collected samples (EBC, urine) in both Butte, MT, and Fairbanks, AK. The fractional contribution from wood smoke is higher in MT and the contribution from fuel oil is higher in AK. The second study utilized chamber-based exposures of people to PM and PM + NO2, or not, with the collection of blood plasma after exposure.PM filters from both studies were solvent-extracted and the extracts were analyzed by 2-D GC/TOF-MS.The SVOC profiles were subjected to multivariate analysis and visualization using SIMCA 13.0 (Umetrics, Umeå, Sweden) which revealed several SVOCs that differentiated MT-based from the AK-based samples. Analysis of data derived from the EPA filter analysis is in process. Differences in exposure, such as high/low PM mass in a given location, relative concentrations of discriminators, and location, will be used to establish groups for planned metabolomics investigations. This work was sponsored by RTI, NIEHS (5R01ES016336), NIH Common fund (11010737) and the US EPA. This abstract does not necessarily reflect EPA policy.

Keywords: B-SVOCs, B-particulate matter, A-biomarkers, C-air, metabolomics

Tu-P-38

Exposure to PM2.5 and Ultrafine Particles in Restaurants Compared to that in Cars

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Abstract: Prior studies have measured exposure to ultrafine particles while traveling in motor vehicles, but few studies have measured exposure due to cooking and almost no studies have measured indoor concentrations in nonsmoking restaurants. We made 50 trips for dinner by automobile to a variety of restaurants in Northern California while carrying portable real-time monitors that measured both fine particles (PM2.5) and ultrafine particles (10-1,000 nanometer UFP) over the entire trip. We also estimated the volume of each restaurant and counted the number of patrons present as an indicator of cooking activity. The window positions of the automobile were set in to allow ample intrusion of pollutants from the roadway, and the drives included one or more busy arterial highways. We found that UFP and PM2.5 concentrations measured in the restaurants were much greater than the in-vehicle exposures while driving to and from the restaurants. For the first 26 restaurants analyzed, the mean UFP concentration inside the restaurants for visits averaging 1.3 hours was 80,600 particles/cm3, compared with a mean of 19,500 particles/cm3 for in-vehicle travel averaging 0.7 hours, and all the restaurant means were higher than the in-vehicle means. The highest 10% of the indoor restaurant UFP concentrations (174,000 particles/cm3) were 5.4 times the highest 10% of the UFP in-vehicle exposures (32,000 particles/cm3). Sushi restaurants with limited cooking activity and restaurants with relatively few patrons had the lowest UFP concentrations. Indoor PM2.5 concentrations in 24 of the 26 restaurants were less than 20 µg/m3, but one restaurant had a PM2.5 concentration of 226 µg/m3, which was also high when the visit was repeated. The results indicated that the exposure a person receives from cooking activity in a restaurant is much greater than the exposure a person receives while traveling by motor vehicle to and from the restaurant.

Keywords: A-indoor environment, B-particulate matter, B-nanoparticles, B-nanoparticles, Vehicle Exposure

Tu-P-39
Investigating the Effects of PM2.5 Number Concentration from Different Sources on Lung Function

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Abstract: Particles with aerodynamic diameters smaller than 2.5 μm (PM2.5) have been shown to link with adverse health effects. Most of these health related studies investigated the associations between the ambient PM2.5 measurements and the health outcomes. However, to understand the underlying disease mechanism and develop effective control strategies, it is also crucial to identify the important sources of PM2.5 that contributed to the observed health effects. The goal of this study is demonstrating the utility of source apportionment models in epidemiological research. A PM2.5 dataset of particle number concentration and size distribution collected at a monitoring station in Taiwan from January to August in 2008 was first complied. The positive matrix factorization (PMF) model was applied to this dataset to identify the sources and their contributions to the number concentrations. A panel of 59 children with asthma and/or allergic rhinitis was recruited in this study. Each subject was monitored for the forced vital capacity (FVC) four to five times during the eight-month study period. The association between FVC and source apportionment results was then investigated with the mixed effect regression equation. The PMF modeling results identified five sources: local-mix, transported-mix, fresh gasoline emission, fresh diesel emission, and transported vehicle emission. The local-mix and transported-mix sources contributed 4.2% and 13.9% of the PM2.5 number concentration. In the health data analysis, it was further found that the transported-mix source was adversely associated with FVC after 1 day lag of exposure. This finding suggests that the importance of controlling the PM2.5 from non-local sources should not be undervalued.

Keywords: B-particulate matter, A-epidemiology

Tu-P-40
Serum Levels of DDE in Residents of Delta and Non-Delta Regions of Mississippi and Association with Type 2 Diabetes

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Abstract: A number of organochlorine compounds, including some legacy organochlorine insecticides or their metabolites/degradates, have been associated with the prevalence of type 2 diabetes. The Mississippi Delta region is an area of high agricultural activity including high pesticide usage including the legacy organochlorine insecticides such as DDT. Random samples of soil from the Delta and non-Delta regions of Mississippi were analyzed for DDE residues by gas chromatography/mass spectrometry. Serum samples and select demographic and clinical data were obtained from male African American and Caucasian subjects from Delta and non-Delta regions from the Veterans' Administration Hospital in Jackson, MS; informed consent was obtained prior to recruitment into the study. All information and samples were de-identified. Serum samples were analyzed for DDE by gas chromatography/mass spectrometry. The Delta soils had about 10-fold higher levels of DDE than the non-Delta soils among those soil samples having quantifiable levels. While 80% of the Delta soils had quantifiable levels of DDE, only 23% of the non-Delta soils had quantifiable levels. DDE levels in serum adjusted for serum lipid levels were about 1.2-fold higher in diabetics than non-diabetics (about 1300 and 1160 ng DDE/g lipid, respectively). African Americans had about 2.6-fold higher DDE than Caucasians (about 1990 and 760 ng DDE/g lipid, respectively). Deltans had about 1.5 times higher serum DDE than non-Deltans (about 1560 and 1010 ng DDE/g lipid, respectively). Results suggest that the higher soil levels of DDE in an agricultural region are reflected in higher serum levels of the region's residents, and that the higher DDE levels in serum of diabetics might be a useful environmental public health indicator of type 2 diabetes risk. (Supported by USEPA STAR RD-83479501-0).

Keywords: A-biomarkers, A-biomonitoring, B-pesticides, C-soil, A-epidemiology

WEDNESDAY, OCTOBER 15, 2014

We-S-A1: Semivolatile Organic Chemicals in Deciduous Teeth: Potential Biomarkers of Perinatal Exposure

We-S-A1-01
Measurement Variation and Distribution of Semivolatile Organic Chemicals in Deciduous Dental Tissues

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Abstract: Measurement variation of semivolatile organic chemicals (SVOC) including acetaminophen, organophosphate insecticide metabolites, and monoester phthalate metabolites was investigated in six pulverized deciduous tooth crowns (paired upper central incisors, first molars, and paired lower canines) of a child whose birth apartment received quarterly insecticide treatments. Measured SVOC concentrations were repeatable in paired simultaneously forming tooth crowns, and generally agreed within 50%. Detected analytes were present in all six teeth, with patterns indicative of exposure variation over the crown formation period. For this infant, uptake of acetaminophen and the specific metabolites of chlorpyrifos and diazinon appeared greater in utero, while uptake of monoethyl and monoethylhexyl phthalates appeared greater after birth. The distribution of SVOC between deciduous tooth pairs of enamel and dentin was also investigated by measuring the concentrations in presumed dentin (lighter) and enamel (heavier) particles of seven pulverized deciduous tooth crowns which had been separated by gravity in a cadmium tungstoborate solution (density 2.4). Determined concentrations of the specific chlorpyrifos metabolite, DEET, and four polyunsaturated fatty acids were consistently larger in dentin than in enamel. In contrast, the distribution of the concentrations of five phthalate monoesters was similar in the dentin and enamel pairs.

Keywords: B-SVOCs, A-biomarkers, A-cumulative exposure, D-prenatal, D-neonatal

We-S-A1-02
Environmental Exposure Measured in Deciduous Teeth as Potential Biomarkers of Autism Risk

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Abstract: Background: Gene/environment interactions are regarded as the probable explanation for idiopathic autism. However, the largest roadblock to investigating adverse environmental exposures has been identifying valid biomarkers of exposures that occur during critical developmental periods. Objective: To determine if maternal retrospective reports about child's exposure to various chemicals would correspond to the chemical concentrations found in the child's deciduous teeth. Methods: Seventy-one deciduous teeth of children diagnosed with autism were analyzed for acetaminophen, insect repellant DEET, fatty acids, and metabolites of pesticides and phthalates. Tooth selection was based on extremes of high and low self-reported exposures in survey responses provided by the mothers. Electrospray ionization liquid chromatography tandem mass spectrometry was used to determine the concentrations of most targeted chemicals in the pulverized tooth samples. Results: Tooth detection rates were 44% for acetaminophen, 75% for DEET, 13% for specific metabolites of diazinon and chlorpyrifos, and 40-100% for different phthalate monoester metabolites. DEET tooth concentration was correlated with mother's reported use of insect repellant on the child (R2 =.16, p<.002); DEET was detected in 91% with higher use vs. 63% with lower use (p <.01). Mother-report of fumes/chemical exposure from remodeling uses, including new paint and new carpet, during child's life was significantly associated with measured tooth ranks of the phthalate metabolites MEHP (p=.02) and MnBP (p=.05). Conclusions: Mother's retrospective self-report of her child's usage/exposure to products possibly containing DEET and phthalates is consistent with measured concentrations or detection of DEET and phthalates in the child's deciduous tooth. This provides evidence that deciduous teeth are useful biomarkers of exposure to DEET and phthalates during child development.

Keywords: A-biomarkers, B-phthalates, A-analytical methods, B-pesticides, D-children

We-S-A1-03
Newly Identified Semivolatile Organic Chemicals in Deciduous Tooth Crowns

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Abstract: Most prior studies of semivolatile organic chemicals (SVOC) in pulverized teeth have investigated specific targeted chemicals using chromatographic methods with comparison to analytical standards of these chemicals. We applied a more exploratory approach to identify previously unstudied SVOC which sequester in teeth. This was accomplished using two-dimensional gas chromatography time-of-flight mass spectrometry (GCxGC-TOF MS) to tentatively identify the mass spectra of semivolatile compounds present in a pulverized shed tooth crown from six children. We then verified the tentative identifications, quantified the confirmed concentrations in the teeth against analytical standards of some of those compounds, and tabulated important physical-chemical properties of the confirmed chemicals which were stored in these teeth. Many of the confirmed compounds found by GCxGC-TOF MS in the six teeth are used in consumer products, including sunscreens (benzophenone, homosalate, oxybenzone), the widely-used antibacterial triclosan and it photo-degradation product 2,4-dichlorophenol, the flame retardant triphenyl phosphate, the plasticizer dibutyl phthalate, the teething analgesic benzocaine, the widely-used antioxidant butylated hydroxytoluene, and benzyl benzoate. The confirmed SVOC possess great diversity in melting and boiling points, octanol-water partition coefficient (log Kow), vapor pressure, Henry's law constant, and dissociation constants, suggesting that numerous SVOC in the circulation possess properties amenable to tooth sequestration.

Keywords: A-biomarkers, A-analytical methods, B-SVOCs, D-children

We-O-B1: Biomarkers and Metabolomics - I

We-O-B1-01
Metabolism and Excretion Kinetics of Aniline in Four Male Volunteers after Oral Dosage

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Abstract: Aniline is an important high-volume production chemical and extensively used for the manufacture of pharmaceuticals, pesticides and colors/dyes. Human biomonitoring studies have shown the ubiquitous exposure of the general population to aniline through urinary aniline measurements. Recently, we also reported on the ubiquitous presence of N-acetyl-4-aminophenol which is both, a major metabolite of aniline and a pain reliever known as paracetamol/acetaminophen. Epidemiological studies suggest intrauterine exposure to paracetamol as risk factor for male reproduction disorders and antiandrogenic effects. Thus, exposure to aniline is of interest to both, occupational and environmental medicine. Knowledge on (human) metabolism of aniline is scare. Therefore we dosed four healthy male volunteers with 5 mg of isotope labelled aniline. Urine was collected consecutively for 48 h and elimination kinetics and conversion factors of the major aniline metabolites were recorded. Aniline and its metabolites were determined using HPLC-MS/MS and GC-MS techniques. N-acetyl-4-aminophenol was the major metabolite representing 50-81% of the dose, followed by its mercapturic acid conjugate with 2.8-8.6% of the dose. The sum of free (unconjuagted) aniline and acetanilide accounted for approximately 0.1-0.3% of the aniline dose. Total recovery of all the aforementioned metabolites was 53-85% of the oral dose. All metabolites were excreted rather fast with elimination half-times between 1.5-4 h except for the mercapturic acid conjugate (7-9 h). In the present study we provide reliable data on the human metabolism of aniline including urinary metabolite conversion factors. We also show analogies in the metabolism of aniline and paracetamol. The knowledge from this study can be used in future human biomonitoring studies for exposure and risk assessment in environmental and occupational settings.

Keywords: aniline, A-biomonitoring, D-occupational, A-exposure factors

We-O-B1-02

The Exposure Dosage Induced Metabolome Changes for Population Based Health Risk Analysis: Example of Arsenic

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Abstract: From chemical exposure to health risk, the different strategies are applied in the exposure assessment. Although with clear information of exposure routes, the bottom-up strategy on scenario models can induce many uncertainties, the top-down strategy on biological monitoring data, on the contrary, can gain the accurate assessment. In the followed population based direct risk analysis, the exposure induced effect biomarkers and their dose-dependent responses are required. To address the possibility of the population based direct risk assessment, the exposure dosages induced urinary metabolome changes and metabolic biomarkers were investigated for arsenic exposure in a male cohort (n=127) by PLS-DA, where the differentiation between the 1st and the 5th quintile samples was recognized by using a pattern supervised approach. Hypothesized the 1st quintile samples was "no exposure" and "no effect" group and the upper tiled groups were set as "exposure" and "effect", then the "dose" can be expressed as the median of each group and the "response value" can be expressed by using the odds ratio model. The dose-response curves between metabolic biomarkers and the internal dosages of inorganic arsenic were also plotted. By analysis the dose-response curves, the LOAEL was derived, which are usually the results of different tiers animal studies in the classic risk analysis procedure. The biomarkers mined from the metabolome changes that responses to the inorganic arsenic exposure were testosterone, hippurate, serine, guanine and acetyl-N-formyl-5-methoxykynurenamine. The dose-response curves suggested that about 18-28% individuals exposed the inorganic arsenic at levels could cause metabolism interruption, and the threshold value was 9.7-14.2µg/g creatinine. Generally the dosage induced metabolomic markers can be used to investigate the pollutant related effect; in further, the dose-response curves can be plotted for directly deriving the population based risk assessing results.

Keywords: A-biomonitoring, A-biomarkers, A-risk assessment, arsenic, metabolome, arsenic, metabolome

We-O-B1-03

Partitioning of Polychlorinated Biphenyls into Human Cells and Adipose Tissues: Evaluation of Octanol, Triolein and Liposomes as Surrogates

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Abstract: Whereas octanol, triacylglycerides, and liposomes have all been proposed as surrogates for measuring the affinity of hydrophobic organic contaminants to human lipids, no comparative evaluation of their suitability exists. Here we present the results of batch sorption experiments to determine the partition coefficients of 18 polychlorinated biphenyls (PCBs) into two types of human materials and two types of surrogate materials from water. The human materials used were human abdominal fat tissues (KAFT/water) from seven individuals and human MCF-7 cells cultured in vitro (Kcells/water). The two surrogate systems were triolein (Ktriolein/water) and eight types of liposomes (Kliposome/water). All experiments were conducted with polyoxymethylene passive samplers at 37 °C. For PCBs, KAFT/water and Kcells/water were under-predicted by both Koctanol/water and Kliposome/water by a factor of 3 on average. Partitioning of PCBs into triolein on the other hand closely mimicked that into human lipids, for which triolein is thus a better surrogate than either octanol or liposomes. Comparison of our measured KAFT/water and Kcells/water values with previously published ppLFERs indicate that, for PCBs, it is possible to predict human lipid-water partitioning with ppLFERs with a root mean square error of less than 0.15 log units. The mechanistic human bioaccumulation model ACC-human was then used to evaluate the potential impact of under-predicting partitioning of PCBs into lipids by a factor of 3 on human body burdens for these 18 PCBs over the course of an individual's lifetime. Overall, this study contributes to a better assessment of hydrophobic organic contaminant bioaccumulation in humans by guiding the selection of (i) a surrogate for the experimental determination and (ii) a method for the prediction of partitioning into human lipids.

Keywords: A-exposure models, A-risk assessment, Lipid partitioning, bioaccumulation, Lipid partitioning, bioaccumulation

We-O-C1: Advances in Pesticide Exposure Assessment - III

We-O-C1-01
Overview of EPA Pesticide Risk Assessment Methods for Spray Drift and Volatilization

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Abstract: Non-occupational exposures such as to bystanders resulting from spray drift and volatilization of pesticides is a potential Environmental Justice concern which must be taken into account in pesticide risk assessments. As such, in 2014 EPA developed scientifically based methods to estimate the potential risks from pesticides as a result these potential exposures. The spray drift method considers the potential risks for those who live adjacent to pesticide applications. It is based on peer reviewed methods to calculate drift potential for various application methods and for calculating subsequent exposures. Specifically, the AgDrift model and EPA's SOPs For Residential Exposure Assessment are used to estimate these risks. Volatile fumigant pesticides have been previously considered in pesticide risk assessment using available air monitoring data and a peer reviewed dispersion model (PERFUM). EPA is now using a similar approach for conventional pesticides which uses a screening method to identify those pesticides that require additional data to evaluate potential exposures that may occur adjacent to treated areas. This screening model predicts emissions because air monitoring data are generally not available for conventional pesticides.

Keywords: A-environmental justice, A-exposure models, A-risk assessment, B-pesticides, C-air

We-O-C1-02
Developing Decontamination Tools and Approaches to Address Indoor Contamination Resulting from Pesticide Misapplications

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Abstract: There is an elevated awareness of pesticide misapplications occurring in the indoor environment due to an increase in the prevalence of bed bug infestations and their resistance to current use pesticides. Misapplications might include the use of pesticide products not registered by the EPA for indoor use, or the application of approved pesticide products at concentrations that far exceed the labeled rates or in a manner that violates the product labeling. Currently, there are few tools to adequately evaluate pesticide residues on indoor surfaces in order to evaluate potential risks to occupants. There are also a limited number of decontamination procedures available to adequately reduce pesticide levels in order to mitigate those risks. Ongoing research is developing information to evaluate indoor pesticide misuse incidents and reduce occupant exposures. The presentation will describe efforts to measure and remediate malathion and carbaryl on select surfaces. The results of surface wipe sampling methods development and surface/pesticide decontamination studies will be presented. Surface wipe findings have shown efficiency variability based on surface type, formulation and surface concentration. Decontamination agents have been identified as efficient at degrading residues, but impacted by surface type. In addition, the use of the Stochastic Human Exposure and Dose Simulation (SHEDS) Lite model to evaluate exposures will be discussed. Findings will guide standardized surface sampling methods, remediation approaches and the safe re-occupancy of remediated sites.

Keywords: B-pesticides, A-emergency response, A-exposure models, A-sampling methods, C-surfaces

We-S-D1-01

The Impact of a Nano-Ceria Diesel Additive on Physicochemical and Toxicological Properties of Diesel Exhaust Particles

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Abstract: Fuel additives incorporating nanosized ceria have been increasingly used in diesel engines as combustion promoters. However, few studies have assessed the impact of these nanotechnology-based additives on pollutant emissions and toxicity. In the Risk Assessment of Manufactured Nano-materials Used in Consumer products (RAMNUC) project, we systematically compare emission rates of particulate and gaseous pollutants from a single-cylinder, four-cycle diesel engine using fuel mixes containing nano-ceria of varying concentrations. The test fuels were made by adding different amounts of a commercial fuel additive Envirox™ into an ultra-low-sulfur diesel fuel at 0 (base fuel), 0.1, 1, and 10-fold the manufacturer-recommended concentration. Our findings on the impact of Envirox on emission rates of particulate and gaseous pollutants have been published, suggesting that risk assessment need not only to consider particle mass reductions and particle number increases but also potential changes in particle toxicity. In this presentation, we report new results on the impact of Envirox on physicochemical and toxicological properties of diesel exhaust particles. We found that increasing fuel ceria concentrations led to decreases in the size of emitted particles, decreases in the fraction of elemental carbon, and increases in the fraction of organic carbon. However, the addition of ceria did not show a clear change pattern in particle electrical charge (zeta potential). Preliminary results from in vitro (in pulmonary cells) and in vivo (mice instillation) experiments showed decreased pro-inflammatory responses to particles emitted from diesel containing Envirox at the 10-fold recommended concentration. More complete and comprehensive data will be available for presentation concerning the impact of Envirox on cytotoxicity, anti-bacterial immunity, cellular and tissue inflammation, and lung mechanical function.

Keywords: B-nanoparticles, C-consumer products, A-risk assessment

We-S-D1-02

Emission Characteristics of Nanoparticles from Consumer Spray Products

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Abstract: Nanotechnology-enabled consumer sprays have a potential for the release of high concentrations of nanoparticles during application, which can result in user exposures. As part of investigation of risks associated with nanotechnology-enabled consumer products, we determined concentration, size distributions, shape and agglomeration of particles released during the use of various Ag and ZnO - containing consumer sprays. The sprays were aerosolized using their built-in sprayers and two different commercial atomizers. The released particles were analyzed using a Scanning Mobility Particle Sizer and an Aerodynamic Particle Sizer. A compact electrostatic collector built in-house was used to capture airborne particles to examine their shape and agglomeration using Transmission Electron Microscopy (TEM), while an ICP-MS method was used to investigate the presence of metals in the selected consumer products. Overall, almost 20 nanotechnology-enabled consumer sprays with Ag and ZnO were investigated. It was found that nanosized particles were released during the use of all investigated products. Also, the release of micron-sized nanoparticle agglomerates and nanoparticles attached to larger particles stemming from product matrices was observed. The presence of individual nano-sized particles and micron-sized agglomerates in the airborne phase was confirmed when analyzing captured airborne particles using TEM. As per ICP-MS analysis, the concentration of Ag in the products ranged from 1 to 16 mg/L, while the concentration of Zn ranged from 10 to 100,000 mg/L; presence of other metals, such as lead, was also detected in some products. The data obtained in this part of the project will serve as input for detailed modeling of nanoparticle deposition in the respiratory system as well as for estimating

the extent of population exposures. In addition, these experiments allow us to select consumer sprays for investigating nanoparticle effects in in-vitro and in-vivo models.

Keywords: B-nanoparticles, A-exposure factors, A-indoor environment, C-consumer products

We-S-D1-03
Potential Toxicity of Nanosilver- and Nanozinc-Containing Consumer Products to the Lung

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Abstract: Zinc and silver nanoparticles (NPs) are in many consumer products - sunscreens, de-odorizing sprays, cleaning products and immune supplements and human exposure during use is likely. It is unclear whether NPs in these products will have adverse health effects. This research aims to determine the potential toxicity and bioreactivity of nano-silver- and nano-zinc-containing consumer spray products in the lung. Consumer products and NPs isolated from these products are being studied in vitro and in vivo. To date, we have tested silver and zinc NPs isolated by filtering selected consumer products through 10kDa ultracentrifugation tubes. Human alveolar type-1 epithelial cells (TT-1) were exposed to the whole products, NPs or vehicle fractions for 24h. MTS assay was used to assess cytotoxicity. Source-well silver spray was not cytotoxic. Smelly Shoe Spray (silver NPs) caused 15% cell death at the highest concentration (1/10 original dilution); the vehicle (without NPs) had no effect on cell viability, whereas exposure to the NPs caused 10% cell death at the highest dose, 0.3877ug/ml (1/10 dilution). Mesosilver was not cytotoxic; however, the NPs caused 20% cytotoxicity at 0.198ug/ml and 0.397ug/ml and 30% at 1.5882ug/ml (1/80, 1/40, 1/10 dilution, respectively). Zinc NPs-containing products and silver NPs-containing Nanofix induced the highest cytotoxicity (100%) at all concentrations; removal of the NPs from Nanofix induced only 10% cell death and only at the highest concentration (1/10 dilution). Preliminary results raise health and safety concerns. The surprisingly high levels of cytotoxicity displayed by some of the products, at low concentrations, causes concern. Our ongoing experiments with additional cell models and a mouse model will provide comprehensive data on the bioreactivity of these consumer products. These experiments will also examine the mechanisms by which these nanoparticle-containing products damage cells, the lung, and the immune system.

Keywords: B-nanoparticles, C-consumer products

We-S-F1: Study Designs for Assessing Human Behavior for Exposure Modelling - I

We-S-F1-01
Experiences from the German Environmental Survey (GerES) and the German Environmental Specimen Bank (ESB)

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Abstract: Introduction & methods: The German health-related environmental monitoring program investigates human exposures to environmental stressors and consists of the German Environmental Survey (GerES) and the Environmental Specimen Bank (ESB). In addition to human biomonitoring (HBM) and indoor monitoring for different segments of the general population, standardized interviews performed in GerES yield reference data on exposure influencing factors. The ESB obtains and cryo-preserves i. a. HBM samples, physiological parameters, and self-administered questionnaire data on exposure-relevant behaviors from adults (20-29 yrs.) on a yearly basis focusing on temporal changes. Results: Children in GerES IV spent 15 h 31 min at home (4:46 in other indoor environments, 3:43 outdoors) differing by socio-economic status. Exposure models indicate the time spent at home being less important for inhalative exposures than indoor pollutant levels. The ESB documents how the decreasing fraction of participants with dental amalgam (1997: 83 % vs. 2013:10 %) is associated with decreasing urinary mercury (1997: 0.6 µg/L vs. 2013: 0.07 µg/L). ESB data on decreasing 24 h urine volumes (1986: 1.3 L vs. 2013: 2.0 L) allows for adjusting time trends in internal exposure. Conclusions & Outlook: GerES and ESB demonstrate how exposure factors can be generated within regularly conducted

population studies. As for all participants also pollutant monitoring data are available, individual associations between exposure factors and internal exposures to various contaminants can be investigated. These analyses can also account for socio-demographic differences and time trends in exposure relevant behaviors. The further development of both studies includes online-questionnaires and interviews on potential sources of emerging pollutants. Acknowledgements: We thank the German Ministries for the Environment (BMUB) and Research (BMBF) for funding and the Robert Koch-Institute for good cooperation in GerES.

Keywords: A-biomonitoring, A-exposure models, A-risk assessment, B-phthalates, B-metals

We-S-F1-02
On-going Harmonization of Eexposure Questionnaires Among Large-scale Birth Cohort Studies

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Abstract: Many exposure models have been developed to assess environmental exposures that may affect human health. The exposure models utilize biological and environmental monitoring data as well as personal behaviour and uptake dose information. Although the monitoring is based on instrumental analyses, the personal behaviour and uptake dose estimation often rely on observations and questionnaires. Major countries have invested resources to put together the information and publish it as exposure factors. The exposure factors are often used to examine public exposure to environmental stressors. In recent years, public interest in the impact of the environment on children's health and development is increasing. Large-scale studies on children's environmental health, including both longitudinal and cross-sectional, have been designed and implemented in several countries. Individual exposure estimation is required in order to examine the relationship between exposure and child health. When the cohort sizes become large, e.g. over 10,000 children, investigators have to rely on questionnaires to obtain the individual exposure information. France, Germany, Japan, Shanghai (China) and the United States that are planning or conducting large-scale children's environmental health studies have gathered to form an international working group to harmonize outcome and exposure measurement methodologies for future data pooling and analyses. Questionnaire harmonization is one of the main topics among the working group. The group identified three major contaminants including mercury, phthalates and organophosphates for the harmonization. The target questionnaire includes not only questions asking the use of related products but also the ones exploring behaviours that may connect the exposure to the contaminants of interest. The progress of the working group discussion will be presented in the symposium. Acknowledgement: Environment and Children's Health International Birth Cohort Group

Keywords: A-behavior, A-epidemiology, A-exposure models, D-children

We-S-F1-03
SUPERB Study: Lessons Learned

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Abstract: Determining use of consumer products, such as personal care products, cleaning products, and pesticides is of interest. In the SUPERB (Study of Use of Products and Exposure-Related Behaviors) Study, four platforms were used to collect information on use within California households with young children and older adults. First, traditional telephone questionnaires were administered annually for three years. We included some experimental questions to determine participant's interpretation of things such as "green" cleaning products. Second, web-based questionnaires were administered quarterly for 18 months. Longitudinal variability in pesticide applications and cleaning products were determined, with more variability found for pesticide use than cleaning product use. Frequency of cleaning product use and performing cleaning tasks did not vary by season. We also present participant response to completing on-line questionnaires. Third, we utilized a novel platform that uses the bar codes readily found on consumer products. The bar code methodology was evaluated based on feasibility, the fraction of products found that had readable bar codes and that could be identify products, and

ability to determine mass used. We found a) 63% of personal care products and 87% of the household care products had readable barcodes with 47% and 41% having sufficient data for product identification, respectively and b) the amount used could be determined most of the time. We attached motion sensors to the two cleaning products the participant cited as the most frequently used as an alternative method to record product use. Fourth, we conducted home walkthroughs to determine furnishings, discussing the furnishings with the participant, allowing us to gain insight to the typical level of knowledge homeowners had on product materials, ages, and treatments. We will provide lessons learned from this effort, insights on the optimal data collection platforms, and needed frequency of collection.

Keywords: A-activity patterns, A-exposure factors, C-consumer products, B-pesticides

We-S-A2: Integration of Life Cycle Assessment (LCA) and Risk Assessment

We-S-A2-01
Life-Cycle inventory/impact Assessment in the context of Chemical Risk Assessment: An Informatics-driven Scoping Review

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Abstract: One of the goals of Life-Cycle Assessment (LCA) is to compare the full range of environmental effects assignable to products and services in order to improve processes, support policy and provide a sound "systems-thinking" basis for decision support. How in fact LCA can be incorporated into chemical risk assessment (CRA) and management/decision support is not as clear, although it is widely anticipated to function symbiotically and provide comprehensive rigor in CRA. Aside from a brief history on how the two disciplines evolved and overlap, in this presentation we will provide an informatics driven scoping review and bibliometric analysis of the entire corpus of literature related to the overlap of LCA/CRA including, but not limited to; visualization of key themes, available and accessible data, information, modeling gaps and chemical space thus far explored in pre-existing literature into a concise overview. We will identify new data-streams, proxies and models to support the initiative of re-contextualizing or tailoring LCA to chemical risk assessment from both a source-to-exposure (receptor) and exposure (receptor)-to tissue dose -adverse outcome pathway context to identify key elements in supporting "screening-level" methods, and translate CRA into an LCA setting. [Disclaimer: The views expressed in this abstract are those of the authors and do not necessarily reflect the views or policies of the U.S. Environmental Protection Agency]

Keywords: A-life cycle analysis, A-risk assessment, Scoping Reviews

We-S-A2-02
Health Impacts of Consumer Exposure During Product Use: Near Field Exposure Applied to Risk Assessment and LCA
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Abstract: Both Risk Assessment (RA) and Life Cycle Assessment (LCA) constitute potential approaches to quantify exposure to consumer products. RA is primarily chemical focused, one chemical being used in numerous consumer products used in very different ways. LCA, in contrast, is product-oriented and usually considers a well-defined application, which a priori makes it well suited to assess chemicals embedded in products. Despite this, LCA paradoxically has often neglected exposures occurring during the use stage and has primarily focused on exposures to outdoor emissions. Thus, there is a need to extend LCA and RA practice and develop appropriate metrics for assessing direct use stage exposure. We first propose a systematic ontology of exposure to relate the product classification within the ACToR and Household Product databases to exposure models, looking at the mode of application and the environment in which each product is used. We then introduce the product intake fraction - the fraction of a chemical in a product that is eventually taken in by the exposed human population, e.g. the product user(s) - as a measure to consistently and transparently quantify human exposure to chemicals in consumer products. The product intake fraction is both LCA and RA compatible: it may be used to estimate average exposure to consumer product chemicals (e.g. phthalates in children's mouthing toys) and it also may be used to back-calculate maximum allowable concentrations of substances inside products (e.g. dermally applied parabens in cosmetics). We finally discuss which method of RA and LCA is best adapted to which application. We show how the use of sentinel products and of plausible

ranges in concentrations derived from chemical function within a product, may be used to assess use stage-related product exposure.

Keywords: A-chemical prioritization, A-exposure models, A-life cycle analysis, A-risk assessment, C-consumer products

We-S-A2-03
Framework on Life Cycle Impact Assessment for Indoor Emissions of Engineered Nanoparticles, Part 1: Exposure and Uptake
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Abstract: The growing use of engineered nanoparticles in consumer products may pose a potential risk to human health based on initial results from toxicity studies. A primary group that will be affected by these materials is the workers involved in the manufacture of either the nanocomponents or the products incorporating them. The inclusion of indoor health risks in life cycle impact assessment methods is still relatively new and has first focused on evaluating exposure to gases using a one-box version of the USEtox model. Further enhancements to this approach are discussed for the purpose of introducing worker health as an impact category when applying life cycle assessment to consumer nanoproducts. Initial modeling results have focused on the exposure and uptake of nanomaterials in the absence of consensus effects data. Preliminary impact calculations are demonstrated using interim characterization factors derived from a literature review of exposure and toxicity studies. A key challenge when modeling nanomaterials is the need to reconcile the use of various concentration units (surface area, particle number, mass, etc.) in reported toxicity and exposure studies.

Keywords: A-nanotechnology, A-indoor environment, A-life cycle analysis, A-risk assessment, A-workplace

We-S-A2-04
Use of Disability Adjusted Life Years (DALYs) in Integration of Life Cycle Assessment (LCA) and Quantitative Microbial Risk Assessment (QMRA): Sydney Replacement Flows Project
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Abstract: Life cycle assessment (LCA) and quantitative microbial risk assessment (QMRA) are commonly used to evaluate human health impacts from the production of goods or services. However, given their very different approaches and coverage of issues, the two methods may yield contradictory results. Here we describe key differences based on health risks for separate analyses and for combining LCA and QMRA through the use of the common health metric, the disability adjusted life years (DALYs) in order to achieve a more holistic environmental assessment of human health impacts. As a part of the Western Sydney Recycled Water Initiative, the Sydney Replacement Flows Project (RFP) is providing some of the required environmental flow in the Hawkesbury-Nepean River with reclaimed wastewater to secure Sydney's water needs. We undertook LCA to assess human health impacts associated with energy and chemicals used in the associated water and wastewater treatment plants and QMRA to address waterborne pathogen risks for two scenarios: with and without RFP. The results of LCA and QMRA were then combined using the common metric, DALYs. The assumptions used behind DALY value derivations and potential obstacles in merging the results of LCA and QHRA will be discussed. Based on the supply chain-associated risk, the LCA results for the "With RFP" scenario yielded more DALYs than "Without RFP" scenario, whereas the direct human exposure QMRA results with reference pathogens (viral, bacterial and parasitic protozoan) indicated that the RFP would yield less DALY impact than the "Without RFP" scenario. Hence, given the different hazards evaluated by the two approaches, the importance of utilizing both LCA and QMRA aspects in comparative health assessments helps to avoid problem shifting and together provides a more holistic assessment.

Keywords: A-life cycle analysis, A-risk assessment, Disability adjusted life years (DALYs), B-microbial agents, C-water

We-S-A2-05

Integration of Quantitative Microbial Risk Assessment with Life Cycle Assessment: Case Study of Options to Provide More Sustainable Household Water Services

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Abstract: The push to assess the sustainability of engineered systems requires that traditionally separate analyses be combined. For municipal water system options, this includes life cycle assessment (LCA) of greenhouse gasses, energy use, and microbial and chemical risk assessment, among others. This presentation will introduce a quantitative microbial risk assessment (QMRA) of options for providing household water services in a coastal community faced with the need to dramatically reduce nitrogen loading from existing septic systems and illustrate the challenges and advantages of integrating QMRA with the LCA approach. The adverse human health effects, greenhouse gas emissions, and energy use from alternative decentralized community water systems were compared to a business as usual (BAU) scenario consisting of conventional centralized drinking water and wastewater services. A comparison of the pathogen related health burdens indicated potential health benefits for decentralized water and wastewater systems relative to BAU. Challenges of integrating the QMRA results with the LCA results include: defining overlapping input parameters related to climate, technology, water use, and population; aligning temporal and spatial scales of analysis; computation of health burden across different population scales; and presentation/stakeholder interpretation of results. The advantages of parallel analysis for the decision-making include consistent system definition, greater ability to modify options, ability to readily reassess with transparent changes in weightings applied to sustainability metrics, and overall uniformity in presenting the results to various stakeholders.

Keywords: B-microbial agents, C-water, A-life cycle analysis, A-risk assessment

We-O-B2: Biomarkers and Metabolomics - II

We-O-B2-01

Mercury and Gene Expression in Adult Avid Seafood Consumers

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Abstract: Fish consumption is highly recommended by the American Heart Association and other health institutions because of the beneficial nutrients it contains, such as n-3 poly unsaturated fatty acids (n-3 PUFA) and selenium (Se). However, seafood also contains varying levels of biomagnified mercury (Hg) that is highly bioavailable and effectively taken up by humans. Exposure to high amounts of mercury has well-documented and wide-ranging negative effects on human health. The effects of lower Hg levels in peripheral blood (5-30 µg/L) to which a much larger population is exposed are not clear, and the nature of possible pathways of physiologic response to continuous low-level Hg needs further investigation. For the first time we applied an approach that combines genomics and exposure, in order to characterize the effects of Hg exposure from avid seafood consumption on the gene expression profile in humans in an attempt to identify: 1) novel exposure indicators; and 2) potential mediators of the response to Hg. Selecting individuals from the Long Island Study of Seafood Consumption, we compared the expression of 158 genes belonging to pathways associated with Hg-induced toxicity (oxidative stress, autoimmunity and inflammation) via qPCR with blood mercury levels determined by Inductively Coupled Plasma-Mass Spectrometry (ICP-MS). We found sixteen genes that are differentially expressed (p-value < 0.05) between low (N=8, average blood Hg=1.75 µg/L) vs. high (N= 7, average blood Hg=31.14 µg/L) Hg individuals. In linear regression 4 genes, CCL16, IL5, ATG5 and ATR, were identified as important predictors of blood Hg; these were detected in all samples (33<Ct<27) with Pearson correlation values with Hg of 0.57, 0.63, 0.69 0.72, respectively, and they produced an adjusted R^2=0.66 in a multiple regression model. Future directions aim to obtain whole transcriptome sequencing from additional high- and low-Hg individuals to provide additional evidence of the involvement of these and other pathways in the response mechanism to Hg.

Keywords: B-metals, A-biomarkers, gene expression

We-O-B2-02

A Novel Associated Particle Neutron Elemental Imaging (APNEI) Technology for 3-D Noninvasive In Vivo Quantification of Trace Elements in Animal and Human Tissue

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Abstract: Trace elements play a crucial role in living organisms. The distribution of trace elements in these organisms provides valuable information about their biological function. In this project, a novel APNEI technology was studied for noninvasive quantification of trace elements in vivo at high 3-D resolution required for disease diagnose or metal toxicology research. The APNEI technology uses fast neutrons produced by a compact neutron generator to extract elemental information from an animal or a human tissue. The technology has two unique features: 1) the penetration of the neutrons and γ-rays to get into the animal or human tissue and to bring the elemental information out of the tissue; and 2) the associated particles to locate the position of the element. In this project, a deuterium-deuterium (D-D) APNEI model was built using Monte Carlo (MC) simulation method. MC simulations for the interaction between a D-D neutron source and a series of elements were performed. The resulting characteristic gamma-rays of interested elements were collected by high-purity germanium (HPGe) detectors simulated in the program. Assuming a 5 mm * 5 mm * 5 mm voxel in soft tissue (about 15 cm away from the neutron source) with iron (Fe) concentration of 1300 ppm, the Fe gamma-ray signals collected by the HPGe detectors is about 120 in 10 minutes with a radiation dose of 0.3 mSv to the irradiated tissue at neutron flux of 10^8 n/s. The number for phosphorus gamma-ray is about 60 counts for a 1 cm^3 voxel in soft tissue with P concentration of 500 ppm. These results show that the technology is sensitive enough to image some trace elements in animal or human tissue with image resolution of mm order at the biologically meaningful concentrations. This technology can be used to investigate metal exposure and alteration of the elemental distributions in animal or human body.

Keywords: B-metals, A-biomarkers

We-O-B2-03

A Detailed Multi-compartmental Skin Penetration Model Coupled to a Physiologically Based Pharmacokinetic Model for Assessing Exposure to Chemical Compounds: the Case of Bisphenol A

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Abstract: The study deals with the development of a multi-compartmental model of skin for explicit description of penetration, absorption and metabolism of chemical compounds under different realistic exposure scenarios. The generic character of the model is supported by calculating input diffusion and partition coefficients from Abraham's equation. The detailed skin model was coupled to a generic PBPK model, giving us the capability to capture the contribution of dermal route of exposure to the overall bioavailabilty of a toxic compound, under complex aggregate exposure scenarios. The model was applied on bisphenol A, a common plasticizer found in many consumer products (mainly food conduct materials), as well as to thermal printing paper and money, thus coming into contact with human skin. Parameterization of the model was based on recent in vivo studies relevant to BPA permeation through the skin. Among several typical exposure scenarios examined, of particular interest is the one of a cashier who receives an additional daily intake of BPA up to 71 µg during a ten-hour work shift from dermal contact with thermal paper that is used commonly for receipts. It was found that the extent of metabolism to inactive BPA-glucuronide was only 2% within the first 24 h, the time in which 90% of the dermal dose is absorbed. Thus, although BPA penetrates slowly the layers of the skin to enter systemic circulation, its contribution to the overall bioavailability is significant, since dermally absorbed BPA is not subjected to 1st pass metabolism (as it is the case of oral exposure) occurring at the liver. For the same normalized bodyweight dose, absorbed BPA through the skin corresponds to a dose twice as high to the one taken orally. However, even in the worst-case exposure scenario of skin exposure to BPA (71µg/day), internal exposure is one order of magnitude lower than the equivalent internal dose corresponding to the revised EFSA TDI of 5 µg/kg_bw/day.

Keywords: A-aggregate exposure, A-biomarkers, A-exposure models, A-risk assessment, C-consumer products

We-O-B2-04

Study of the Dermal Absorption of Cyclic Siloxanes D4 and D5 in a Human Volunteer Study by Analysis or End-Exhaled Air

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Abstract: Consumer exposure to personal care products (PCPs) may be studied through the analysis of PCP components in end-exhaled air. The aim of this study was the quantitative determination of octamethylcyclotetrasiloxane (D4) and decamethylcyclopentasiloxane (D5) in end-exhaled air in order to investigate dermal absorption of PCPs. We exposed the forearm of healthy volunteers for 60 minutes to pure D4 or D5 and to commercial products containing D4 and D5. Inhalation was minimized. Inhalation uptake was minimized by keeping the forearm in a fume hood during dermal exposure and by supplying filtered air to the breathing zone of the volunteer during the post-exposure period. End-exhaled air was collected using a breath sampler (Bio-VOC), transferred to carbograph multi-bed adsorbent tubes and analyzed by thermal desorption gas chromatography mass spectrometry (TD-GC-MS). In the end-exhaled air of non-exposed volunteers a background level of D4 (0.8-3.5 ng/L) and D5 (0.8-4.0 ng/L) was observed. When the volunteers were exposed to one of the aforementioned products the level of D4 and D5 in end-exhaled air did not or barely exceeded the background. At t=90 min a sharp increase of the D4/D5 concentration in end-exhaled air was observed. We attribute this increase to inhalation of the substances during a toilet visit for collection of a urine sample. When this visit was removed from the protocol the sharp increase disappeared. Overall, the results of our experimental work, using D4 or D5 (as pure substances), a cream, a deodorant or a combination of the two indicate that dermal absorption of D4 and D5 cannot be discriminated from the level explained by a background. As inhalation is the primary route of entry, risk assessment of consumer products should be focussing on this route. Analysis of end-exhaled air represents a new and promising non-invasive approach of exposure assessment to study use of PCPs in residential settings.

Keywords: A-aggregate exposure, A-biomonitoring, A-risk assessment, B-VOCs, C-consumer products

We-S-C2: Cyanobacterial Harmful Algal Blooms (HABs): Ecological and Human Exposure Issues

We-S-C2-01

Satellite Remote Sensing for Monitoring Cyanobacteria Blooms

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Abstract: Algal blooms cause extensive problems in lakes worldwide, including human and animal health risks, anoxia and fish kills, and taste and odor in potable water. Cyanobacterial blooms are a particular concern because of their dense biomass, toxins, and taste-and-odor. These cyanobacteria blooms can be successfully monitored using satellite remote sensing technologies based on algorithms to derive chlorophyll-a and phycocyanin. Satellite technology allows for the development of a unified harmful algal bloom indicator at the local scale with national coverage. Satellite instruments with the smallest spatial footprints (< 300m) provide the most desirable resources for studies in coastal and in-land waters. The European Space Agency MEdium Resolution Imaging Spectrometer (MERIS) and future Sentinel-3 Ocean and Land Colour Instrument (OLCI) provide the greatest potential for retrieving high spatial resolution data from lakes at 2-3 day intervals. The overarching project goal was to support the environmental management and public use of U.S. lakes and estuaries by providing a capability of detecting and quantifying algal blooms using satellite data records. This project assessed and validated the performance of an algorithm for MERIS and OLCI using existing in-situ data from the National Lakes Assessment and multiple state databases. Results indicated that MERIS provided robust estimates for low (10,000-109,000 cells/mL) and very high (>1,000,000 cells/mL) cell enumeration ranges, with correspondence of 90% and 83% respectively. This approach may provide rapid detection of potentially harmful algae, which is essential for protecting the general population from exposure, and support monitoring of cyanobacteria cell concentrations in drinking and recreational waters to identify emerging threats.

Keywords: C-water, A-geospatial analysis/GIS, A-sensor technology, satellite

We-S-C2-02

Occurrence of Cyanobacteria and Associated Toxins in Surface Water, Relative Risk, and Potential Changes Due to Environmental Factors in the United States

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Abstract: Cyanobacteria are photosynthetic microorganisms found in surface water and are known to produce multiple classes of harmful toxins with a range of acute and chronic symptoms that can include cytotoxicity, dermatoxicity, gastroenteritis, hepatoxicity, neurotoxicity, respiratory distress, and tumor promotion in mammals and other organisms. Severity of symptoms can range from unnoticeable to death depending on exposure scenarios. Known cyanobacteria toxins (cyanotoxins) are made up of several chemical classes and include anatoxins, cylindrospermopsins, microcystins, nodularins, and saxitoxins, although there are multiple classes of less well known cyanotoxins where research is limited by the availability of adequate standards and methods. While general relationships correlating a variety of water quality, light, and climatic factors with cyanobacteria occurrence, growth, and toxin production have been investigated, much is yet to be learned. National surface water data will be presented summarizing the occurrence of cyanobacteria and the known toxins from across the United States including Alaska, Guam, Hawaii, and Puerto Rico. Relative risks due to cyanotoxin exposure and relationships between cyanobacteria, cyanotoxins, and the environment will be discussed.

Keywords: A-ecological exposure, A-risk assessment, cyanotoxins

We-S-C2-03

High Frequency Monitoring for Harmful Algal Blooms

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Abstract: Harmful algal blooms (HABs) are increasingly becoming a significant ecologic, economic, and social driver in the use of water resources. Cyanobacteria and their toxins play an important role in management decisions for drinking water utilities and public health officials. Online monitors can provide high frequency data to assess water quality status and assist those decision makers in reducing risk and costs associated with HABs. Of particular interest are sensors capable of assessing algal community dynamics, specifically those that can differentiate between the major Divisions which can provide a real-time indication of overall population trends. Online Toxicity Monitors (OTMs) may also be able to provide an indication of their presence in toxic concentrations. An effort is underway to deploy a suite of water quality monitors at the drinking water intake structure located on Lake Harsha, a multi-use reservoir located in Clermont County, OH during the 2014 season. Historically, harmful algal blooms (HABs) have been observed in Lake Harsha and, along with contaminants associated with mixed agriculture and suburban land uses, represent a significant challenge to the cost-effective production of safe drinking water. The goal of this monitoring effort is to provide time-relevant feedback to the drinking water producer and watershed water quality managers regarding potential HABs and episodic contamination events. The selected suite includes an Algae Online Analyzer, a *Daphnia magna* behavior OTM, an optical particle analysis system, a multiparameter sonde, a UV-vis absorbance spectrophotometer, and total organic carbon analyzer. Details of this approach and experience gained will be presented.

Keywords: A-sensor technology, A-ecological exposure, A-climate change, C-water

We-S-C2-04

Microcystis Aeruginosa Allergenic Peptides and Their Interactions with Cyanobacterial Toxins

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Abstract: Health effects caused by cyanobacteria (blue green algae) are poorly elucidated. The cyanobacteria specie, Microcystis aeruginosa (Ma), produces an array of metabolites believed responsible for their toxicity and/or immunogenicity. Previously, chronic rhinitis patients were demonstrated to elicit a specific IgE response to non-toxic strains of Ma by skin-prick testing indicating that cyanobacteria allergenicity likely resides in the non-toxin producing component of the organism. This study sought to identify and characterize Ma peptide(s) responsible for allergic sensitization in susceptible individuals and to investigate interactions between cyanobacterial toxins (cyanotoxins) and their co-expressed immunogenic peptides. Sera from Ma sensitized rhinitis patients were used to identify sensitizing proteins by IgE-specific direct and indirect ELISAs in response to Ma. 2-D gel electrophoresis followed by specific IgE immunoblot and mass spectroscopy (MS) was performed

to identify relevant protein spots. A mediator release assay was performed using lysates from Ma and patients' sera. Specific IgE was increased in sera of Ma sensitized patients which was inhibited by pre-incubation of serum with the Ma lysate in a dose-dependent manner. 2-D gel electrophoresis followed by MS revealed the relevant sensitizing peptides were phycocyanin and the core-membrane linker peptide, both components of the cyanobacteria phycobillisome complex. Ma phycocyanin exhibits 85% sequence homology with the phycocyanin found in the food supplement, Spirulina, previously reported to cause anaphylaxis. Ma extracts, containing the phycobillisome complex, induced β-hexosaminidase release in rat basophil leukemia (RBL) cells. We identified peptides in the non-toxic strains of Ma that elicit specific IgE responses in sensitized individuals and induce mediator release using RBL cells. The interactions between these peptides and cyanotoxins (microcystin) are currently being investigated.

Keywords: C-water, B-microbial agents, A-ecological exposure

We-S-C2-05
Challenges in the Cultivation of Cyanobacteria Microcystis

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Abstract: The establishment of axenic cultures of cyanobacteria is essential in the determination of the role of cyanobacterial endotoxins in causing health effects. In this study, the challenges encountered in the cultivation of Microcystis spp. are presented. The cyanobacteria, Microcystis, is the most frequently detected genus in harmful blooms of cyanobacteria in bodies of water used for drinking and recreational water sources and is a major producer of the most common cyanobacterial toxin, microcystins. Various physical and biochemical procedures were performed to generate "pure" (free from contaminating heterotrophic bacteria) isolates. Environmental isolates and established strains of Microcystis spp. were cultivated in vitro in a supplemented BG11 medium in a growth chamber. Strains of Microcystis spp. obtained from the University of Texas (UTEX strains) have undergone changes during continuous cultivation; UTEX 2385 (microcystin-producer) now produces very little or no microcystins; all clone lines attach vigorously to glassware. The UTEX 2388 (microcystin-producer) and its clones exhibit disperse morphologies in liquid medium and produce microcystins. Antibiotics treatments of UTEX 2385 and 2388 yielded non-microcystin producing cells but failed to eliminate associated heterotrophic bacteria. Environmental isolates of Microcystis spp. producing microcystins also yielded clones of non-microcystin producers and attached to glassware. Both environmental isolates and established strains are predisposed to photobleaching. Green colonies (capable of photosynthesis) were only evident in BG11 agar plates prepared with ≤ 1% agarose. Cultivated Microcystis spp. are slow growers with doubling time of > 48 hrs. The cultivation and establishment of purified clones of Microcystis spp. can be challenging. The laboratory stocks of Microcystis spp. in our study appear to display variable colonial morphologies and responses.

Keywords: C-water, B-microbial agents, A-ecological exposure, cyanobacteria

We-S-D2: Assessing Risk-Relevant Exposures to Manufactured Nanoparticles Used in Consumer Products - II

We-S-D2-01
Toxicity of Diesel Exhaust Particles with Nano-Ceria Fuel Additive in Zebrafish

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Abstract: Cerium dioxide nanoparticles (CeO2 NP) are used in fuel additives to improve diesel combustion efficiency and decrease PAH emissions. However, few studies have examined the impact of CeO2 NP additives in aquatic systems and on the toxicity of diesel exhaust particles (DEP) to aquatic vertebrates. We used zebrafish, Danio rerio, as a model to investigate the developmental and molecular effects of waterborne exposure to DEP from fuel with and without CeO2 NP. Envirox, a commercial fuel additive containing CeO2 NP, was added to diesel fuel at 0, 0.1, 1 and 10-fold the manufacturer's recommended concentration and combusted in a diesel electrical generator. The resultant diesel exhaust particles were collected onto Teflon filters and suspended in ultrapure water to make DEP stock solutions. Zebrafish embryos were dosed intact at 4-5 hours post fertilization (hpf), dechorionated and dosed at 24 hpf, or allowed to hatch and dosed at 5 dpf. Acute

mortality, hatching, swim bladder inflation, cardiac and yolk edema, and skeletal deformities were monitored every 24 hr for up to 144 hours. DEP without CeO2 additive was significantly more acutely toxic to dechorionated embryos than DEP from diesel containing 10 times the recommended fuel additive concentration. No significant differences have been seen in any morphological endpoint with intact embryos or hatchlings, suggesting that the embryonic chorion might be an effective barrier to DEP exposure. Cytochrome P450 activity (via in ovo EROD assay) showed no significant differences among DEP treatments both with and without exposure to UV light. Studies of oxidative stress and aryl hydrocarbon receptor (AHR)-pathway gene expression are underway and will be presented.

Keywords: B-nanoparticles, C-consumer products, A-ecological exposure

We-S-D2-02
Thermal Degradation Byproducts of Carbon Nanotube Enriched Composite Materials
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Abstract: Engineered carbon nanomaterials (ECN), such as carbon nanotubes (CNT) and carbon nanofibers (CNF), have been increasingly used in polymer composites, due to their high strength, light weight and electrical conductivity, etc. The ECN containing composite materials , e.g., tires, auto parts, sporting goods, epoxy resins and textile materials, etc. are high in carbon and energy contents. When these materials catch fire, or when they are processed thermally (thermal decomposition) for energy or material recovery at the end of their life cycle, it is critical to evaluate the nanomaterial release and new nanomaterial or product formation during these high temperature processes. The size, morphology, metal contents and other physical and chemicals properties of these ECNs containing composites, and the associated byproducts should be analyzed, in order to better understand the parameters that govern the release, dispersion and transformation of the ECNs in composite matrixes. In this study, a few ECN containing composites were obtained from a few manufacturers and thermal degradation process were studied under a variety of temperatures from 400 to 1000C. The ECNs and the composites were also studied. Both gaseous and solid by products were collected and analyzed. Various techniques such as TEM/SEM, ICP-AED, GC-MS and TGA, etc. were employed. New nano-material formation has been observed in select carbon nano composites. The conditions favoring new nano-material formation is being analyzed.

Keywords: A-analytical methods, B-nanoparticles, carbon nano composites, engineered carbon nanomaterials

We-S-D2-03
Computational Modeling to Support Characterization of Human Exposures and Health Risks Associated with Manufactured Nanoparticles in Consumer Products
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Abstract: Human exposures to Manufactured Nanoparticles (MNPs) are expected to increase as use of MNPs in consumer products becomes more widespread. This work presents a new set of modeling tools, developed as components of the Prioritization/Ranking of Toxic Exposures with GIS Extension (PRoTEGE) system to support characterization of population exposures, intakes, uptakes, as well as associated potential risks from established or hypothesized Adverse Outcome Pathways (AOPs) involving MNPs used in consumer products. Example applications focus on two MNPs that are widely used in consumer products: silver and zinc oxide nanoparticles. Modules for simulating ambient and indoor settings have been developed, utilizing (a) available production, usage, and properties databases on MNPs and (b) new data on size distributions of MNPs in consumer products, collected by "Risk Assessment for Manufactured Nanoparticles Used in Consumer Products" (RAMNUC) collaborators. Modeling of environmental and microenvironmental levels of MNPs employs material balances combined with product Life Cycle Analysis (LCA) to account for manufacturing, transport, usage, disposal, etc. processes. Human exposure characterization further employs intake fraction methods combined with Life Stage Analysis (LSA) for potentially exposed populations, to assess differences associated with gender, age, and demographics. Resulting population intake estimates incorporate and characterize uncertainties in the data associated with the production, market penetration, and usage of MNPs as well as inherent inter-individual variabilities in physiology and activity patterns. Distribution of intakes are then used to calculate biologically-relevant uptakes and target tissue doses through customized versions of dosimetric models such as the human airway Multiple-Path Particle Dosimetry (MPPD) model and of whole

body physiologically-based toxicokinetic (PBTK) models for nanoparticles, under ongoing development by the project team.

We-S-E2: New Findings from Measurements of Exposure to Air Pollutants from Smoking and Cooking

We-S-E2-01
Exposure and Response to Secondhand Smoke in Multi-unit Housing: What We Know and What We Wish We Knew

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Abstract: Objectives. To investigate nicotine levels associated with residents' complaints of secondhand smoke (SHS) infiltration in multi-unit housing. Methods. Using passive and active monitors, we measured nicotine in a sample of 39 nonsmokers' apartments (condominiums, co-operatives, and rentals) whose residents had secondhand smoke complaints. Residents provided descriptions of their complaints. Limited controlled experiments conducted in adjacent motel rooms investigated pressure differences affecting relative penetration of nicotine and irritating PM2.5 in SHS. Results. The geometric mean nicotine for complaint residences was 0.026 µg/m3 (range 0.003 to 0.24 µg/m3), consistent with the range reported in the literature for multi-unit housing. Anecdotal complaints included one or more of the following: headaches, dizziness, nausea, eye, nose, or throat irritation, coughing, difficulty breathing, tachycardia, and malodor. Symptom severity was idiosyncratically related to nicotine levels. More than a third reported consulting a physician. Residents requested monitoring to provide credibility for their complaints of SHS infiltration. Inter-unit pressure differentials appeared to drive infiltration of nicotine and fine particles in the controlled experiments. In the absence of smoke-free housing laws, affected nonsmokers often resorted to litigation in attempts to clear the air. Conclusions. Residents' anecdotal perceptions were often severe, and consistent with known SHS symptomatic effects despite low nicotine levels, suggesting much higher levels of PM2.5. The ratio of PM2.5 and nicotine in SHS after penetrating through apartment surfaces remains an important research topic. The severity of nonsmokers' complaints and the widespread reports of infiltration suggest that SHS infiltration in privately-owned multi-unit housing is an important public health and nuisance issue remaining largely unaddressed by policy-makers.

We-S-E2-02
Measurements of Particulate Matter Due to Secondhand Smoke Drift in Minnesota Multifamily Units of Nonsmokers

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Abstract: Objectives: This project sought to quantify the incursion of secondhand smoke (SHS) into nonsmokers units from other parts of the building by measuring the light-absorbing characteristics of airborne particulate matter collected from the units. **Methods**: The ratio of absorbance of ultraviolet light (UV) to absorbance of near-infrared light ("black carbon," or BC) depends on the characteristics of the particles. Chamber experiments indicate the UV/BC ratio of SHS is higher than that of most other particles found in residential environments. Eighty seven Minnesota apartments (65 in smoking-permitted and 22 in nonsmoking buildings) were monitored for 6 days in winter. Repeat visits were conducted in mild weather in 45 of these apartments. Fine particle concentration and its UV and BC absorbance were quantified using photometers and dual-channel aethalometers. Analysis of the number and size of particle peaks with high UV/BC ratios for the units in smoking-permitted and non-smoking buildings will demonstrate the extent of SHS incursion. **Results**: The apartments in smoking-permitted buildings had a significantly greater proportion of high ratio events than the apartments in nonsmoking buildings. A total of 11.7% of the particle events in the smoking-permitted apartments had (UV-BC)/BC > 7.0, compared with 6.5% of the events in the non-smoking apartments. The average $PM_{2.5}$ concentration for events with (UV-BC)/BC > 7.0 was 103.7 µg/m^3 (SD 14.0) in apartments in smoking-permitted buildings and 38.2 µg/m^3 (17.2) in apartments in nonsmoking buildings. The medians were 44.0 µg/m^3 (IQR 18.0-116.4) and 10.2 µg/m^3 (6.0-39.0) respectively. **Conclusions**: Past work has shown that it is difficult to document SHS transfer using $PM_{2.5}$ alone because of the multiplicity of sources. With supplemental

gas phase tracer data, real-time ultraviolet-absorbing particulate matter monitoring can be useful in identifying SHS events even when they are infrequent.

Keywords: A-built environment, A-indoor environment, B-particulate matter, A-second-hand smoke

We-S-E2-03
The Influence of Secondhand Smoke (SHS) on Outdoor Air Quality in Leisure and Sport Facilities: measurements at a Stadium, Pedestrian Area, City Park, Public Beach and outdoor/indoor Disco Club

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Abstract: BACKGROUND: Outdoor SHS exposure is often encountered in leisure and sport activities areas. AIMS: to evaluate SHS outdoor exposure METHOD: PM2.5 measurements with OPC, BC (Black Carbon) with Aethalometers, nicotine with passive samplers and GC. Procedures: Stadium: analyzers and nicotine samplers inside/outside. Pedestrian area: measurements on Friday to Monday in pedestrian area and in trafficked zones. City Parks: analyzers on park benches up/downwind smokers. Public Beach: BC analyzer up/downwind beach umbrellas. Outdoor smoking/indoor non smoking Disco Club: 3 days continuous measurements. RESULTS: Stadium: BC, PM2.5, nicotine outside: 2.1, 6.2, and 0.12 µg/m3 , inside during game: 3.1, 13.9, 3.16 µg/m3, respectively (p < 0.005). Pedestrian area: quiet hours pedestrian area: 2.8, and 35.4, rush hours: 4.1 and 64.9 µg/m3 respectively. (p=0.001). Quiet hours trafficked area: 3.7, 30.4 and 4.8, 31.8 µg/m3 rush hours for BC and PM2.5 respectively. Nicotine:< 0.02 g/m3 in trafficked area and 0.26 µg/m3 in pedestrian area. City parks: BC bckg 5.1, near smokers 12.6µg/m3(p=<0.001). PM2.5 bckg 16.6, near smokers 17.8(p= 0.039). Public beach: BC:0.8 and 1.5µg/m3 up/downwind respectively(p=<0.001). Disco Club: summer outdoor: BC bckg 9.0µg/m3, during Disco activity 30.3µg/m3. PM2.5 bckg: 26.4µg/m3, Disco activity: 85.5µg/m3. Nicotine.: 0.67µg/m3. Winter indoor: BC bckg 2.5µg/m3, Disco activity 13.2µg/m3. PM2.5 bckg:33.6µg/m3, during Disco activity:122.6µg/m3, Nicotine: 0.83µg/m3. BC lower in Winter but not PM2.5 because of indoor fireworks. Nicotine. higher in winter indicating illegal smoking but with lower impact on air quality than in summer. CONCLUSION: Leisure and sport facilities outdoor air quality heavily compromised by smoking activity. Increase of several epidemiological change units for BC and PM2.5 observed in all places due to SHS with concern for short and long-term health consequences.

Keywords: A-environmental policy, A-exposure factors, A-second-hand smoke, B-particulate matter, Black carbon

We-S-E2-04
Tobacco Smoke is the Major Source of Acrolein Exposure in the US population: NHANES 2005-2006

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Abstract: BACKGROUND: Acrolein is a highly reactive aldehyde and respiratory irritant. Acrolein is formed during combustion (e.g. burning tobacco or biomass), during high-temperature cooking of foods, and in vivo as a product of oxidative stress and polyamine metabolism. No biomonitoring reference data has been reported to characterize acrolein exposure of the US population. OBJECTIVES: Our goals were to: a) evaluate two acrolein metabolites in urine -N-Acetyl-S-(3-hydroxypropyl)-L-cysteine (3HPMA) and N-acetyl-S-(2-carboxyethyl)-L-cysteine (CEMA) — as biomarkers of exposure to acrolein for the US population by age, sex, race, and smoking status; and b) determine the predictors of acrolein exposure. METHODS: We analyzed urine from National Health and Nutrition Examination Survey (NHANES 2005-2006) participants ≥12 years-old (n = 3,067) for 3HPMA and CEMA using ultra high performance liquid chromatography coupled with electrospray ionization tandem mass spectrometry (UPLC/ESI-MSMS). Sample-weighted linear regression models stratified by smoking status characterized the association of urinary 3HPMA and CEMA with tobacco smoke exposure, controlling for urinary creatinine and other potential confounders. RESULTS: 3HPMA and CEMA levels were higher among smokers compared with non-smokers. The median 3HPMA levels for smokers and non-smokers were 1089 and 219 µg/g creatinine respectively. Similarly, median CEMA levels were 203 µg/g creatinine for smokers and 78.8 µg/g creatinine for non-smokers. Regression analysis showed that serum cotinine was a significant positive predictor (p <0.0001) of both 3HPMA and CEMA levels in urine. The CEMA/3HPMA molar

ratio was significantly higher for non-smokers compared to smokers (p <0.0001). CONCLUSIONS: Our data suggests that tobacco smoke is a major acrolein exposure source for the US population.

Keywords: A-exposure factors, A-second-hand smoke, Acrolein

We-S-E2-05
Fine and Ultrafine Particle Emissions from Electric Burners and Stainless Steel Pans
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Abstract: Recent studies have documented emissions of ultrafine particles from cooking on electric stoves. A few of these studies show emissions from the electric coil itself (no pan). We have performed more than 100 experiments on an electric coil, or on the coil with an empty stainless steel pan on top, in an attempt to characterize the emissions of fine and ultrafine particles from these two sources. We used a condensation particle counter (CPC) capable of measuring ultrafine particles > 10 nm (UFP10) and a laser photometer to estimate PM2.5 mass concentrations. Since the coil produces most of its particles in the range from 3-10 nm, our studies do not apply to this size range. We find that both the coil and pan produce copious emissions of UFP10 on first heating, but that repeated heating (without intervening cleaning) produces smaller amounts, and with sufficient heating periods, both coil and pan approach zero emissions of UFP10. Cleaning with dishwasher detergent produces quite large UFP10 emissions on first use after the cleaning, but subsequent experiments (without intervening cleaning) again produce smaller and smaller emissions until near-zero emissions are recorded. An older pan that was once used for cooking was also shown after a large number of repeated heatings to approach zero emissions. If the coil or pan is covered between experiments, no UFP10 particles are produced, but if either is left open to the indoor air for a few days, particles are produced. In all these experiments, PM2.5 mass emissions were essentially zero. We conclude that the UFP10 particles are not coming from the electric coil or stainless steel pan themselves, but from some material that is either deposited on them while open to the air or is a residue from cleaning materials or food cooked in the pan.

Keywords: B-particulate matter, A-indoor environment, C-air, ultrafine particles, cooking, fine particles, ultrafine particles, cooking, fine particles

We-O-F2: Advances in Exposure Science to Inform Risk Assessment

We-O-F2-01
Human Health Risk Assessment for Improved Access to Health Hazards Information
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Abstract: Introduction. Universal practice shows that community is constantly late with an awareness of the importance of ecological processes and overall burden imposed by urbanization on human health. This proves the need for accurate information regarding environmental health risks that are present in everyday life. Recent studies revealed that air pollution is a major factor of harmful environmental impact in Ukraine resulting in various negative health outcomes (risk indicators at 10-3÷10-4). The study objective was to aggregate the information on health risks attributed to air pollution in Ukrainian cities for raising public awareness and development of risk mitigation measures. Methods: Health risks formed by industrial air pollution in 4 cities, were estimated according to HHRA procedure (U.S. EPA). 1-h, 24-h and annual pollutants' concentrations were modeled with dispersion model ISC-AERMOD View. Results: Human health risk levels attributed to emissions of energy production in Kyiv, chemical industry in Cherkassy, metallurgical enterprises in Zaporizhia and machine-building enterprises in Druzhkivka were calculated. In Kyiv, risk indicators were at ICRtotal=8.8×10-6÷4.5×10-4 and were attributed to benzo(a)pyrene emissions mainly. In Cherkassy health risk were related to high levels of formaldehyde and benzene emissions: ICRtotal=2.7×10-5÷4.6×10-4. As for Druzhkivka, were formed by chromium(VI) emissions: ICRtotal=1.8×10-6÷2.5×10-4. In Zaporizhia the total cancer risk was attributed to chromium(VI) and nickel emissions mainly: ICRtotal=1.4×10-4÷2.3×10-2. Discussion. The results helped to supplement the information on the health risks formed by air pollution within studied cities and to develop environmental health risks information system for enhanced public awareness on environmental impacts. The

study outcomes can be further used for ecological control of the air-polluting-enterprises as well as in development of the regional air quality standards.

Keywords: C-air, A-risk assessment, A-exposure models, B-metals

We-O-F2-02
Addressing Complex Exposures in Risk Assessment: Needs and Opportunities
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Abstract: In regulatory risk assessment, there remains a strong focus on toxicity testing, epidemiological research, and mechanistic research on single chemical exposure events whereas exposure science and biomonitoring data reveal complex exposures to multiple chemicals (and multiple stressors) through multiple pathways. Three recent National Academy of Science studies have laid out a vision and strategy for the future of risk assessment—"Toxicology Testing in the 21st Century", "Science and Decisions: Advancing Risk Assessment", and "Exposure Science in the 21st Century". All of these reports have identified the importance of complex exposures and proposed opportunities and methods for confronting the scientific challenges posed by these exposures. But to date the guidance for addressing these challenges remains mostly unexplored. In this presentation I discuss needs and opportunities for addressing complex exposures according to the core elements of risk assessment—hazard assessment, exposure science, dose-response, and risk characterization. In hazard assessment, we must find metrics and protocols for characterizing the toxicity, mechanism, and disease endpoints for complex mixtures in a world still dominated by single-substance assessments. In exposure science we must track the long-term exposure profiles and temporal relationships among multi-pathway, mutli-route, and time-varying exposures to a broad range of stressors—the "Eco-Exposome". Dose response assessment needs metrics that can incorporate complex mixture exposures. Risk characterization must weave together the above elements by effective use of exposure biology, improved environmental monitoring and disease surveillance, models, and statistical tools. An additional need is to pursue the research necessary to understand how any joint occurrence of stressor, target, space and time determine a level of organization and detail that must be captured to understand disease burden and other impacts.

Keywords: A-risk assessment, A-cumulative exposure, A-biomonitoring, C-multimedia, D-vulnerable

We-O-F2-03 - Withdrawn

We-O-F2-04
Assessment of Health Risk and Trace Metal Pollution in Surface Soil and Road Dust from an E-waste Recycling Area in China
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Abstract: Informal recycling of e-waste has resulted in heavy metal pollution of the ecosystem in Guiyu, a prominent e-waste recycling town in China. We determined the extent of the exposure of heavy metals in community soil and road dust samples and conducted a risk assessment. We collected soil and road dust samples from 11 locations in Guiyu and 5 locations in a non-recycling reference area in each of the 4 seasons in 2012-2013. We measured trace metal levels (Pb, Cd, Cr, and Mn) using GFAAS. The mean Pb, Cd, Cr and Mn for the four seasons in Guiyu were 448.73, 0.71, 63.90 and 806.54 mg/kg for soil and 589.74, 1.94, 69.71 and 693.74 mg/kg for road dust; Pb and Cd levels were higher than in the reference area. Mean Pb and Cd concentrations in both matrices were higher than Grade II China permissible level (Pb 300 mg/kg, Cd 0.3 mg/kg) while in road dust they were above the Grade III level (Pb 500 mg/kg, Cd 1 mg/kg). Mixed model analysis with repeated seasonal measurements showed that the soil Pb and Cd levels were 2.32 and 4.34 times higher in Guiyu compared with the reference area, respectively; in dust samples, the ratios were 4.10 and 3.18 times, respectively. Contamination indices showed both matrices from exposed area were polluted compared with the reference area with average pollution load index above limit . In the risk assessment, the estimated hazard index for children was highest for Pb among metals, with the values in exposed area 4.18- and 4.52 times higher than in the reference area for soil and road dust, respectively. The cumulative hazard index for Pb, Cd, Cr and Mn in exposed area for children was 1.91 and 2.38 for soil and dust, respectively, which suggests they might have higher non-cancer health risk. The accumulation of trace metals in the recycling site is significant

and may increase body burden especially in sensitive populations such as pregnant women and children; and thus constitute a potentially serious health risk.

Keywords: C-soil, D-community, B-metals, e-waste

We-O-F2-05
Enhanced Distributions and Identification of Key Factors for the Daily Water Intake Exposure Factor, Analyzed from 1999-2010 NHANES data for the US Population

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Abstract: Daily intake of drinking water is an important exposure factor in assessing human health risks from water-borne pollutants. 1999-2010 NHANES data contain drinking water information of ~60,000 subjects with more than 100,000 person-days. Indirect drinking water is estimated from dietary surveys with Recipe files From USDA/EPA. We analyzed the data for summary statistics; distributions by age, gender and other factors; and main influencing factors. Males 20-49 years old have the highest total drinking water intake: 1783, 1462 and 4370 ml/day for mean, median and 95th percentiles; male infants (< 1 years old) have the highest total drinking water intake weighted by body weight: 59.1, 37.0 and 165.4 ml/kg/day. Daily intake of total drinking water in 1999-2002 was higher than 2003-2010. We found that Weibull distributions are a significantly better fit than lognormal distributions for total drinking water intakes which are currently provided in the EPA Exposure Factors Handbook. GLM analyses found that age, gender, education, ethnicity, body weight, body mass index, daily sodium, potassium, and caloric intake are among the main factors influencing total drinking water intakes. The results of these new NHANES analyses can improve health risk assessments and inform risk management decisions from the water ingestion pathway.

Keywords: A-exposure factors, A-cumulative exposure, C-water

We-O-G2: Indoor / Outdoor Air Pollution - IV

We-O-G2-01
Classification of Multi-pollutant Peak Events in Mobile Monitoring Data

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Abstract: BACKGROUND: Proximity to major roadways is associated with both chronic and short-term adverse health outcomes. Near-roadway exposures are characterized in part by transient events that are several orders of magnitude above background. We hypothesize that the composition, frequency and duration of these peaks is a characteristic of a roadway and is associated with traffic composition, driving conditions and atmospheric reactivity. METHODS: The University of Washington mobile monitoring platform sampled 16 pollutants in 10 second intervals over 2-week periods in summer and winter 2012 in Baltimore, MD. Multi-pollutant peaks were defined as time periods where a 10 s increase in two or more independently measured pollutants were outlier values ($z>3.5$). The peaks were grouped based on the correlation structure using K-means analysis to identify characteristic pollutant profiles of these events. RESULTS: There were 89 summer and 72 winter multi-pollutant peaks, evenly distributed across days but not geographically. Four distinct profiles were identified with cluster analysis. One-third of all peaks were characterized by extreme increases in both BC and NO2. These peaks occurred on roadways with high truck traffic. Another fraction of events was associated with rapid increases in NOx and O3 suggesting the plumes are subject to photochemical processes. In winter, a peak was identified with high increases in NOx and particle-bound PAH; events likely associated with a combustion source. Lastly, in both summer and winter some peaks were associated with increases in only PM10 and PM2.5 likely indicating re-suspension of road dust. CONCLUSIONS: Analyzing extreme events in mobile monitoring data yields unique profiles, attributable to different roadway processes. Some events relate to primary sources, while others reflect on-roadway chemical transformations. The frequency of these peaks and their composition is linked to important roadway and traffic features.

Keywords: C-air, A-exposure factors, A-exposure models, A-geospatial analysis/GIS, Multipollutant Exposures

We-O-G2-02

Residential Indoor and Personal PM10 Exposure of Ambient Origin Based on Chemical Components

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Abstract: Lots of studies have focused on the relationships of particulate matter between indoor, outdoor and personal exposure; there still remain considerable uncertainties about the portion of indoor particles and personal exposure of ambient origin. As part of the Particle Exposure Assessment for Community Elderly (PEACE) study in Tianjin, China, we have further interpreted the relationships between personal, residential indoor, outdoor and community PM10. Comparisons of the chemical composition of PM10 samples were performed using the coefficient of divergence (COD). A robust regression method, least-trimmed squared (LTS) regression, was used to estimate the infiltration factors of PM10 from residential outdoor to indoor environments, based on particle component concentrations. Personal exposures of ambient origin were also estimated. A relatively good correspondence of chemical composition was found between personal and indoor PM10 samples. The infiltration factors (Finf) of residential indoor-outdoor PM10 were 0.74±0.31 (mean±SD) in summer and 0.44±0.22 in winter, with medians of 0.98 and 0.48, respectively. Residential outdoor contributions to indoor environments were 87±55 µg m-3 in summer and 80±54 µg m-3 in winter, with medians of 75 and 61 µg m-3, respectively. The personal exposures of ambient origin were 92±44 µg m-3 in summer and 89±47 µg m-3 in winter, with medians of 81 and 80 µg m-3, respectively. This study indicated that infiltrations in an urbanized area in North China had seasonal difference that residential outdoor contributions to residential indoor environments were larger in summer due to more natural ventilations. The personal exposures of ambient origin were comparable during different seasons, while those of non-ambient origin were higher in summer than in winter.

Keywords: A-cumulative exposure, A-indoor environment, D-community, ambient contribution

We-O-G2-03

Modeling the Impact of Deep Energy Retrofits on Indoor Air Quality in Low-Income Multi-Family Housing

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Abstract: Elevated rates of asthma morbidity among low-income urban children may be related in part to exposure to indoor pollutants, such as PM2.5, NO2, and allergens. Retrofits implemented to reduce energy consumption can affect indoor air quality by modifying airflow patterns, ventilation, and pollution source characteristics. These impacts are challenging to quantify in multi-family housing given complex airflow dynamics as well as variable and uncertain pollution source characteristics and resident behavior. Simulation modeling can be a useful tool to study these interactions. In this study, we simulated the indoor environmental conditions of a low-income housing complex in Boston, MA that underwent a deep energy retrofit targeting a 70% reduction in energy consumption. We modeled low-rise and mid-rise buildings using CONTAM, a multi-zone airflow and contaminant transport analysis program developed by the National Institute of Standards and Technology. Detailed architectural and mechanical plans were used to assign building design characteristics and ventilation patterns. Occupant activity variables (e.g., cooking frequency, window opening, and smoking) were based on population-specific information collected from a self-administered resident survey on pre- and post-retrofit conditions. Leakiness levels were based on building conditions before and after retrofits, and results from blower door tests were used to validate modeled ventilation rates. Pollutant emission rates were parameterized using published literature values, and were evaluated with monitoring data from a concurrent field study in the same building complex. We ran CONTAM across multiple occupant and building conditions using a factorial design, and constructed regression models to explain variability in indoor humidity, PM2.5, and NO2. Our study characterized the key drivers for indoor pollutant concentrations in pre- and post-retrofit conditions of a multi-family apartment complex in Boston.

Keywords: A-built environment, A-exposure models, C-air, A-indoor environment, D-susceptible

We-O-G2-04

Predictions and Determinants of Size-resolved Particle Infiltration Factors in Single-family Homes in the U.S

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Abstract: Relying on ambient measurements of particulate matter can result in significant exposure misclassification in epidemiological studies. There remains a lack of information on size-resolved particle infiltration factors across the U.S. single-family residential building stock, as well as on the determinants of those factors. This work develops and applies a Monte Carlo simulation tool for predicting the statistical distribution of time-averaged size-resolved indoor concentrations of outdoor particles (0.001-10 µm) across the U.S. single-family residential building stock. The tool was used to perform 100,000 simulations using best available data on influential building-related input parameters, including statistical distributions of air exchange rates, building envelope penetration factors, deposition rates, window opening behaviors, central forced-air mechanical system ownership, and mechanical system filter efficiency, to predict time-averaged indoor proportions of outdoor particles in U.S. residences. Model results suggest that size-resolved infiltration factors vary highly across the U.S. single-family residential building stock. Size-resolved infiltration factors were strongly dependent on home characteristics, and vary by a factor of 20-100+ from the least protective of homes (99th percentile) to the most protective (1st percentile), depending on particle size. In a linear regression analysis, size-resolved deposition rates, closed window air exchange rates, and size-resolved envelope penetration factors were all identified as the most important predictors of size-resolved infiltration factors, in descending order of importance. These results suggest that a wide variability in size-resolved infiltration factors among U.S. residences should be accounted for in future epidemiological studies. Additionally, there are several existing data gaps that should be addressed to improve knowledge of size-resolved infiltration factors in homes.

Keywords: A-indoor environment, C-air, A-built environment, B-particulate matter

We-O-G2-05 - Withdrawn

We-S-A3: The Exposure Dimension of Environmental Epidemiology: A Critical but Under-Explored Study Quality Issue in Environmental Health - I

We-S-A3-01

Systematic Assessment of Study Quality: Proposed Approaches and Experience to Date

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Abstract: While determination of study quality will always to some extent involve professional judgment, there appears to be an emerging consensus that any evaluation of the strength of evidence should rely on agreed-upon criteria that are applied systematically. These considerations motivated the development and refinement of several study quality assessment tools that are used in clinical and other related research. Some of these tools (e.g., STROBE for observational studies and CONSORT for clinical trials) address general issues that apply across disciplines. Other tools were developed specifically for various areas of medicine or life sciences (e.g., STREGA for genetic studies, GRADE for comparative treatment effectiveness research, and STARD for studies of diagnostic accuracy.) In view of the current tendency towards standardization of weight-of evidence assessment that incorporates study quality, the relative paucity of instruments for evaluating environmental epidemiology studies is notable, but recent years have seen some progress in this area as well. Commonly evaluated study components include: 1) relative merits of different observational and experimental designs, 2) methods of minimizing selection bias, 3) strength and weaknesses of various exposure assessment approaches, 4) accuracy of outcome ascertainment; 5) data analysis methods, 6) adjustment for confounders, and 7) reporting and interpretation of findings. Much of the accumulated experience from other fields of science can readily be adapted to assessment of environmental health studies. Certain aspects of study quality that are specific to environmental health research will also be discussed.

Keywords: A-epidemiology, systematic reviews

We-S-A3-02

Exposure Uncertainties in Epidemiology: BPA and Phthalates as Case Studies

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Abstract: Systematic reviews of the epidemiology literature for BPA and phthalates reveal inconsistencies in results that are likely due to study design issues. An important methodological issue, which pertains specifically to studies of chemicals with short (e.g. hours, days) physiologic half-lives such as BPA and phthalates, is whether single measures of these compounds and/or their metabolites provide robust representations of long-term exposure status. Relatively few papers have followed study participants over time to examine temporal variability for these types of chemicals. The need for better exposure assessments for these types of chemicals will be reviewed and case studies discussed.

Keywords: A-biomonitoring, A-epidemiology, B-phthalates, C-consumer products

We-S-A3-03

The Biomonitoring, Environmental Epidemiology, and Short-Lived Chemicals (BEES-C) Instrument for Assessing Study Quality

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Abstract: Environmental epidemiology studies can be an effective means to assess impacts on human health from exposure to environmental stressors. Exposure scenarios are often extremely complex and proper assessment is critical for interpreting epidemiological study results. Biomarkers are now regularly utilized as exposure surrogates in environmental epidemiology studies. This strategy has proven effective for a small number of biomarkers (e.g., blood lead) that persist in the environment and human body. However, environmental epidemiology studies that utilize biomarkers of short-lived chemicals are considerably more challenging because it can be difficult to select and measure biomarkers that accurately reflect biologically-relevant exposure to a specific chemical during a critical time window. There is currently limited guidance for the design, implementation, and interpretation of environmental epidemiology studies that utilize biomarkers of short-lived chemicals as quantitative exposure surrogates. To address this need, we developed the Biomonitoring, Environmental Epidemiology, and Short-Lived Chemicals (BEES-C) instrument. This instrument is intended to guide research proposals, technical manuscripts, and weight-of-evidence assessments based on quality criteria for: 1) biomarker selection and measurement, 2) study design and execution, and 3) general epidemiological considerations. This presentation will discuss key challenges in using biomarkers of short-lived chemicals in environmental epidemiology studies, highlight the key components of the BEES-C instrument, and offer examples for evaluating proposals/studies based on the BEES-C criteria.

Keywords: A-biomarkers, A-biomonitoring, A-epidemiology

We-O-C3: Environmental Epidemiology - I

We-O-C3-01

Residential Greenness Exposure and Pregnancy Outcomes: A Study of Birth Weight, Preterm Birth and Preeclampsia

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Abstract: Little is known about the impacts of green spaces on pregnancy outcomes. The relationship between green space exposure and preeclampsia has never been studied. We used a hospital-based perinatal database including more than 80,000 infants born in Orange and Los Angeles Counties (California, USA) to study the relationships between greenness and three pregnancy outcomes: birth weight in infants born at term (>=37 weeks of gestation), preterm birth (< 37 weeks of gestation) and preeclampsia. Greenness was characterized

using the normalized difference vegetation index (NDVI) within circular buffers of 50, 100 and 150 m radii around homes. Analyses were conducted using generalized estimating equations, adjusting for maternal race/ethnicity, insurance status, age, parity, and diabetes, neighborhood socioeconomic level and indicators of air pollution exposure (measurements for nitrogen oxides, carbon monoxide, ozone and particulate matter of less than 10 or 2.5 micrometers in aerodynamic diameter (PM10 and PM2.5 respectively), local traffic-generated nitrogen oxides concentrations estimated using the CALINE4 dispersion model and traffic density in proximity to maternal homes (50, 150 or 300 m)). A 6 grams (95% confidence interval (CI): 3.11, 9.06) increase in term birth weight is observed per inter-quartile range (IQR) increase in NDVI exposure within 50 m buffers. A reduced risk of preterm birth (odds ratio: 0.98, 95% CI: 0.97, 1) is associated with an IQR increase in NDVI exposure within 150 m buffers. This association is not significant anymore after adjusting for traffic density or PM2.5 but significant decreases in preterm birth risks are still observed for the highest quartile of NDVI, even after adjusting for any air pollution indicator. No significant association was observed between NDVI and preeclampsia. This study provides modest support for beneficial effects of greenness exposure on pregnancy outcomes and calls for confirmation in other study settings.

Keywords: D-prenatal, A-epidemiology, C-air, A-built environment

We-O-C3-02
The Impacts of Exposure Uncertainty on the Reported Association between Perfluorooctanoate and Preeclampsia

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Abstract: A recent review concluded that there is a weak to moderate association between perfluorooctanoate (PFOA) exposure and the occurrence of pregnancy-induced hypertension and preeclampsia, with an increased strength of association for studies with higher confidence/accuracy exposure estimates (C8 Science Panel, 2011). This review was heavily influenced by data from cross-sectional studies of over 69,000 people who were environmentally exposed to PFOA near a major U.S. fluoropolymer production facility located in West Virginia. These studies relied on a retrospective PFOA exposure assessment, including a PFOA release assessment, integrated fate and transport modeling, and dose reconstruction to predict the annual exposure dose to each individual in the C8 Health Project from 1951 to 2008; exposure predictions were validated using 2005-2006 serum PFOA measurements (Shin et al., 2011a, b). The fate and transport model used to predict the PFOA water concentration in each of six public water districts (PWD) utilizes a number of uncertain physiochemical and hydrogeological parameters. The aim of the present study is to assess the impact of the uncertain PFOA water concentration predictions on the exposure estimates and subsequently, the epidemiological association between PFOA exposure and preeclampsia (Savitz et al., 2012). Using Monte Carlo simulation, we changed the individual PWD-PFOA water concentration for every year by randomly sampling from lognormal (uncertainty) distributions for the total PFOA release rate, the PWD-specific water concentrations, and auto-correlated annual water concentrations within each PWD using the original predicted concentrations as medians and a range of 2, 5 and 10-fold uncertainty. We find that exposure uncertainty (i.e., coefficient of variation of the log odds ranging from 11.3% to 39.2%) may contribute almost as much as the original sampling variability (47.8%) to overall uncertainty in the association between PFOA and preeclampsia.

Keywords: A-exposure models, Uncertainty Analysis, Monte Carlo simulation, Perfluorooctanoate(PFOA), Preeclampsia, Uncertainty Analysis, Monte Carlo simulation, Perfluorooctanoate(PFOA), Preeclampsia, Uncertainty Analysis, Monte Carlo simulation, Perfluorooctanoate(PFOA), Preeclampsia, Uncertainty Analysis, Monte Carlo simulation, Perfluorooctanoate(PFOA), Preeclampsia

We-O-C3-03
Impacts of the 2011 Heat Wave on Mortality and Emergency Department Visits in Houston, Texas

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Abstract: Background: Heat waves have been linked to increased risk of mortality and morbidity, and are projected to increase in frequency and intensity in a changing climate. Houston and other areas in Texas and Oklahoma experienced an exceptional heat wave in 2011 summer. As a result, Houston has been reported to have the hottest August and the most consecutive days with the temperatures of 100 degrees Fahrenheit or above since 1889. This study examines the effects of the 2011 heat wave on mortality counts and emergency department visits in Houston. Methods: Generalized additive models were used to examine the associations

between the 2011 heat wave and daily all-cause mortality counts and emergency department visits without and with controlling for maximum temperature measured at the George Bush International Airport (IAH) in the summer season (May 1st to September 30th) from 2007 to 2011. The 2011 heat wave is defined as a continuous period from August 2nd to August 30th, 2011 according to the heat warnings issued by the National Weather Service Houston/Galveston office, and is included in the models as a dummy variable. Results: Without adjusting daily maximum temperature, the 2011 heat wave was associated with a 2.7% increase in mortality risk (95% CI: -3.1%, 8.8%) and a 12.1% increase in emergency department visit risk (95% CI: -8.4%, 16.0%) compared to other days in the study period. After controlling for daily maximum temperature, the estimates for changes in mortality risk and emergency department visit risk were decreased to 0.48% (95% CI: -6.7%, 8.2%) and 2.5% (95% CI: -1.6%, 6.8%), respectively. Conclusion: To the best of our knowledge, this study is the first to evaluate the health effects of the 2011 Texas heat wave. The heat wave has larger impacts on emergency department visits than deaths.

Keywords: A-climate change, A-epidemiology

We-S-E3: Towards Integration of International Exposure Factors' Systems - I

We-S-E3-01
Japanese Exposure Factors Handbook
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Abstract: Use of appropriated exposure factors is essential for conducting realistic exposure/risk assessment of chemical substances. In Japan, conservative default factors, arbitrary factors set by assessors, or factors cited from handbooks developed in other countries have been often used in exposure/risk assessments. Since different countries/areas have different life styles and then different exposure factors, we developed "Japanese Exposure Factors Handbook" previously in FY 2005-2006 based on available literature and statistics. It includes some categories of factors, such as Food Consumption, Self-sufficiency of Food Items, Time for Activities and so on reflecting the Japanese lifestyle. In addition, Inter-individual Variability data in exposure level and body burden of some chemical substances were compiled. Summary tables of representative values (in both English and Japanese) and documents each of which describes the representative value and supporting information (in Japanese only) are provided at websites. English Page: http://unit.aist.go.jp/riss/crm/exposurefactors/english_summary.html Japanese Page: http://unit.aist.go.jp/riss/crm/exposurefactors/

Keywords: A-exposure factors

We-S-E3-02
EPA's Exposure Assessment Tools
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Abstract: In 2013, EPA released EPA-Expo-Box, an innovative, user-friendly, encyclopedia-like online resource for exposure assessment information. EPA-Expo-Box includes links to more than 800 resources that may be useful to exposure assessors, including databases, models, guidance documents and other resources organized by topic areas. One of the resources featured in the toolbox is EPA's Exposure Factors Handbook: 2011 Edition. The Exposure Factors module provides highlights of the data and recommendations for each factor; nearly 300 data tables in downloadable MS Excel spreadsheet format; links to over 700 source references via EPA's Health and Environmental Research Online (HERO) database; links to related resources; and a search interface that allows users to search for relevant sections and tables of the Exposure Factors Handbook using keywords or phrases. EPA is also developing a new Exposure Scenarios Tool that will utilize data from the Exposure Factors Handbook: 2011 Edition. The Exposure Scenarios Tool will be an interactive computational online tool that will allow users to select scenarios of interest, populate standard exposure algorithms with data from the Exposure Factors Handbook: 2011 Edition, and calculate exposures/doses in a self-contained, online application. This presentation will highlight some of the key features of the Exposure Factors module of EPA-Expo-Box and the Exposure Scenarios Tool.

Keywords: A-exposure factors, A-exposure models, A-risk assessment, C-multimedia, exposure assessment tools

We-S-E3-03

The German Exposure Factors Database (RefXP): Complementing the National Health-related Environmental Monitoring Program

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Abstract: Introduction: Building on the German Exposure Factors (EF) Handbook of 1995 the Xprob consortium updated and expanded the available exposure reference data in 2007 and transferred it into the specifically designed EF Database RefXP. Moreover, Xprob developed a consistent approach for deriving age and sex stratified EF distributions and methods for evaluating the reference data quality. The national health-related environmental monitoring program, consisting of the German Environmental Survey (GerES) and the Environmental Specimen Bank (ESB), is a key source for augmenting and updating RefXP. Results: RefXP comprises approx. 1,000 entries on EF reference data for the German population, i. a. anthropometrics, food and drinking water consumption, and soil/dust ingestion. RefXP contains information about the analyzed data sources including sample size and characteristics and an overall data quality assessment. For most EF, RefXP provides descriptive statistics such as percentiles of the empirical distribution and fitted statistical distributions. Recently, data on children's time-location patterns obtained in GerES were added to RefXP. ESB data on time trends in 24 h urine sample volumes and other physiological parameters are currently evaluated for being transferred into RefXP. Conclusions & outlook: Aspects of the Xprob/RefXP approach may prove beneficial for harmonizing and integrating international EF systems, such as the consistent method of deriving EF distributions for facilitating probabilistic assessment. Also the approach for a systematic data quality rating may be useful in this process. Carrying out exposure estimations based on RefXP in parallel to exposure monitoring studies like GerES and ESB demonstrates how all three instruments can be applied for complementing and validating each other. Acknowledgements: RefXP was funded by the Federal Environment Ministry (BMUB) and endorsed by the German Working Group on Environment-related Health Protection (LAUG).

Keywords: A-exposure factors, A-exposure models, A-risk assessment, A-statistical methods, A-activity patterns

We-S-F3: Study Designs for Assessing Human Behavior for Exposure Modelling - II

We-S-F3-01

How Questionnaires and Multimedia Measurements collected in the U.S. EPA's Observational Human Exposure Measurement Studies Inform Exposures

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Abstract: In the last decade, the U.S. EPA has conducted and/or funded numerous observational human exposure measurement studies where questionnaires were administered to the study participants in addition to the collection of multimedia measurements. Questionnaire responses provide ancillary information with which to interpret multimedia measurements and estimate human exposure. The types of information collected via questionnaire include personal (activities, location, diet and eating habits), housing (type, size, content, cleanliness), and community (location, services, roadways, green space) information. Examples of data collected via questionnaires include activity pattern information detailing macro- and micro-activities which can be used to better estimate aggregate and cumulative exposures; diet information on the types of foods eaten which helps to inform ingestion estimates; consumer product use information which helps to interpret residue concentrations found in residential dust and air and to assess exposures from uses of these products. Additionally, publicly available information or information collected by other federal agencies are used for measurement interpretation. These data can be used to support interpretation of measurement data, derive exposure factors, and assist in model predictions and risk assessment/risk management decisions. Historically, questionnaires have been administered using pen and paper, whereas more recently, the U.S. EPA has been exploring ways to administer questionnaires using electronic devices (computer, smartphone, tablet). Regardless of the method, data quality metrics such as response rate and range, compliance, and descriptive statistics are used to explore the quality of the collected responses. This talk will further describe the types of information collected, uses of the data for assessing exposure and risk, and provide a few specific examples from studies conducted by the U.S. EPA.

Keywords: A-activity patterns, A-exposure factors, A-behavior

We-S-F3-02
Challenges in Designing Product-use Surveys for Assessing Consumer Exposure via Personal Care Products: Case Studies from Switzerland and the Netherlands
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Abstract: To estimate exposure to potentially harmful ingredients contained in personal care products (PCPs) and assess their risks to our health, access to reliable PCP use data is needed. Properly designed and conducted PCP use surveys are powerful tools for the collection of such data. Two PCP use surveys have recently been carried out in the German-speaking part of Switzerland and the Netherlands. In the former study, PCP use and co-use patterns of eight leave-on PCP categories were determined by a postal questionnaire (1196 respondents; ages 0-97 years), which included, for the first time in Europe, children below the age of 12, who may be more vulnerable to certain adverse effects of some PCP ingredients. Apart from the use frequency also most frequently used products were inquired. In the Netherlands, on the other hand, an attractive alternative to traditional postal survey was used i.e., a web-based questionnaire (516 respondents; ages 18-71 years). Respondents however still received a letter containing a link to the questionnaire, which they had to type in the web-browser. The use frequencies and co-use patterns of 32 PCP categories were investigated, along with used amounts (by photos) and most frequently used brands for products. The objective of this presentation is to compare the results of the two surveys and discuss the use of surrogate PCP use data from other countries. Moreover, the questionnaire designs and means of administration will be evaluated in the context of their suitability for assessing adequate exposure factors for consumer exposure modelling. Possible enhancements that could be included into future studies will be discussed.

Keywords: A-exposure factors, A-aggregate exposure, A-behavior, C-consumer products, C-personal care products

We-S-F3-03
Online Questionnaires for Gathering Exposure Factors for Dermal Exposure to Consumer Articles (Textiles, PVC Flooring and Paper): Results and Experience from the DRESS Project
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Abstract: Dermal exposure to substances present in articles is more than likely affected by the nature, frequency, area and duration of contact between articles and skin. By lack of sound information on these dermal exposure factors for articles, crude assumptions are currently applied in lower tier dermal exposure models for articles, and even in higher tier dermal exposure assessment studies published in scientific literature. In order to advance from assumption-based towards facts-based exposure factors for dermal exposure to substances in articles, an online questionnaire was launched in the framework of the DRESS (DeRmal Exposure aSsessment Strategies) project. The final aim was to recruit information on habits and practices in order to derive sound exposure factors. The questionnaire was focused on three article categories: textiles, PVC flooring and paper articles, covering in total about 20 specific articles. The questionnaire included dedicated questions about penetration of the articles in their everyday life, frequency and duration of contact with specific articles, use context and habits. The online questionnaire was completed by 9000 individuals (> 18 years), recruited from the IPSOS panel in 6 EU countries (Czech Republic, Germany, Spain, Poland, Sweden, UK). The sample population was a balanced representation of society in terms of region, age, gender, and occupational status. Survey results will be presented, including variability of responses, and differences between regions, gender and age. It will be explained how the survey results were used for derivation of dermal exposure factors, exposure scenario development, and illustrations in case studies will be given. In addition, limitations of the use of questionnaires for derivation of some dermal exposure factors will be discussed, together with suggestions for alternative approaches. Acknowledgments: Project funded by Cefic LRI contract LRI B9

Keywords: A-exposure factors, A-behavior, C-consumer products, A-exposure models

We-O-G3-01
Multi-pollutant Mixtures Identified from a Principal Component Analysis by Melding Mobile Monitoring and integrated Passive Sampler Data
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Abstract: Background: A multi-pollutant approach to traffic related air pollution may be more relevant to health effect inference if identified mixtures are more easily predicted than single pollutants. Multi pollutant features may also improve exposure assessments in locations without monitoring data if the multi-pollutant features are more robustly predicted in spatial prediction models. Objective: To identify multi pollutant mixtures using 10 second mobile monitoring data combined with two-week integrated passive sampler data for SO2, O3, NO, NOx, and volatile organic compounds from winter and summer 2012 monitoring campaigns in Baltimore, MD in a principal component analysis (PCA). The combined dataset consists of 30 separate pollutant measurements at 43 monitoring locations. Results: Data from passive samplers exhibit correlation with mobile monitoring data for NO and NOx. In addition, mobile black carbon demonstrates correlation with high molecular weight hydrocarbons consistent with enriched diesel emissions. Preliminary results identified 5 principal components that explain 76% of the variance in the overall data set. The PCA features are consistent with overall traffic volume, enriched diesel traffic, and urban background. Ozone measurements from the passive sampler show little correlation with any other co-pollutants. In addition, several sites have PCA scores that appear inconsistent with traffic data, indicating that local sources may dominate the pollutant concentrations at these sites. Conclusion: Mobile monitoring measurements combined with passive samplers provide a rich multi-pollutant picture that incorporates both short term (mobile) and two week (passive samplers) air pollutant measurements into a unified spatial description of traffic related pollutant mixtures. The consistency of these mixtures will be examined in multiple cities across the U.S. in future work, and the potential use of these features in spatial models will also be determined.

Keywords: C-air, B-particulate matter, A-exposure factors, B-VOCs

We-O-G3-02
Quantifying Uncertainties in Pollutant Mapping Studies Using the Monte Carlo Method
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Abstract: Routine air monitoring provides accurate measurements of annual average concentrations of air pollutants, but the low density of monitoring sites limits its capability in capturing intra-urban variation. Pollutant mapping studies measure air pollutants at a large number of sites during short periods. Such incomplete measurement can cause substantial uncertainty in reproducing annual mean concentrations. We conducted Monte Carlo experiments with nationwide monitoring data from the EPA Air Quality System to quantify this uncertainty for 17 different sampling strategies. The performance of each sampling strategy is defined as the occurrence of "accurate" samples (within +/-20% of true annual mean concentrations) in Monte Carlo experiments. Fixed sampling strategies have much better capabilities to reproduce the annual mean concentration of a single site than mobile sampling strategies. The performance of a strategy decreases and the 95% confidence interval (CI) of estimated annual mean concentration increases when data variation increases, indicating potential difficulties in measuring high traffic sites. The uncertainty can be reduced by estimating the mean concentrations of site groups. Mobile sampling becomes comparable with fixed sampling when the group consists of 4 sites. Correcting measurements with reference sites cannot completely remove the uncertainty from incomplete measurement. Using reference sites with the addition method can better improve the performance than the multiplication method. The multiplication method could introduce additional errors at less variable sites. Simulated sampling strategies have large uncertainties in reproducing seasonal and diurnal variations at individual sites, but are capable to predict temporal variations for site groups. Future pollutant mapping studies should increase the randomness of their design rather than simply increase the total sampling time to reduce the uncertainty from incomplete measurement.

Keywords: A-statistical methods, A-epidemiology, C-air, B-particulate matter, field sampling

We-O-G3-03

Social Costs of Air Pollution in Population Highly Exposed to Industrial Emissions

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Abstract: Introduction. Over the past decade, Ukraine has seen a significant increase in number of cancer patients (15% of all deaths). According to reports, the estimated number of cancer cases is 90,000 annually; of wich almost 40% are working-age people. The aim of the study was to assess the social costs of industrial air pollution in terms of probability of additional cancer cases for further preventive health programs' and mitigation measures' development. Methods: Population in 12 Ukrainian cities was described according to demographic analysis methods. Residential exposure was assessed by geocoding over 45,000 residential addresses and using previously developed air pollution maps. Cancer risks and social costs were estimated in accordance with U.S. EPA methodologies. Average value of human life in U.S. dollars was calculated using methods of international comparisons, labor market researches, utility theory and actuarial approach. Results: It was revealed that almost 80% of the population was highly exposed to industrial air pollution. Potential social cost among working-age people was estimated as lifetime risk of additional cancer cases occurrence. Results showed that annually metallurgical industry was responsible for 51.0 newly diagnosed cancer cases. The impact of combined heat and power enterprises, coke and chemical production was substantially lower and equaled 4.0, 1.0 and up to 6.0 newly diagnosed cases respectively. An average value of human life in Ukraine was estimated at about 0.4-0.5 million U.S. dollars, which annually gives 0.5 to 25.5 million U.S. dollars of social costs attributed to air pollution-related additional cancer morbidity. Conclusion: Methodological approach to estimation of average value of human life in Ukraine was worked out. Based on research outcomes, a set of instruments was developed for implementation of air pollution risk management programs aimed at mitigation of health risks in highly exposed groups.

Keywords: C-air, A-risk assessment, A-environmental regulation, A-geospatial analysis/GIS, A-exposure factors

We-S-A4: The Exposure Dimension of Environmental Epidemiology: A Critical but Under-Explored Study Quality Issue in Environmental Health - II

We-S-A4-01

Evaluating and Improving the Quality of Exposure Assessment in Environmental Epidemiology: The Role of Peer Review and Journal Standards

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Abstract: Peer reviewers and journal editors can improve the quality of environmental epidemiology by critically evaluating methods and demanding clear and complete reporting, but may lack the specific expertise needed to critique exposure assessment. Use of standardized instruments to evaluate the quality of exposure assessment could improve the quality of peer review, but strict adherence to generic standards that may not be valid or appropriate for all study designs, exposures, and outcomes could have a negative impact by preventing the publication of informative research. I will discuss approaches that might be used by reviewers and editors to improve the quality of exposure assessment in environmental epidemiology, and potential limitations and barriers that would need to be addressed to implement them successfully.

Keywords: A-epidemiology

We-S-A4-02

Improving Exposure Assessments in NIH Grant Proposals

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Abstract: Research grants submitted to National Institutes of Health are peer reviewed at Study Sections. Up to now, no study sections have been organized around the theme of exposure science, making it difficult to review proposals focusing on exposure analysis. Although exposure assessment is a significant component of environmental health studies, reviewer expertise on exposure assessment is often underrepresented in study sections that are normally organized by health outcome. Because of the imbalance of reviewers' expertise, emphases have often relied heavily on outcome assessment and inadequately on exposure assessment. Thus, this review paradigm does not provide incentives for investigators to spend more effort on improving exposure

assessment, negatively affecting the overall quality of studies. This is troubling since it is well recognized that the uncertainty in exposure estimates is larger than the uncertainty in outcome assessments but is justified by the notion that "there is nothing we can do about improving exposure estimates". Despite the advancement in exposure science, cutting-edge exposure assessment technologies have rarely been applied in epidemiological studies. This is largely due to the fear that novel methodologies will be reviewed as too risky. Moving forward, the role of exposure science in environmental health shall be enhanced, starting with improved two-way communications. On one hand, the advancement in exposure assessment methodology needs input from health scientists, which will improve the relevance of the methods. On the other, health scientists need to welcome advice from exposure scientists. The NIH grant review system needs more active participation of exposure scientists and needs to encourage health studies using novel exposure assessment methods. Special funding programs should be made available to encourage collaborations between exposure scientists and epidemiologists in the development of high-risk/-impact exposure analysis methods.

Keywords: A-exposure factors

We-S-A4-03
Challenges of Exposure Assessment Quality on Occupational Epidemiology Risk Estimates
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Abstract: High quality exposure assessments are essential to the validity of occupational epidemiology studies. However, changes occurring in the manufacturing work force and work environment over the past two decades have led to significant challenges in conducting exposure assessments in occupational epidemiological studies. Key changes include fewer workers required to run operations, less discriminating job titles, worker cross-training, frequent use of rotating work shift schedules, outsourcing, and acquisition and merger of companies. Concurrent with these are the availability of advanced analytical methods to detect concentrations of specific chemicals and/or their metabolites in blood and urine at increasing smaller levels. Biomonitoring can be incorporated in industrial hygiene surveys to augment the quantification of current exposures. Further, biomonitoring can enhance and validate job exposure matrices that estimate exposes in the past. However, the pharmacokinetics of each chemical must be considered in the design of collection and subsequent interpretation of the worker exposure. These changes present unique challenges in estimating and validating exposure in epidemiology studies. Examples of biomonitoring data and their use (and misuse) in epidemiology studies will be presented.

Keywords: A-biomonitoring, A-epidemiology, A-workplace

We-S-A4-04
Improving Exposure Assessment Technology
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Abstract: Exposure assessment is an integral component of occupational and environmental epidemiology, risk assessment and management, as well as regulatory compliance. For the most part, air sampling and analysis tools used in occupational and environmental exposure assessments are based on technologies that have changed little since the 1970s. In many cases the lack of simple, inexpensive, exposure assessment technologies has limited epidemiologists' and risk assessors' ability to evaluate the environmental and occupational causes of disease. While there have been tremendous investments and advances in medical diagnostic and biomonitoring technologies (e.g., glucose testing, human genetics), there has been less effort invested in advancing the science of exposure assessment. Developing and applying new sensing technology for personal sampling can improve the way epidemiologic studies are conducted. Time-series panel studies that investigate short-term (hours to days) changes in personal exposure that are linked to changes in health care encounters, symptoms, and biological markers of preclinical disease and/or susceptibility are needed to more fully evaluate the impact of chemicals and other agents on health. Current sampling technology limits our ability to assess time-varying concentrations. The purpose of this paper is to discuss the current state of air sampling and health assessment and the need for improved assessment technology for use in health effects studies.

Keywords: Exposure Assessment Technology

We-S-B4-01
Towards Point-of-Care Metal Exposure Assessment Using Electrochemical Microsensors

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Abstract: Metals are ubiquitous in the environment and have long been recognized to pose significant threats to human health. Blood lead (Pb) has been consistently associated with deficits in IQ and academic achievement in numerous controlled studies. Manganese (Mn) is an essential element, yet neurotoxic in excess, capable of crossing the blood-brain barrier and accumulating in the brain. Current approaches for measuring such exposures suffer from high costs including extensive labor, equipment and time-consuming laboratory procedures, and often, demonstrate long turnaround times. Our group is addressing this need by developing point-of-care sensors for assessment of metal exposure by integrating the electroanalytical techniques of stripping voltammetry with microfluidics. This talk will discuss our recent results that show feasibility of measuring of Mn and Pb metals with point-of-care sensors. We ultimately aim to demonstrate rapid, point-of-care, multi-analyte assessment of Mn and Pb metals in a finger prick of blood.

Keywords: A-sensor technology, A-analytical methods, B-metals

We-S-B4-02
Uncovering Early Life Chemical Exposure History Using Teeth

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Abstract: The concept of critical developmental windows includes heightened susceptibility to toxic insults at specific life stages that increases the risk of maladaptive phenotypes. Researchers have been limited in their ability to determine critical windows specific to chemicals because such studies invariably require large-scale prospective data and exposure assessment tools that may not include the correct life stage. Foremost is the challenge of directly measuring fetal exposure and the inadequacy of maternal biomarkers to accurately quantify prenatal exposure for many chemicals that undergo complex partitioning across the placenta. Furthermore, it is now recognized that measuring toxicant exposures alone is not sufficient to elucidate health risks but rather it is important to determine whether chemical exposures are accompanied by disruption of key physiological pathways that would ultimately increase the risk of clinically detectable disease. To address these issues, the speaker will present the development of a methodology that combines detailed histological and chemical analyses of deciduous teeth layers corresponding to specific life stages, thereby reconstructing exposure to individual chemicals and chemical mixtures in the second and third trimesters, in early childhood, and also cumulative life-long exposure. Recent developments in the application of this biomarker to study pathway disruptions will also be discussed, and the presentation will conclude by providing examples of novel statistical techniques that address the multi-dimensional temporal exposure data generated by the tooth-chemical biomarker.

Keywords: A-biomarkers, D-children, D-prenatal

We-S-B4-03
Method improvements for blood lead analysis in dried blood spot (DBS) formats

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Abstract: Trace analysis for lead (Pb) in dried blood samples is an attractive method for reducing costs in lead monitoring programs for public health. Two major contributors to measurement variance in blood lead concentrations were addressed in an NIEHS funded program at GE Global Research. Methods are described that reduce lead contamination in the sampling matrix and mitigates variability in original sample volume determination. A simple washing procedure for reducing lead contamination in sample collection matrices yields materials with Pb concentrations less than 0.3 ng/g. The extremely low levels of Pb allow detection down to 0.1 µg/dL in extracted caprine blood standards. Despite good method capability, the actual detection limit for samples prepared outside of a cleanroom setting was 7.0 µg/dL due to trace environmental contamination. The environmental background interfered with nearly half of the CDC recommended working range and highlights a challenge associated with DBS methodology that does not impact venous blood samples. Determining initial

sample volume is critical for a quantitative Pb assay. A multivariate model for estimating sample volumes from measurements of spot area, mass, and potassium concentration was developed with a prediction accuracy of 5.2 ± 4.2% at 95% confidence. The model was used to reduce the variability from unmetered, or poorly metered, sample collection and was found to reduce the CV in the final measurement to 15 %. A demonstration of the method on a multipatient cohort and a discussion of additional development needs are described.

Keywords: A-biomonitoring, A-analytical methods, A-sampling methods, B-metals, D-community

We-S-B4-04
Using Surface Plasmon Resonance Microarrays to Analyze Diverse Analyte Types with High Sensitivity and a Wide Dynamic Range
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Abstract: This presentation will describe two complementary Surface Plasmon Resonance (SPR) modalities: Grating coupled SPR imaging (GCSPRI), and Grating coupled surface plasmon coupled emissions (GCSPCE), and the use that these two modalities have been put to in the analysis of molecular and particulate analytes that can comprise elements of a biomarker signature. We have developed integrated instrumentation that can make sequential measurements of a biosensor chip in each of these two modalities, and has reached limits of detection of 500 fg/ml for molecular analytes. The instrumentation can measure more than 1000 different regions of interest on a sensor chip, and can assess analytes in microvolumes of sample as small as 200 µl. The instrumentation can simultaneously assess macromolecules such as cytokines, soluble antigens and antibodies, particulates such as viruses and bacteria, small molecular toxicants, and can functionally phenotype immune cells captured on regions of interest on the sensor chip that are specific for individual T cell subpopulations. This technology will be useful both for a variety of research applications, and as a point of care diagnostic platform.

Keywords: A-biomarkers, A-biomonitoring, A-sensor technology

We-S-C4: Exposure Considerations to Evaluate Health Risks over the Life Cycle of Nanomaterials

We-S-C4-01
Legal and Regulatory Considerations over the Lifecycle of a Nanomaterial
L. L. Bergeson; Bergeson & Campbell, P.C., Washington, DC

Abstract: Nanomaterials that are considered new under the Toxic Substances Control Act (TSCA) must be notified to the U.S. Environmental Protection Agency (EPA) through a Premanufacture Notification (PMN). Under TSCA, EPA must review the nanomaterial and assess whether its intended uses and applications will cause unreasonable risk of injury to health or the environment. TSCA is a risk/benefit statute and EPA must balance the potential risk of a new chemical substance with the benefits the chemical substance offers. This balancing is especially crucial for nanomaterials because in the absence of actual data on the new chemical substance, which is often the case, EPA uses defined assumptions and assumed risk factors in conducting its risk evaluation. These assumptions and risk factors are very conservative, making the need for a well-defined and compelling "benefits" analysis all the more important. How benefits are identified, defined, and quantified is by no means clear, however, and PMN submitters are often unaware of the significant importance of a compelling and demonstrable "benefits" analysis to include in the optional Pollution Prevention (P2) field of the PMN form. This presentation will identify and discuss key legal and regulatory considerations for manufacturers and users of nanomaterials that are subject to TSCA Section 5 new chemical review to optimize their ability to ensure EPA concludes the new chemical substance does not pose unreasonable risk and, even if it does in certain respects, the P2 benefits of the new chemical substance are sufficiently compelling to offset any such risk. This presentation will also briefly review the risk assessment process and demonstrate just how important the benefits analysis has become under TSCA and why the concept of a life cycle assessment has become such a critically important part of the new chemical review process.

Keywords: A-nanotechnology

We-S-C4-02

Risk Management Issues in the Control of Occupational Exposures to New Generations of Nanomaterials

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Abstract: There are still many issues to be resolved for risk assessment guidance for "first" generation nanomaterials. In the meantime more sophisticated nanomaterials and nanosystems are being developed and beginning to enter commerce increasing the likelihood that workers, beyond the initial investigating scientists, may have workplace exposures to them. If these new entrants act merely as ultrafine particles, they will be expected to behave like familiar 'passive' nanoparticles. However, there is little published information on the potential hazards of these more sophisticated nanomaterials, including the extent to which their characteristics may potentiate toxicity. It is incumbent on researchers, manufacturers, and government agencies to consider "second and third" generation nanomaterials, such as self-assembling nanostructures, and consider what hazards, exposure, and risks potentially exist and whether the current control guidelines for nanomaterials are appropriate. What is needed is a risk management framework to help develop a precautionary strategy for identifying and controlling exposures to new types of nanomaterials. We used the 5 functional categories described by Maynard et al (2011) as a foundation to construct a "proto"-framework, a beginning step in thinking about hazards, exposures, risks, and controls of new generations of nanomaterials. The challenge is to construct the rest of the framework from that foundation. To begin to meet this challenge, a 5x5 matrix could be constructed to help orient investigators, exposure and risk assessors, and guidance developers. The five functional categories of nanomaterials will be on one axis of the matrix. On the other axis will be 1) examples of the nanomaterials in each category; 2) the potential commercial uses; 3) processes involved in the use; 4) the potential for release and exposure; and 5) likely controls and control issues. The tasks involved in filling the cells in the matrix will be described.

Keywords: A-nanotechnology, risk management,advanced materials,risk assessor, risk management,advanced materials,risk assessor, risk management,advanced materials,risk assessor

We-S-C4-03

Exposure Assessment Techniques and Strategies within the R&D Environment

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Abstract: The life cycle of the nano-enabled product begins with research and development. This environment often presents many unknowns related to exposure, toxicity, and hazard control for the research community especially when scale-up is attempted. The literature addressing this transition phase between post bench-top and pre scale-up (pre-pilot) is sparse. Our work attempts to answer the question of whether or not same or similar engineering controls exhibit adequate efficacy. Utilizing exposure assessment techniques adapted from NIOSH methodologies which employ a multi-faceted approach are necessary to ascertain whether exposure from engineered nanomaterials directly associated with the task at hand occurs. Direct-read instrumentation, traditional air sampling on filter media in addition to collection of airborne particulate via a point to plane electrostatic precipitator (PTP-ESP) onto a TEM grid are used to assess and quantify unique factors associated with novel nano-materials R&D. A case study focused on exposure assessment and control will be presented as it relates to materials such as high aspect ratio engineered nanomaterials (nanowires/nanofibers or nanolayers). A pre pilot scale production process employed in the R&D environment, such as atomic layer deposition or electrospinning will be the premise upon which the case study is based. Verification of engineering controls will be estimated through a mass balance deduction in conjunction with researcher input. Despite a contained process with an inert atmosphere it is expected that capture via the designed engineering controls will be less than 100% effective. This discussion will communicate the findings.

Keywords: A-nanotechnology, A-sampling methods, B-nanoparticles, B-particulate matter, Research Scale-up

We-S-C4-04
The Potential for Release of Carbon Nanotubes from Solid Matrices
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Abstract: Nanomaterials, especially carbon nanotubes, are useful additives to strengthen polymeric matrices. Because the health and environmental effects of carbon nanotubes are still being investigated, the release of nanomaterials from solid matrices is an important question. However, what constitutes significant release and under what conditions needs to be addressed. This presentation will review studies and methods used to answer these questions. The impact of abrasion, cutting, and weathering on release and health effects of released particles will be presented. In addition, the international activities to standardize methods to evaluate release will be discussed.

Keywords: A-nanotechnology

We-S-C4-05
Transport of Single-walled Carbon Nanotubes in Human Mucus
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Abstract: As the production of engineered nanoparticles are scaled to meet their increasing demand, the potential for occupational exposure to ambient nanoparticles increases. Although exposure to ambient nanoparticles can occur via multiple routes, exposure to nanoparticles via inhalation remains the predominant route. While inhaled nanoparticles are capable of deposition throughout the human respiratory tract, nearly a third can deposit in the tracheobronchial region which are coated with a layer of mucus. The mucus secretions offer a dense mesh network that can trap foreign particles and rapidly remove them thereby protecting the body against injury or infection by foreign particles. Whether mucus layers lining entrance points into the body, including the lung airways, provide protection against the penetration of engineered nanoparticles remains poorly understood. Carbon nanotubes (CNTs), due to their favorable physicochemical properties, are manufactured in substantial quantities for use in many applications but concerns have been raised about toxicity related to CNT exposure in industrial settings. Single-walled carbon nanotubes (SWCNTs) are an important type of engineered nanoparticles and CNTs. We measured the diffusion of hundreds of individual nanoparticles of two types of SWCNTs in human mucus. We used multiple particle tracking, which allows us to quantify the motion of hundreds of individual nanoparticles with high spatial and temporal resolution. Virtually, all SWCNTs were slowed compared with fast moving control nanoparticles. By fitting a mathematical model to the measured diffusion coefficients for hundreds of nanoparticles, we were able to estimate the fraction of SWCNTs that may penetrate a mucus gel layer. We found that the vast majority of these SWCTNs are efficiently trapped in human mucus. We conclude that human mucus layers probably provide considerable protection for mucosal tissues from the penetration of SWCNTs.

Keywords: A-nanotechnology, D-occupational, C-air

We-S-D4: Saturation and Mobile Monitoring Studies: What have we Learned About Small Scale Variations in Exposure and Where are we Going?

We-S-D4-01
Benefits of Saturation and Mobile Monitoring for Exposure Assessment
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Abstract: Fine scale spatial variation in average outdoor air pollutant concentrations such as occurs within cities has long since been appreciated. However, only relatively recently has it been characterized quantitatively for exposure assessment using models. This is motivated by interest in understanding the health risks of residing in high versus low concentration locations within cities and by epidemiological evidence of risks associated with spending considerable time near roadways. Although physically-based models (e.g., dispersion models coupled with emissions data) have been used, the models are often empirically-based, derived from short term datasets specifically acquired across many urban locations of contrasting concentrations. Saturation monitoring, involving simultaneous measurement at multiple (≥25) locations, is most common for obtaining these data. Mobile

measurements can also yield valuable information on spatial differences although their use for exposure model development is less common. This presentation will discuss the strengths and weaknesses of these two sources of data and the results from Canadian cities where both are available. For Montreal, empirical models (Land-Use Regression-LUR) have been developed from both saturation and mobile monitoring. Depending upon predictors and time period, LUR explains 54-80% of the spatial variability in average nitrogen dioxide (NO2) from saturation monitoring. Multi-pollutant, multi-day mobile measurements cover many Montreal locations and show average NO2 ranging from 6-50 ppb (median=12 ppb). A preliminary LUR model using ultrafine particle counts from these measurements (median=25,000 p/cc) is promising (R2=0.7) and models for multiple pollutants, including NO2, are currently being developed. These results and their limitations and comparison with the LUR model from saturation monitoring will be discussed.

Keywords: A-exposure models, C-air, A-geospatial analysis/GIS, A-sampling methods

We-S-D4-02
Multi-Pollutant Variability Using Saturation Monitoring across an Area with Complex Terrain

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Abstract: Background: Land use regression (LUR) models have recently become an important tool for urban exposure assessment, integrating geographic and traffic information, but few studies examined variation during key hours of interest, such as inversion conditions. Saturation monitoring can assess pollutant variability by source stratification across an area with complex terrain and frequent atmospheric inversion events. Source apportionment can identify suites of metals, and LUR modeling of factor scores can reinforce proposed sources. Methods: A two-year monitoring campaign was designed to capture intra-urban seasonal variability in fine particulate matter (PM2.5), black carbon (BC), and trace metal constituent concentrations across 37 distributed sites that were influenced by a prior mobile monitoring campaign. Spatial distributions of local pollution sources (i.e., traffic, industry) and potential modifiers (i.e., elevation) were explored via geographic information systems (GIS). Sampling intervals captured inversion-prone morning rush hours, and were compared to 24-hour integrated sampling intervals. Seasonal LUR models and factor analysis were performed, and LUR was run on factor scores to clarify source apportionment. Results: Land use, sulfur dioxide (SO2) emissions, elevation, and meteorology were significant LUR predictors. Pollutant surface exposure maps detected greater spatial contrast in the inversion-focused LURs compared to 24-hr integrated LURs. For source apportionment, factor loadings and factor score LURs identified brake/tire wear, steel making, coal, and motor vehicle emissions. Conclusions: Targeting air monitoring campaigns to capture peak hours and local modifiers (e.g., elevation) can improve the accuracy of exposure assessment for environmental epidemiology. Sampling methodologies could be replicated in other cities, with an emphasis on observing more pollutant spatial variability during peak hours, which may be more predictive of health outcomes.

Keywords: A-exposure models, B-particulate matter, A-exposure factors, A-geospatial analysis/GIS

We-S-D4-03
Deriving Spatial Trends of Air Pollution at a Neighborhood-scale Through Mobile Monitoring

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Abstract: Measuring air pollution in real-time using an instrumented vehicle platform has been an emerging strategy to resolve air pollution trends at a very fine spatial scale (10s of meters). Achieving second-by-second data representative of urban air quality trends requires advanced instrumentation, such as a quantum cascade laser utilized to resolve carbon monoxide and real-time optical detection of black carbon. An equally challenging area of development is processing and visualization of complex geospatial air monitoring data to decipher key trends of interest. EPA's Office of Research and Development staff have applied air monitoring to evaluate community air quality in a variety of environments, including assessing air quality surrounding rail yards, evaluating noise wall or tree stand effects on roadside and on-road air quality, and surveying of traffic-related exposure zones for comparison with land-use regression estimates. ORD has ongoing efforts to improve mobile monitoring data collection and interpretation, including instrumentation testing, evaluating the effect of post-

processing algorithms on derived trends, and developing a web-based tool called Real-Time Geospatial Data Viewer (RETIGO) allowing for a simple plug-and-play of mobile monitoring data. Example findings from mobile data sets include an estimated 50% reduction in roadside ultrafine particle levels when immediately downwind of a noise barrier, increases in neighborhood-wide black carbon levels (30-104%) downwind of a rail yard relative to upwind neighborhoods, and that data smoothing approaches (spatially vs. temporally) can significantly affect inter-pollutant correlation estimates.

Keywords: C-air, A-geospatial analysis/GIS, D-community

We-S-D4-04
Modeling Approaches for Spatially Resolved Pollutant Measurements
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Abstract: Mobile monitoring has become increasingly popular as an exposure assessment strategy for traffic-related air pollutants, given interest in characterizing near-roadway concentration gradients. However, continuously-measured mobile monitoring data are challenging to analyze, given significant autocorrelation, limited data on key predictors of concentrations, and issues in separating spatial and temporal variability. Furthermore, the optimal analytical approach depends significantly on the size of the domain of interest, the number of local sources and their configurations, and the averaging time and spatial resolution needed for the ultimate application of the exposure model. Three case studies provide insight regarding the strengths and weaknesses of various analytical strategies for mobile monitoring data. In the first case, multiple alternative regression models were used to characterize spatial-temporal patterns of multiple traffic-related air pollutants near two major highways, with explicit consideration of the influence of short-term and long-term temporal autocorrelation and the tradeoffs between statistical fidelity and physical interpretability. In the second case, multiple major sources with differing spatial-temporal profiles were present, with implications for both the mobile monitoring study design and the resulting statistical analyses. In the final case, fixed-site and mobile monitoring data were used jointly to characterize source contributions from major roadways. Future mobile monitoring campaigns should make use of innovative data resources to characterize real-time traffic flows, use statistical techniques that account for the autocorrelated nature of continuously monitored concentrations while maintaining physical interpretability, and leverage strategically-placed fixed-site monitors to increase applicability to other points in time and space.

Keywords: A-geospatial analysis/GIS, A-exposure models, A-statistical methods, B-particulate matter, C-air

We-S-D4-05
Fixed Site Monitoring Versus Personal Sensor Use for Communicating Risk in London
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Abstract: Recent advancements in sensor, data storage and communication technologies have led to an expanding range of time resolved mobile sensors of air pollution and other environmental variables such as temperature and humidity. These sensors present an opportunity to make a step change improvement in the quality, accuracy and scope of reliable exposure metrics for use in population studies. It should therefore be feasible to establish more robust and targeted links between air pollution and negative health outcomes and provide a direct means of communicating these risks to the public. However, epidemiological studies rely on relationships between health outcomes and risk in the general population and it is unlikely that we will reach the stage where thousands of sensors can be distributed across a population. Therefore, mobile sensors will not replace, but likely support and extend the use and development of population exposure models. The research to be presented brings together two fields of activity that have made rapid advancements in recent years - personal pollution sensors and time-activity models. In London we have started a series of pilot studies in which we examine the cumulative exposure of citizens. Unsurprisingly our finding indicate that place of residence and workplace, time of travel and mode of transport all play important roles in dictating an individual's exposure to particulate pollution. However, the availability of these data at an individual level provides a powerful communication tool and instrument for achieving change leading to lower exposure levels for urban populations.

Keywords: A-epidemiology, B-particulate matter, A-sensor technology

We-S-E4: Towards Integration of International Exposure Factors' Systems - II

We-S-E4-01
Overview of the Development of Korean Exposure Factors Handbook
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Abstract: A set of exposure factors that reflects the characteristics of individual behavior capable of influencing exposure is essential for risk and exposure assessment. In 2007, the Korean Exposure Factors Handbook was, therefore, issued, driven by the need to develop reliable exposure factors representing the population. The purpose of this study was to overview the development process of the Korean Exposure Factors Handbook and major recommended exposure values for the Korean population to allow for information exchanges and comparison of recommended values among nations. The researchers reviewed the domestic data that could be used in the development of exposure factors, confirmed a knowledge gap, and set a priority of development by phases. A methodology to measure exposure factors was established to develop measuring techniques and test their validity. Data were processed or a survey was conducted according to the availability of data. The study thus produced recommended values for 24 exposure factors grouped by general exposure factors, food ingestion factors, and activity factors by setting up a database of exposure factors and carrying out statistical analysis. The study has significantly contributed to reducing the potential uncertainty of the risk and exposure assessment derived by the application of foreign data or research findings lacking representativeness or grounds by developing a set of exposure factors reflecting the characteristics of the Korean people. It will be necessary to conduct revisions in light of the changing statistical values of national data and the exposure factors based on Korean characteristics.

Keywords: A-risk assessment, Environmental exposure, Handbook

We-S-E4-02
The European Exposure Factors Database: Analysis and Interpretation of ExpoFacts Determinants
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Abstract: ExpoFacts database compiles exposure factors of the 28 Member States of the European Union, Iceland, Norway and Switzerland in one centrally available database, through a freely accessible website: http://expofacts.jrc.ec.europa.eu. ExpoFacts enables a quantitative description of exposure determinants, which are structured into seven categories, characterised by three main attributes: population, variability and uncertainty. The five new functionalities that characterise the ExpoFacts database version 3.0, together with the new values, information and categories, aim at: (i) aggregating elementary values of categories of food sub products (basketing function); (ii) visualising exposure factors values by predefined age groups, gender and countries; (iii) filtering the available data sources according to three classification levels: survey based, unknown source and study based; (iv) categorising consumer and food products (Specific Consumer Exposure Determinants initiative) and (v) mapping the available values to the corresponding exposure routes. These functionalities have augmented the user friendliness of the ExpoFacts database. However, some results can be misinterpreted without adopting a harmonised interpretation perspective. This presentation is starting promoting a systematic approach to the interpretation of the determinants' values, applicable to each of the 31 considered countries. ExpoFacts 3.0 is expanding its linkage to include currently worldwide available exposure factors' systems in U.S.A., Korea, Australia, Japan, Germany and recently China.

Keywords: A-exposure factors, C-consumer products, C-food, D-children, D-community

We-S-E4-03
Introduction of Exposure Factors Handbook of Chinese Population (Adults)
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Abstract: The purpose of this paper is to introduce the development of Chinese Exposure Factors Handbook, giving an overview of the structure, contents, methods, and recommendation value. The development process of the Exposure Factors Handbook of Chinese Population (Adults) (CEFH-A) was designed into two steps. On the first step, the Environmental Exposure Related Human Activity Patterns Survey of Chinese Population

(Adults) (CEERHAPS-A) was carried out in order to fill in the major data gap especially time activity patterns data, drinking water intake data etc. At the same time, data from other sources were collected. After critical evaluation of the data sources, the recommended values were retrieved and the handbook was developed. There're twelve exposure factors in the CEFH-A. The recommended values are in the group of urban/rural and male/female since difference of exposure factors between urban and rural population are an obvious pattern. The differences of CEFH-A with other countries/regions are in terms of a) the Ways of development and data sources, b) the Structure and content, c) the data presenting format and d) the recommended vales. The recommended value of exposure factors in CEFH-A are different from not only western but also eastern countries, in terms of not only physical characteristics like body weight, surface area etc. but also behavior factors like outdoor air, showering/bathing time etc. The CEFH-A is the first exposure factors handbook in China. By filling the data gap it will improve the accuracy of exposure assessment and risk assessment in Chinese population Future steps like studies on soil ingestion rate, air exchange rate, consumer products etc and children's exposure factors handbook is needed.

Keywords: A-activity patterns, A-behavior, A-exposure factors

We-S-E4-04
Australian Exposure Factors
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Abstract: Australian Exposure Factors provide guidance on what exposure factors are applicable in Australia in order to be used with enHealth Risk Assessment Guidelines. They have been developed primarily for use in screening (Tier 1) risk assessments. When available the exposure factors are based on Australian data: National Nutrition Surveys (Australian Bureau of Statistics (1995, 2008 & 2011)) and National Health Survey (2008 & 2011). Where insufficient Australian data is available, factors from Europe or the US are used. This adds uncertainty into any risk assessments as the basis of the exposure factors can differ.

Keywords: A-exposure factors, A-risk assessment

We-S-E4-05
2013 Canadian Exposure Factors Handbook
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Abstract: In 1997, the Compendium of Canadian Human Exposure Factors for Risk Assessment was published to provide Canadian population data and information as a basis for human health risk assessments in Canada. That Compendium is now the most common source of receptor characteristics for contaminated site (and other) risk assessments in Canada, is the primary source of assumptions for human characteristics within Health Canada's risk assessment guidance for federal contaminated sites, and is cited in various provincial environmental regulations, regulatory risk assessment guidance, protocols for the derivation of risk-based environmental quality guidelines to protect human health, and in technical documents for individual risk-based environmental guidelines and risk assessments. Recognizing that the 1997 Compendium was significantly out of date, recent Statistics Canada data have been accessed and analyzed towards bringing the Compendium up to date. The overall aim of the update was to improve the accuracy of, and reduce uncertainty in, assessments of risk posed to the Canadian population by exposure to environmental contaminants. Recent Canadian data were available to update exposure factors for a variety of the variables contained in the Compendium, including body weights, skin surface areas, and time-activity patterns. Revised soil ingestion rates are also recommended. The basis for revised receptor characteristics will be discussed, and revised values compared to those recommended in 1997. The risk assessment implications of changes in the characteristics of the Canadian population will also be discussed.

Keywords: A-exposure factors, A-risk assessment

We-S-F4-01
Adult Cancers and Adverse Reproductive Outcomes from Exposure to PCE-contaminated Drinking Water

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Abstract: Investigators at Boston University (BU) School of Public Health have conducted a series of epidemiological studies to evaluate the risk of cancer and adverse reproductive outcomes following exposure to tetrachloroethylene (PCE)-contaminated drinking water among residents of Cape Cod, Massachusetts. Beginning in the late 1960s, residents were exposed to PCE in their drinking water when it leached from the vinyl lining of asbestos-cement water distribution pipes. The liner, which was used to address alkalinity problems, had been applied to the interior of the pipe surface using a slurry of vinyl toluene resin and PCE. While it was assumed that most of the PCE would evaporate by the time the pipes were installed, more than a decade passed before officials discovered that sizeable quantities of PCE had remained and were leaching into the public drinking water supplies. Because the contamination occurred during the 1960s-1980s, the BU investigators had to estimate each subject's past exposure. To do so they constructed a leaching and transport model based on the initial amount of PCE in the liner, the age of the pipe, and the leaching rate of PCE from the liner. This was coupled with estimates of water flow rate and direction derived from open source water distribution software developed by the U.S. Environmental Protection Agency (EPANet). This was made possible because of the availability of the software's source code. Notable findings from this research include an increased risk of breast cancer among women with high cumulative exposure levels and elevated risks of oral clefts and neural tube defects among offspring of women exposed during pregnancy. BU researchers continue to study adverse health effects stemming from this ubiquitous environmental contaminant. Funding for this research has been provided by the Superfund Research Program at the National Institute of Environmental Health Sciences (P42ES007381).

Keywords: A-epidemiology, C-water, B-VOCs, D-prenatal

We-S-F4-02
Improving Assessment of Biologically-Relevant Exposures to Water Contaminants in Urban Populations
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Abstract: Microbial water-borne health risk is often considered manageable in developed countries, because of vast improvements in sanitation and hygiene practices via access to centralized water treatment facilities, advances in disinfection agents, and novel water treatment technologies. However, chemical contaminants may often appear in treated water either by escaping water treatment, or by generating or inadvertently introducing post treatment chemical formation. Chemical exposures during sensitive life stages, i.e., both preconception and pregnancy periods, play a major role in formulating early-life health status. While monitoring of exposures to air pollution and dietary contaminants is rigorously practiced in pregnancy-birth cohorts (PBC), water contamination remains understudied in PBC. The classical notion that drinking-water quality reaching households is conserved between the point of entry (water treatment plants) and point of use (households) in aged urban drinking-water distribution systems does not hold true anymore. Episodic release of pipe anchored metals/metalloids and irregularities in spatial and temporal distribution of disinfection by-products are two illustrative features of a changing tap water quality in urban centers. Contaminants often measured in drinking-water may be also found in consumer products (cans, packaged food, personal care products, etc.), complicating their daily intake calculations. Evidence of improved and integrated exposure assessment protocols for environmental chemicals that may be also found in water will be showcased. Related health studies highlighting the associations of water contaminants with elevated type II diabetes risk will be presented. It appears that chemical-based water contamination and related human exposures represent an under-appreciated niche of exposure science pertaining to human health.

Keywords: A-biomarkers, A-biomonitoring, A-epidemiology, A-indoor environment, B-SVOCs

We-S-F4-03

Application of Water-Modeling Tools to Reconstruct Historical Drinking Water Concentrations in Epidemiological Studies

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Abstract: During the 1854 cholera outbreak in London, England, John Snow illustrated a connection between the quality of a water source and a cluster of cholera cases around the Broad Street pump. Ever since, epidemiologists have been searching for and applying refined methods and tools to more specifically characterize and quantify exposure to drinking water. With the common availability of desktop computers and computer programs, it is now possible to reconstruct historical drinking-water concentrations at the residential or street level for spatial distributions and for monthly time increments in terms of temporal distributions. These computational tools now provide epidemiologists with enhanced exposure characterization methods, compared to the simplistic approach of exposed versus non-exposed. The purpose of this presentation is to review three high-profile epidemiological studies that have applied water-modeling tools for enhanced exposure characterization. In these studies, water-modeling tools have included the application of groundwater flow and contaminant fate and transport models, materials mass balance models (simple mixing), and water-distribution system models The three case studies that will be used to illustrate the application of these water-modeling tools are: Woburn, MA, Dover Township (Toms River), NJ, and U.S. Marine Corps Base Camp Lejeune, NC.

Keywords: A-exposure models, A-epidemiology, D-community, contaminated drinking water, historical reconstruction, contaminated drinking water, historical reconstruction

We-S-F4-04

The role of Expert Panels in Guiding Scientific and Technical Approaches in Contaminated Drinking Water Health Studies

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Abstract: Background: From the 1950s through the 1980s, contaminants affected drinking water in communities such as Woburn, MA, Tom's River, NJ and Camp Lejeune, NC. Water contamination exposure models of increasing sophistication were developed for use in epidemiologic studies. Examples: In Woburn, a community advisory panel was established by the Department of Public Health to assist in devising a case-control study of childhood leukemia. In Tom's River, NJ a panel was established by the Department of Health and Senior Services to assist state staff and Agency for Toxic Substances and Disease Registry (ATSDR) in developing a water model and case-control study of childhood cancer. In Camp Lejeune, the ATSDR established a series of expert panels to review proposed plans and preliminary approaches for modeling a complex water system for use in multiple epidemiologic studies. Results: The water model eventually developed in Woburn was used to estimate exposures to children during pregnancy and subsequently. This extended previous findings and suggested that prenatal exposures conferred greatest leukemia risk. In Tom's River, the lessons learned in Woburn were applied in modeling the town water system and used in the case-control study. A similar finding regarding prenatal exposure and childhood leukemia was obtained. In Camp Lejeune, expert panels reviewed and commented on a complex water system models. Environmental exposure experts and epidemiologists made recommendations that were incorporated into a childhood cancer and birth defects study, as well as a Marine cohort mortality study. The exposure model will also be used in a male breast cancer study currently underway. Conclusion: State and Federal health agencies conducting complex contaminated drinking water health studies have benefited from expert panels in the design and implementation phases. The credibility of the resulting studies is enhanced by expert involvement.

Keywords: A-exposure models, A-epidemiology, C-water, environmental epidemiology, expert panels, water contamination

Posters

We-P-01
Body Surface Area in the French Population: A Proposed Distribution for Health Risk Assessments
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Abstract: Use of French data for human exposure variables improves the specificity of health risk assessments in the French population. Until now, no data has been available for French body surface areas (BSA), although this information is necessary for estimating exposure through dermal absorption. Since no French study measures this variable directly, we thus propose an estimation of the BSA of the French population. A review of existing models for the estimation of BSA allowed selecting models that were robust and could be applied to available French data, providing estimated BSA data values. To facilitate the use of these data in a probabilistic risk assessment, theoretical probability distributions were then fitted to these data. To identify the best-fit distribution for the BSA estimated data, the Kolmogorov-Smirnov and Cramer-Von Mises criteria were used. The association between BSA and body mass was also, characterized in the probabilistic risk assessment using the Spearman correlation coefficient. Tikuisis model was selected for adults 18-74 years old, and Gehan and George model for children < 18 years. Both use population weights and heights, for which recent and representative French data are available (2006 French national health and nutrition survey, and medical pediatric health certificates from 2009). Median BSA in the French adult population is 1.82 m^2. 5% of the population is estimated to have a BSA < 1.52 m^2, whereas 5% have a BSA > 2.16 m^2. Men have higher (median = 1.92m^2) BSA than women (median = 1.70 m^2). In children, independently of sex, BSA first increases quickly with age, before staling. After stratification on age (and sex, when enough data was available), the Log-normal distribution was the better fit to estimate BSA distributions in most cases. The BSA distribution produced will contribute to health risk assessment in the French population, whether deterministic or probabilistic risk assessments are used.

Keywords: A-exposure factors, A-risk assessment, body surface area

We-P-02
Describing Exposures to Environmental Contaminants in the French General Population: the Esteban Study 2014-2015
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Abstract: As part of the French biomonitoring program, a cross-sectional survey (Environment, SanTé, Biomonitoring, physical activity, Nutrition: Esteban), combining health exams and a nutrition study with biomarker dosages in a sample representative of the population aged 6-74 living in metropolitan France is ongoing. Its aims in the field of exposure biomonitoring are to describe and establish reference values for the levels of biomarkers of exposure to chemical agents present in the environment (incl. food); to analyse the determinants of exposure biomarkers levels; to monitor time trends in biomarkers levels, when previous results are available; to compare with results from studies conducted abroad; and to monitor the impact of public health policies and regulations aiming to reduce environmental exposures to chemicals. Esteban is a descriptive cross-sectional study conducted on a national sample of 1,000 children from ages 6-17 and 4,000 adults from ages 18-74, residing in metropolitan France. Inclusions will begin in April 2014, starting with a test phase of 4 months, followed by the full size implementation of data collection over 12 months. This sampling duration allows to take into account seasonality of exposure to environmental and food substances. Each participant answers a « questionnaire survey » (partially conducted face-to-face during 2 visits at home and partially self-administered and via telephone), and undergo a « biological and clinical exam » including collection of biological samples (blood, urine and hair, collected either at home during a visit by a nurse, or in a clinic). Biological samples are prepared and sent to a biobank, for long term conservation at -80°C. This biobank will allow measurements of biomarkers of exposure to chemicals. In October 2014, apart from detailed description of the study design, first results on acceptation rate and effective participation in the entire data collection will be made available.

Keywords: A-biomonitoring, A-epidemiology, D-children, D-community, C-food

We-P-03

Describing Exposures to Environmental Contaminants in Mothers of Newborns in France, 2011: First Results Obtained in the Framework of the French Biomonitoring Program

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Abstract: As part of the French biomonitoring program, exposure biomarkers were measured in biological samples collected in 2011 from mothers of newborns randomly selected among the participants in the clinical and biological component of the cohort Elfe. The aim was to describe impregnation levels by various chemicals in mothers giving birth in continental France in 2011. For each biomarker, the geometric mean, median, 75th and 95th percentiles of the biomarkers levels distribution were estimated, taking into account the sampling design and adjusting via calibration, in order to obtain estimates representative of this population. Studied biomarkers were lead (measured in cord blood for approx. 1,900 births), phthalates (measured in urine for approx. 990 mothers), BPA (measured in urine for 1,760 mothers), pyrethroids metabolites (measured in urine for 1,080 mothers) and other pesticides or their metabolites (dialkylphosphates, chlorophenols, glyphosate and propoxur, measured in urine for 1,030 mothers), metals (measured in urine for 990 mothers), and mercury (measured in hair for 1,900 mothers). Taking into account available data on levels of impregnation in the French population, expected precisions of geometric means estimates range from 3.4% (for lead) to approx. 14% (for free BPA and some phthalates). Results will be available from July 2014. These first results on impregnation by various chemicals in a representative sample of French mothers will provide public health relevant information about prenatal exposures that could later impair child health. Comparisons of these results with the ones previously obtained in France will provide useful insights on the effects of regulations taken to limit exposures to some chemicals. This could be particularly relevant for some pesticides, since previous studies showed that the French population displayed some peculiarities when compared to other countries.

Keywords: A-biomonitoring, D-prenatal, B-phthalates, B-pesticides, B-metals

We-P-04

Indoor-outdoor Relationships and Source Apportionment of Fine Particulate Matter (PM2.5) in Retirement Communities of the Los Angeles Basin

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Abstract: Concurrent indoor and outdoor measurements of PM2.5 were conducted at three retirement homes in the Los Angeles Basin during two separate seasons between 2005 and 2006. Indoor-to-outdoor (I/O) mass ratios and correlation coefficients of PM2.5 chemical constituents were calculated to determine the influence of outdoor and indoor sources on PM2.5 levels inside the retirement homes. Elemental carbon (EC), a tracer of diesel emissions, displayed very high I/O ratios accompanied by strong I/O correlations, indicating the significant impact of outdoor sources on indoor levels of EC. Likewise, indoor concentrations of metals and trace elements were found to be significantly affected by outdoor sources. Indoor levels of PAHs, hopanes and steranes were generally strongly correlated with their outdoor components and displayed I/O ratios close to unity. On the other hand, concentrations of n-alkanes and organic acids inside the retirement communities were dominated by indoor sources, as indicated by their I/O ratios, which exceeded unity. Source apportionment analysis, which was conducted by means of a molecular-marker chemical mass balance model, revealed that vehicular sources were the major contributor to both indoor and outdoor PM2.5, respectively accounting for 39 and 46% of total mass. Moreover, the contribution of vehicular sources to indoor levels was generally comparable to their corresponding outdoor estimates, illustrating the strong influence of these sources on indoor PM2.5. "Other water-insoluble organic matter", which accounts for the emissions from uncharacterized primary biogenic sources, displayed a wide range of contribution from 2 to 73% of PM2.5, across all sites. Lastly, higher indoor than outdoor contribution of "other water-soluble organic matter" was evident at some of the sites, suggesting the production of secondary aerosols as well as emissions from primary sources, including cleaning or other consumer products, at indoor environments.

Keywords: A-indoor environment, B-metals, B-particulate matter, Source apportionment

We-P-05

Characterization of Short Time Duration, High Concentration Plume Events in Near-Source Microenvironments Using a Mobile Sampling Platform

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Abstract: In some urban microenvironments dominated by traffic or point source emissions, short time duration plume events spanning intervals ranging from seconds to tens of minutes can result in elevated air pollutant concentrations and thus, disproportionately impact exposures for nearby populations. Central monitoring networks, generally designed to obtain hourly and daily average pollutant concentrations representative of a regulatory airshed, may not be well suited to assess these short term, localized events. To explore the importance of source plume events, we conducted over 200 hours of sampling at 36 sites in Allegheny County, Pennsylvania in summer 2013 and winter 2013-2014 using a mobile measurement platform. Site selection was stratified according to three control variables: elevation, proximity to traffic, and proximity to point sources, allowing for investigation of a broad range of source influences. In-situ measurements of gas and particle phase air pollutants were conducted using continuous or semi-continuous instrumentation. Species considered include black carbon (BC), particle-bound polycyclic aromatic hydrocarbons (PAH), nitrogen oxides, sulfur dioxide, ozone, carbon dioxide (CO_2), and volatile organic compounds. Most instruments were operated with a time resolution of less than 10 seconds, allowing for the characterization of source related plume events. Data will be analyzed to determine the contribution of these intermittent events to hourly average pollutant concentrations measured at each site. Additionally, pollutant ratios (e.g. PAH/BC) and ratios of pollutants to CO_2 for individual plume events will be used to better characterize emission profiles for the various source types encountered.

Keywords: A-sampling methods, C-air, B-particulate matter, A-exposure factors

We-P-06

Arterial Hypertension Precursors for Underground Mining Workers

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Abstract: Background/Aims: Explore relationship between arterial hypertension precursors and underground mining working conditions. Methods: Study group: 139 male underground mining workers exposed to noise (83-94 dBA), sylvinite dust (57-61.5 mg/m3). Control group - 53 male surface workers unexposed to sylvinite dust; noise level no more than 73 dBA. Groups were comparable in age, length of employment, smoking status length and percentage of smokers. Noise levels were measured by noise level and vibration meter, dust levels were detected using gravimetric method. Smoking status was assessed according to questionnaire survey results. As arterial hypertension precursors we used IMT, endothelial dysfunction, blood homocysteine level, lipid composition characteristics. Laboratory tests were performed using biochemical analyzer «Konelab 20»; ultrasound examinations - with «Toshiba VIAMO»; IMT estimation - according to standard methodology; endothelium vasculomotor function - according to update technique Celermajer D.S. (1992); statistical data procession - with SPSS 16.0, Stata/SE 12.1 for Windows. Results: Statistically significant relationship between the Atherogenic Index increase and working conditions for study group was determined (OR=4.36, CI=2.18-8.69). Blood homocysteine level was significantly higher in study group in comparison with controls (P<0.05). We revealed increase of endothelial reaction decrease rate from 5 years employment period, for 10 years employment period this parameter is 0.62% per year (normal value for men in absence of risk factors - under 0.2% per year). Dynamic increase of IMT growth from 5 years employment period (P<0.05) to 0.016 mm per year (normal growth value - 0.0124-0.0138 mm per year) was detected. Conclusion: Arterial hypertension precursors for underground mining workers are increase of endothelial reaction decrease rate and IMT growth, increase of the Atherogenic Index and blood homocysteine level.

Keywords: D-occupational, A-epidemiology, A-exposure factors, Arterial hypertension

We-P-07

Probabilistic Assessment of Cutaneous Exposure to Baby Wipes in French Children Between 0 and 3 Years Old

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Abstract: Wipes are leave-on cosmetics used for cleaning baby. Baby wipes are composed of up to 90 % water. Wipes may also contain preservatives such as parabens or phenoxyethanol. Actually, few data are available concerning consumption of baby wipes. Consequently, exposure assessment can't be performed and the safety of children can't be guaranteed. The aim of this study was to assess the cutaneous exposure to wipes in children aged 0-3 years. A national questionnaire survey realized on 395 babies enabled to collect information on usage patterns of baby wipes by body parts including the percentage of users, the frequency of use and the number of wipes per application. Experiences were performed in order to define the amount of product per wipe; and after use by an adult, the fraction which could be applied on child. Each parameter was then described by a distribution. Probabilistic exposure assessment was performed using Monte Carlo random simulations with @Risk 6 software. 77 % of parent use wipes for cleaning their baby. Among users, 84 %, 54 %, 33 % and 29 % respectively use wipes for bottom, face, hand and body. The median frequency of use was respectively equal to 4 day-1, 1 day-1, 1 day-1 and 1 day-1 for bottom, face, hand and body; and the number of wipes per application was respectively equal to 2, 2, 1 and 3. Amount of cosmetic product per wipe was equal to 2.9 g (P50) and 4.3 g (P95). After use of wipe, 18 % (P50) and 25 % (P95) of product could be applied on children. Baby cutaneous exposure to wipes was equal to 341 mg/kg bw/day (P50) and 1635 mg/kg bw/day (P95). Baby cutaneous exposure to preservatives was respectively equal to 3.6 mg/kg bw/day (P50) and 17 mg/kg bw/day (P95).

Keywords: C-personal care products, D-children, exposure assessment

We-P-08

How to Assess the Dermal Systemic Exposure to Compounds Present in a Cosmetic Product? Methodology

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Abstract: The European Regulation (EC) No 1223/2009 states that cosmetic products found on the European market have to be safe for consumer health. In order to perform a safety evaluation, it is crucial to possess accurate exposure data. Actually few informations are available concerning the concentration of ingredients contained in a finished product and their respective cutaneous absorption parameter: exposure to ingredients is calculated from finished product data by considering 100 % of absorption. The aim was to develop methods to assess the dermal systemic exposure to compounds found in a cosmetic product. Nail polish was used for example. Exposure was assessed with the Monte Carlo probabilistic method. Frequency and quantity data were respectively obtained by a web national enquiry (n=1512) and by laboratory tests with volunteers (n = 97) in order to assess external dermal exposure to finished product; A method was developed for estimating the percentage of ingredients commonly found in polish, in order to assess external exposure per ingredient. This method involved three major steps: (i) elaboration of the list of ingredients commonly present in the cosmetic of interest; (ii) determination of concentrations by weight of ingredients in the final product (using 34 patents and publications) and (iii) concentration adjustments of ingredient concentrations under distribution form. An algebraic model to calculate systemic dermal exposure per ingredient in finite dose conditions was developed. This model was based on the use of substance permeability coefficient (Kp) with respect to the diffusion resistance induced by membrane thickness according to time. External exposure by nail and skin routes was evaluated for polish and for 23 compounds commonly found in it. Systemic exposure was assessed for 6 ingredients. Developed methods could be applied in exposure assessment and could allow a better safety assessment in case of cosmetic products.

Keywords: A-exposure models, C-personal care products, C-consumer products

We-P-09

Combined Exposure Science and Occupational Medicine Approach to Developing Effective Workplace Health and Safety Training

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Abstract: INTRODUCTION Despite significant improvements in workplace safety in recent decades, hazards with potential serious health consequences still exist in some industries. Effective worker health and safety training is needed. METHODS Through a Susan Harwood Training Grant, we developed, delivered, and validated comprehensive training programs for the beryllium-using and flavor production industries. We are completing training for cosmetology workers and initiating the same for the automotive industry. Results from our work with beryllium-using and flavor production industry partners are presented. Training topics included workers' rights under OSHA, health effects, and exposure recognition and control. We used an iterative 5-pronged approach: 1) needs assessment, 2) training material development, 3) pilot testing, evaluation, and training material revision, 4) worker training, 5) program evaluation (using knowledge assessment and reaction surveys) and validation (using impact survey). RESULTS We trained 440 workers at five beryllium-using companies and 553 workers at ten flavor production companies. The mean test score in the beryllium workers increased 14% to 96% post-test (p<0.005) and essentially unchanged at 90-day follow-up (94%, p=0.744). The reaction assessment revealed workers found the training helpful (96%) and learned something useful (95%). In the impact survey, 49% reported work practices changed to reduce beryllium exposure. In the flavor workers, the mean test score increased from 78% to 89% (p<0.001). The 90-day follow-up at one partner was essentially unchanged from the post-test (86% vs. 87%, respectively). In the impact survey, 35% reported using a respirator more often; 50% reported using local exhaust ventilation more often. CONCLUSION Systematically-developed worker health and safety training was effective, well-received, and resulted in improved workplace practices. The training materials are available from the OSHA website under public domain.

Keywords: D-occupational, A-workplace, worker training

We-P-10

Characterization of Personal Exposure to PM2.5, Ultrafine Particles with Indoor and Outdoor Measurements in Fresno California

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Abstract: Air pollution in Fresno California has been an important issue for decades. Personal exposure to multiple air pollutants in Fresno was characterized by field sampling study that measured air pollutants along with individual time-location data for proximity to traffic emission. During 2012-2013, PM2.5, ultrafine particles, ozone, and black carbon concentrations were measured using the real-time monitors and gravimetric monitors. Sampling locations were ambient and indoor on campus of California State University Fresno, and residences, and in-vehicle during commute. During the 3-week intensive measurements period in January and February of 2013, indoor, outdoor, and personal air were measured in comparison with ambient monitoring site on Campus. PM2.5 concentrations were measured using Dust Trak DRX 8533 and 8534. 24-hour PM2.5 mass concentrations were collected in indoor, outdoor, and personal air. Using CPC 3007, personal exposures to ultrafine particles were measured. The time-location data was mapped using GPS loggers. PM2.5 was dominantly higher in outdoor air compared to personal or indoor air during most of time. Exceptions were short peak time exposures that a person may encounter any type of combustion sources in confined indoors. Ultrafine particle concentrations were influenced by close proximity to combustion sources, such as gas stove, electric stove, boiling, grilling, hot water use, lit candles, and existence of smoker whether the cigarette light is on or not. Roadway traffic conditions and fleets traveling in front of the sampling vehicle influenced in-vehicle air quality immediately. Indoor ozone concentration measurements indicated that major contribution of ambient air to indoor air of University buildings those were built in 1950s. Time-location data recorded subject's location information accurately most of the time during sampling periods. The air pollution levels by location and time are being analyzed and will be compared with previous studies.

Keywords: A-activity patterns, B-particulate matter, A-indoor environment, C-air

We-P-11

The Influence of Temperature, Ventilation and Humidity on the Fate and Transport of Indoor Phthalates: A Case Study

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Abstract: INTRODUCTION: Indoor environments contain a wide range of products that can emit a variety of pollutants. Among these chemicals, phthalate esters are particularly important, because they are used extensively as additives in consumer products and are associated with serious health concerns. As semi-volatile organic compounds (SVOCs), they partition strongly to all interior surfaces, including airborne particles, dust, and skin. The objectives of this field study are to: 1) examine equilibrium partitioning of phthalates (benzyl butyl phthalate [BBzP] and di-2-ethylhexyl phthalate [DEHP]) among indoor compartments, including air, dust, and various interior surfaces; 2) evaluate kinetic constraints on the sorptive partitioning; and 3) determine the influence of temperature and ventilation on emission, partition, and sorption kinetics of BBzP and DEHP. Field measurements were conducted in a residential test house (UTestHouse) located at Austin, Texas. This study suggests that temperature and ventilation have important influence on the concentrations of phthalates in indoor environments. The results enable environmental intervention designs to reduce indoor exposures by developing a clear understanding of the factors that govern emissions and sorption of phthalates and their indoor fate and transport.

Keywords: Emission, Adsorption kinetics, Temperature, Ventilation, Phthalates, Field measurements

We-P-12

Ex Priori: Exposure-based Prioritization across Chemical Space

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Abstract: EPA's Exposure Prioritization (Ex Priori) is a simplified, quantitative visual dashboard that makes use of data from various inputs to provide rank-ordered internalized dose metric. This complements other high throughput screening by viewing exposures within all chemical space simultaneously (not chemical by chemical). Within modern society, exposure to a wide range of chemicals through our daily habits and routines is ubiquitous and largely unavoidable. The initial focus to estimate exposure to chemicals in products used in microenvironments (uE) necessitates a "systems" model to delineate data needs arising from numerous knowledge bases to integrate product formulations, purchasing and use activities, and human activities. This will indicate products likely to be in the uE and how people come into contact with chemicals in these products. Ex Priori quantitatively extrapolates single-point estimates of both exposure and internal dose for multiple exposure scenarios, factors, products, and pathways in rank order by biological dose. To rank-order internalized dose from everyday consumer product exposures for a given individual profile, the approach uses multiple integrated data streams including (a) everyday product ingredient data; (b) pharmacokinetic factors, (c) consumer product category-specific "exposure factor surrogates" and (d) time/activity estimates (human factors). These different data streams are integrated within an interface such that different exposure scenarios for "individual," "population," or "occupational" time-use profiles can be interchanged and quantitatively explored to prioritize tailored chemical exposure and, ultimately, dose. This allows estimates of multi-chemical signatures of exposure, internalized dose (uptake), remaining dose or body burden and elimination. This overview shares lessons learned that translate into how the future of data-driven informatics-based approaches in support of chemical risk assessment can evolve.

Keywords: A-chemical prioritization, A-exposure factors, A-exposure models, A-activity patterns, A-aggregate exposure

We-P-13

Disaster Preparedness and Response: Applied Exposure Science

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Abstract: In 2007, the ISEA, predecessor to ISES, held a special roundtable to discuss lessons learned for exposure science during and following environmental disasters, especially the 9/11 attacks and Hurricane Katrina. Since then, environmental agencies have been involved in responses to the Deepwater Horizon oil spill, Fukushima tsunami and nuclear plant failures, Hurricane Sandy, as well as regional disasters, such as ash pile

leaks near coal-fired power plants. This discussion will compare actual exposure science application experiences to the recommendations from the 2007 discussion and subsequent literature. The discussion will include an assessment of potential decision support tools can be used in such a comparison, e.g. multi-criteria decision analysis, life cycle analysis, Bayesian belief networks and root cause failure analysis. It will also propose a taxonomy system for disasters based on a scale between exclusively human exposure potential to exclusively ecological exposure potential. The comparison will focus on the differences in exposure assessment needs during response, recovery, reentry, reconstruction and re-habitation.

Keywords: A-emergency response, A-life cycle analysis, A-risk assessment, A-ecological exposure, C-multimedia

We-P-14
Monitoring Air Pollutant Exposure on Public Transportation Systems with Direct Reading Instruments
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Abstract: Public transportation, such as buses, shuttles, and trains, is not only a traffic management alternative to solve the congestion problems commonly found in urban areas. The associated benefits also include cost savings, less GHG emissions and less pollutant emissions. Meanwhile, it is essential to understand pollutant exposure levels in these facilities, to better serve and protect the public. With this in mind, air pollutant emissions, such as CO (carbon monoxide) and black carbon were measured on the trains (high-speed and regular), buses, and shuttles in Cincinnati OH, Singapore and China with direct reading instruments. Traffic parameters were recorded by a GPS. Data analysis will be performed to evaluate pollutant levels in these public transportation systems, the impacts of operation (such as open/close window, air conditioning, etc.), transportation impacts, such as speed, on air pollutants levels inside these facilities. The results are also compared with other publications and similar studies.

Keywords: C-air, B-particulate matter, carbon monoxide (CO), black carbon (BC), public transportation, exposure

We-P-15
Comparing Approaches for Summarizing Exposure to Multiple, Correlated Pollutants and Resulting Risk Estimates
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Abstract: In air pollution epidemiology, researchers often encounter the issue of having to analyze the effect of multiple correlated co-exposures. Approaches regularly seen in the literature include adding co-exposures to the model with main exposure of interest, treating them as simple confounders; using dimension reduction methods, such as Principal Component Analysis, whose weight vectors can lack interpretability; and exploiting the correlation structure among the pollutants to aggregate them into clusters. In addition to the above approaches, we explored an alternative machine-learning method, supervised clustering, which incorporates outcome information directly into the dimension reduction process. Supervised clustering is a machine-learning method that analyzes the data to produce small, potentially overlapping clusters that best predict risk. We applied this approach to a breast cancer risk analysis of 112,379 female teachers in California exposed to a set of 24 mammary gland carcinogens. There were 5,361 cases of invasive breast cancer diagnosed in the study population between 1996 and 2010. The Spearman correlation coefficient among these 24 compounds ranged between 0.96 and -0.86. Supervised clustering identified four sets of clusters composed of six overlapping compounds. These clusters were then used in the risk analysis of breast cancer. The resulting risk estimates were different from, but complementary to, the estimates provided by traditional methods. This exercise demonstrates that supervised clustering can be a useful tool in air pollution studies examining the effects of multiple, correlated pollutant exposures.

Keywords: A-analytical methods, A-epidemiology, C-air, A-aggregate exposure

We-P-16

Assessment of ambient air formaldehyde impact on the respiratory system

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Abstract: Background/Aims: To derive the dependency between respiratory diseases morbidity increase among children aged 4-7 years and chronic inhalation exposure of ambient air formaldehyde. Methods: We examined 92 children aged 4-7 years who were chronically exposed to environmental air formaldehyde. The Monitoring Group - 94 children aged 4-7 years with environmental air formaldehyde chronic inhalation level less than 0.003 mg/m3. For exposure assessment the results of instrumental and calculating ambient air quality data conjugation were used. Incidence estimation was carried out by using children medical aid appealability and primary medical records. Diseases of the respiratory system (Chapter X of ICD-10) were chosen as a response to formaldehyde exposure in accordance with the health risk assessment methodology. Results: A significant cause-effect relation between ambient air formaldehyde inhalation exposure and respiratory diseases (OR=1.14; 95%CI 1.02-1.27), including tonsillar hypertrophy (OR = 15.76; 95%CI 8.2-27.2), acute laryngitis and tracheitis (OR = 14.99; 95%CI 7.8-25.9), acute nasopharyngitis (OR = 1.20; 95%CI 1.03-1.27) were determined. Conclusion: Chronic ambient air formaldehyde exposure exceeding the concentration of 0.003 mg/m3 causes significant increase of respiratory diseases proved by critical organs and systems.

Keywords: A-ecological exposure, C-air, D-children

We-P-17 - Withdrawn

We-P-18

Sensitivity of Regulatory Ozone Risk Assessment to Improved Exposure and Response Models

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Abstract: We evaluate the sensitivity of EPA's current ozone exposure model (APEX) to (1) alternative pulmonary function response models, (2) attainment air quality (AQ) rollback approaches, (3) altitude effects, and (4) newly measured ozone penetration/deposition rates and microenvironmental (ME) factors, corrected for ozone measurement error. Results are provided for Denver AQ scenarios representing 2006 "as is" conditions and the attainment of the current ozone NAAQS. We test recently published pulmonary function models that incorporate realistic ozone response thresholds and subject response variability proportional to the level of response. A CAMx model is used to adjust 2006 Denver AQ to simulate NAAQS attainment conditions. The modeled rollback projections account for NOx control-related increases in urban and background ozone levels from reduced NO-ozone titration that are not addressed by EPA's quadratic rollback approach. Inhaled ozone mass is adjusted to account for altitude acclimation among Denver residents. Impacts of newly measured indoor ozone penetration-deposition rates on estimated responses are compared to projections using current APEX indoor mass-balance model assumptions. APEX ME factors are also adjusted according to field measurements made during 2012 and 2013 in Durham NC using new interference-free ozone photometers. Cumulative impacts of these updated components in the APEX exposure analysis are tabulated and compared to those of the current APEX model.

Keywords: A-exposure factors, A-exposure models, microenvironment, ozone, A-sampling methods, microenvironment, ozone

We-P-19

Factors Predicting Concentrations of Urinary VOC Metabolites among Pregnant Women in the National Children's Study

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Abstract: Volatile organic compounds (VOCs) have numerous sources, e.g., tobacco smoke, gasoline, paints, and scented products. We modeled the relationship between urinary VOC metabolite concentrations and sources of VOC exposure in 488 third trimester pregnant women enrolled in the National Children's Study

Vanguard Study from 2009-2010. VOC source information included observations of scented products in the home, and questions about use of air fresheners, aerosols, paint or varnish, organic solvents, and smoking exposure. The Division of Laboratory Sciences at CDC simultaneously quantified 28 urinary VOC metabolites using a reversed-phase ultra-high performance liquid chromatography (UPLC) coupled with electrospray ionization tandem mass spectrometry (ESI/MSMS). These are metabolites of acrolein, acrylamide, acrylonitrile, benzene, 1-bromopropane, 1,3-butadiene, carbon-disulfide, crotonaldehyde, cyanide, N,N-dimethylformamide, ethylbenzene, ethylene oxide, propylene oxide, styrene, tetrachloroethylene, toluene, trichloroethylene, vinyl chloride, and xylene. We used complete models which included all previously described VOC sources as possible predictors of VOC metabolite concentration. Smoking exposure predicted (p<0.01) all VOC metabolites which are biomarkers of tobacco constituents except: PMA and MU (both benzene metabolites), TTCA (a carbon disulfide metabolite), PGA (an ethylbenzene and styrene metabolite), and BMA (a toluene metabolite). Paint use was associated with increased concentration of the xylene metabolites 2-MHA and 3-MHA+4-MHA, and concentrations of the toluene metabolite BMA were lower in rural locations than in urban locations. Observed scented products, use of aerosols, and air fresheners were not predictive of any VOC metabolite. These models suggest smoking exposure, paint use, and rural/ urban location affect VOC exposure; suggesting the NCS Main Study Protocols include similar biospecimens and information about sources of exposure to VOCs.

Keywords: B-VOCs, D-prenatal, A-biomarkers, A-behavior, A-epidemiology

We-P-20
Exposure Assessment of Organophosphates for Pesticide-spraying Workers in Crop Farm
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Abstract: The aim of this study is to determine the exposure levels of pesticide-praying workers. Forty workers participated. Seven organophosphates, including methamidophos, dimethoate, diazinon, chlorpyrifos, parathion, ethion, and EPN were monitored. The highest detection rate and dermal exposure dose were chlorpyrifos and the second was methamidophos. The highest ADDRE occurred from chlorpyrifos exposure, which was 9.19 µg/kg/day and it's ADDDE was 78.15 µg/kg/day. The cumulative dose equivalent to chlorpyrifos estimated from urinary metabolite concentrations was 163.54 µg/kg/day for the pre-shift samples and was 193.78 µg/kg/day for post-shift one. Health risk assessment from the internal dose indicates that over 90% of workers exceeded the BMD10/100 of chlorpyrifos. The health risk assessment by MOS calculation present no acute exposure risk but chronic exposure risk needs to be concerned. The highest risk resulted from the exposure of chlorpyrifos and followed by methamidophos.

Keywords: A-biomonitoring, A-workplace, A-analytical methods, A-risk assessment

We-P-21
Residential Tap Water Sampling for Water Contaminants to Determine True Exposure in Human
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Abstract: Traditionally, epidemiologist and toxicologist rely on the indirect methods of exposure assessment (environmental monitoring, modeling, questionnaire etc.) to determine chronic health risk in humans via drinking water consumption. These methods are limited in scope because of inherent temporal-spatial variability, mixture interactions, and characteristics of water distribution networks. In the absence of good exposure assessment, many toxicological and epidemiological studies remain inconclusive about the toxicity of environmental chemicals. Hence, a precise exposure measurement is needed to determine environmentally realistic concentrations of chemicals in a population and the associated health risks. Precise exposure assessment can be achieved by sampling tap water from residential sites. This method accounts for variability in the exposure assessment and is believed to be the most accurate measure of human exposure via drinking water. Therefore, we have proposed a sampling program to measure pesticides and other urban contaminants in Indianapolis Community Water System (IndyCWS). The seven residential sites are identified to capture the large part of IndyCWS. The samples will be collected weekly, biweekly, and monthly basis during the April-June period. The samples will be analyzed in a certified laboratory using EPA recommended methods. The data from this study will be used to determine temporal-spatial variability of measured chemicals, compare with the exposure levels reported by public agencies, evaluate cumulative exposure of mixtures, and develop association with health outcomes. Currently, this work is in-progress and the results from the study will be discussed in the meeting.

We-P-22 - Withdrawn

We-P-23
Innovation in Exposure Science - New Tools and Approaches from the Superfund Research Program
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Abstract: Accurate measurements of exposure are central to determining the risk of hazardous substances, whether for public health, occupational settings or ecological systems. National Institute of Environmental Health Sciences (NIEHS) has set a priority to transform exposure science and advance combined exposure research. In support of this goal, the NIEHS Superfund Research Program (SRP) invests in development of fast, accurate, robust, and advanced technologies that allow for portable real-time, on-site characterization, monitoring, and assessment of contaminant concentration and/or toxicity. Exposure assessment method advancements maximize collection efficiency, such as increasing the number of analytes measured while minimizing laboratory and participant burden; as well as new tracer methods to identify and track the actual adsorption/uptake of contaminants to the target systems. In looking forward, the SRP is well-positioned to address integration of environmental data within a contextual framework of how contaminants affect populations (human, occupational or wildlife). Some of the emerging exposure science issues being addressed by the program include: tools for rapid assessment of bioavailable fractions of hazardous substances in the environment; development of cost-effective, real-time, and validated methods to detect vapor intrusion; development of innovative detection technologies for combined exposures; and approaches to characterize the exposome, which describes the totality of human exposures in an integrated temporal, spatial, and biological framework. In addition, SRP initiatives in emerging exposure pathways will be introduced such as recent concern for risks from inhalation of PCBs in leaky light fixtures in schools; exposure risks from urban gardening; occupational exposures of emerging concern; and identifying the health effects associated with the exposure to hazardous substances found as part of e-waste and other reclamation activities.

We-P-24
PFOA Concentration in Serum Collected from Ohio River Valley Community Members, 1991-2008
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Abstract: Background: Certain perfluoroalkyl compounds (PFCs) are bioaccumulative; health effects are not well understood, but may include impaired liver function, cholesterol metabolism, pubertal development and cancer. PFCs were detected in Ohio River water samples in 2009. An industrial plant in Parkersburg, WV discharged PFCs into the Ohio River beginning in 1980 and other sources for the chemical may exist in the Ohio River Valley. We previously reported that communities downstream of the Parkersburg plant and a cohort of girls in Greater Cincinnati, OH have serum concentrations of perfluorooctanoate (PFOA) higher than US general population background. Methods: We measured PFC concentrations in 517 archived serum samples collected from 1990-2008 from 210 members of an established cohort, and collected detailed residential history and beverage consumption information from them. Some members of this cohort, living in towns along the Ohio River during the 1990s and 2000s, may have been exposed to PFCs from drinking water sourced from the Ohio River and the Ohio River aquifer. Results: Over the period of follow-up, members of the cohort had mixed sources of drinking water. The highest median PFOA concentrations were of samples obtained in 1992 and 1996 (16.6 ng/ml) and from those ever-living in Kenton and Campbell Counties, KY (19.6 ng/ml, N=89) ranging from 25.9 in 1991-3 to 15.7 in 2000-8, and Boone County KY, (14.2 ng/ml). Lowest median concentrations were from those ever-living in suburban areas west of Cincinnati (6.8 ng/ml). Ongoing statistical analyses are relating PFOA serum concentrations to person-years of drinking water from each source, water consumption, and stratified by use of granular activated carbon water treatment. Conclusion: The findings of this project will better characterize the extent of PFOA exposure through drinking water to the Ohio River Valley population. Funding: EPA-RD-83478801, P30-ES006096, T32-ES10957

We-P-25

Exposure Biomarker Communication to Study Participants

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Abstract: Background: Measurement of environmental biomarkers in biomedia is increasingly used as a method of exposure characterization in human population studies. Reporting the results of individual biomarker measures back to study participants has been controversial, including questions of ethics and whether the study participants would want to receive and would understand the results. Methods: Recently we mailed individual measurements of two serum biomarkers, perfluorooctanoate (PFOA) and perfluorooctane sulfonate (PFOS) to participants in three exposure studies of persons living in the Ohio River Valley, of whom 60 were parents of children who had been sampled. Reporting forms used in the three studies were somewhat different. With the report, we included a survey designed to ascertain the opinions of the study participants about the information they received. Results: Approximately 48% (267/557) returned the survey, and 97% reported that they were pleased that we had sent them the report. Most (89%) responded that the results were easy to read and the enclosed fact sheet was helpful in answering questions (93%). Regarding the amount of information, most felt that we provided the "right amount" (78%) but some "too much" (7%) and some "not enough" (15%). The majority (61%) were surprised at their serum concentrations. Surprisingly, many talked to no one about their levels; those who did were most likely to discuss the report with family members. Conclusions: Reporting back individual environmental biomarker results is generally well received by study participants. Funding: EPA RD-83478801; NIH R21-ES017176, U01-ES12771, P30-ES006096, T32-ES10957

We-P-26

Uranium Exposure to a Community Population: Biomarkers of Uranium Exposure and Renal Proximal Tubule Damage

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Abstract: Background: We evaluated uranium exposure estimates, urine uranium and biomarkers of renal function in the Fernald Community Cohort (FCC), a volunteer population who lived within 5 miles of a uranium ore processing plant in Fernald, OH, USA and followed 1990-2008 in a medical monitoring program which included clinical laboratory measurements of biomarkers of renal function. Uranium plant workers were excluded. Materials and Methods: Releases of soluble and insoluble uranium (U) particulates during plant operation from 1952-1989 were used by the US Centers for Disease Control and Prevention to develop dose estimation models. We used this algorithm to estimate U exposure for 8770 persons in the FCC. Urine U biomarkers were used to conduct two validation studies of 189 and 144 members of the cohort, selected on exposure criteria (highest exposure scores, with and without a well or cistern as a drinking water source). Urine samples, collected in the early 1990's, were analyzed by the Armed Forces Institute of Pathology and the Centers for Disease Control and Prevention. Results: Urine U concentrations for 93.1% of this study sample were below 1999-2000 NHANES population 95% percentile (0.03 μg/gr Cr). Geometric mean concentrations were highest for those using a well (0.010 ug/gCr) or cistern (0.009 ug/gCr) as a drinking water source compared to those living far from the plant (0.007 ug/gCr). A strong correlation existed between urine U and urine β -2-microglobulin (β2M) in sub-groups of those with high β2M (R=0.664), and a mild correlation among those using a well (R=0.238) or cistern (R=0.218) as drinking water source. Serum creatinine, blood urea nitrogen and urinary microglobulin also were associated with urine U. Conclusions: Chronic, low dose uranium exposure including soluble uranium particulates is reflected by urine U concentration and is associated with renal health effects. Funding: EPA-RD-83478801, P30-ES006096, T32-ES10957

We-P-27

Using Chemical Characteristics to Explain Agricultural Pesticide Transport Pathways from the Field into Homes

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Abstract: In agricultural communities where many pesticides are applied, it is difficult to assess which types of pesticides pose the greatest hazard and the main pathway of pesticide transport from the field into the home. The chemical characteristics of pesticides may be useful to explain the detected pesticides in the community and shed light on the transport pathway(s) of pesticides. We collected soil, outdoor air, and house dust samples from 21 homes in Yuma County, Arizona, an agricultural community located along the US-Mexico border. Samples were analyzed for multiple pesticides with a wide-range of chemical characteristics. Spearman's rank correlations were used to determine whether there was a relationship between measured detection frequency of each pesticide in outdoor air, soil, and house dust with the various chemical characteristics of each pesticide. Vapor pressure, aqueous solubility, octanol-water coefficient, soil half-life, and Henry's Law Constant were considered for this analysis. The chemical characteristics most strongly correlated with air detection frequency were logKow ($\rho=0.72$) and aqueous solubility ($\rho=-0.73$), suggesting that pesticides detected in air may be mainly adhered to soil particles, rather than in the vapor phase. Similar correlations exist between house dust detection frequency and logKow ($\rho=0.73$) and water solubility ($\rho=-0.73$). Yet, these relationships are not present for soil detection frequency. This suggests that a major pathway of pesticides into the house dust may be through air infiltration of pesticides adhered to soil particles in the air. This idea is further supported by the strong negative correlations between vapor pressure and soil detection frequency ($\rho=-0.84$) and house dust detection frequency ($\rho=-0.73$). Therefore, less volatile pesticides may pose a notable hazard in agricultural communities because they are likely to remain in the soil and be transported into the home adhered to soil particles and persist as house dust.

Keywords: B-pesticides, A-chemical prioritization, D-community

We-P-28

Exploring the Influence of Household and Housing Characteristics on Transport of Agricultural Pesticides into Farmworkers' Homes

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Abstract: Agricultural pesticides can enter farmworkers' homes via track-in on shoes, clothes, and skin, along with air-infiltration from pesticide spray drift and wind-resuspension of contaminated soil particles from nearby fields. Using predictive analysis techniques, we explored which household and housing characteristics were most strongly associated with agricultural pesticide levels in farmworkers' homes and whether they are more indicative of the track-in or air-infiltration pathway of pesticides into the home. Surveys that included household and housing characteristics questions were administered to 21 farmworker families in Yuma County, Arizona, an agricultural community along the U.S.-Mexico border, and soil, outdoor air, and household dust were collected from each home. Samples were analyzed for the following pesticides: bifenthrin, endosulfan, permethrin, pronamide, trifluralin, carbaryl, and DDT. Spearman's rank correlations and classification and regression tree (CART) analyses were performed for characteristics that could potentially influence the soil-track in pathway, the air-infiltration pathway, as well as both pathways combined. The number of window panes, increased cooling of the home, and distance to the nearest field were found to most highly influence pesticide detection in house dust. In addition, distance to the nearest field was most influential on pesticide detection in air, while total pounds of pesticides applied in Yuma the month prior to sampling was most influential on pesticide detection in soil. These results suggest that pesticides may be largely entering farmworkers' homes via air infiltration through windows and ventilation systems. Future interventions should focus on the air-infiltration pathway to effectively decrease pesticide levels in farmworkers' homes.

Keywords: B-pesticides, D-community, A-built environment, A-indoor environment

We-P-29

A Review of Risk Assessment Selection and Prioritization Schemes Across the Globe

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Abstract: Regulatory authorities across the globe and industry recognize that understanding the risk from the manufacture and use of chemicals is essential for protection of public health. However, conducting risk assessment for the tens of thousands of chemicals in commerce is resource and time-intensive. To focus risk assessment efforts, many regulatory authorities have implemented various selection or prioritization schemes within their chemical management frameworks. Some industrial groups, to include the American Chemistry Council (ACC) and the International Council of Chemical Associations (ICCA) have also proposed risk assessment prioritization ranking systems. A review of these myriad procedures was completed for the regulatory authorities in Australia, Canada, China, the European Union, Japan, Korea, and the United States and for the ACC and ICCA. The main objectives were to summarize for each entity under what conditions a risk assessment would be required and at what priority level and to identify the specific information and resource requirements for completion of the risk assessment. Another objective was to conclude what criteria were deemed most essential for the risk assessment screening process.

Keywords: A-risk assessment, A-chemical prioritization, Chemical management, risk assessment screening

We-P-30

Quantification of CVesium-137 Infernal Equivalent Dose in a Cohort of Children from Narodichi, Ukraine Utilizing a Mechanistic Ecological Model

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Abstract: Impoverished children living in Narodichi, Ukraine have been chronically exposed to low-doses of cesium-137 derived from the Chernobyl Nuclear Power Plant accident in 1986. Narodichi's children represent an important cohort for determining the presence or absence of deterministic health effects from chronic internal low-dose beta and gamma radiation. Epidemiological studies have already discovered associations between internal cesium-137 annual dose in children and adverse immunological and pulmonary consequences. However, more adequate dose data, in conjunction with epidemiological and toxicological study, are needed to further determine causality. We conducted a multivariate linear regression of whole body dose estimations (utilizing whole body count (WBC) method) and associated risk factors for the Narodichi cohort. The predictive model identified proximal residential soil activity as the most significant predictor of dose ($t=4.92$, $p<0.001$). Based on this finding and the fact that citizens of Narodichi use residential soil for subsistence agriculture, we utilized a validated agricultural-soil based mechanistic model to further estimate dose for the cohort. The geometric mean whole body dose from the mechanistic model was 0.112 mSv/y, which was significantly lower than the geometric mean dose estimated by the WBC method ($t=-57.57$, $p<0.001$). However, both dose estimation models were significantly correlated ($r=0.416$, $p<0.001$). The mechanistic model does not include the consumption of highly contaminated non-agricultural food products and could explain the significantly lower dose estimates when compared to the WBC method.

Keywords: A-exposure factors, A-epidemiology, A-exposure models, A-global health, A-ecological exposure

We-P-31

Meta-Analysis on Near-Road Air Pollutants Concentrations for Developing Traffic Indicators for Exposure Assessment

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Abstract: Near-road air pollution has been associated with various health risks in human populations living near roadways. To better understand relationship between vehicle emissions and spatial profiles of traffic-related air pollutants we performed a comprehensive and systematic literature survey on publications containing measurement data for air pollutants with distance information from roads. 8169 publications matched to the initial wide-scope keywords search and 3799 publications were retained after excluding publications related to models, health effects, and land use. 1879 publications were collected into an Endnote library after screening

the 3799 publications for containing information on black carbon (BC), carbon monoxide (CO), nitrogen oxides (NO, NO2, or NOx), and particulate matter (PM). Three researchers independently read the abstracts of these 1879 publications to find those containing actual data for the selected air pollutants near major roads with distance profiles. Analyses were performed on concentration data of the selected air pollutants from 65 publications meeting the final criteria. These analyses showed no apparent distance decay relationship for PM but a clear distance-decay for BC. NOx also showed distance gradients which are more obvious than that shown for CO. These initial observations suggest that some near-road air pollutants bear closer relationship with the vehicle emissions than the others. Further analysis of original data obtained from EPA near-road study projects will refine these spatial-distance-decay patterns. Thus it is possible to develop traffic density-defined parameters for serving as surrogate pollution indexes for these air pollutants.

Keywords: Air pollutants, Near-road, Traffic density, Exposure, Meta-analysis

We-P-32
Exposure Biomarkers for Putative Breast Carcinogens

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Abstract: Background Many breast cancer risk factors share characteristics with chemical exposures that have been reported to cause mammary tumors in rodents. For example, pharmaceutical hormones, alcoholic beverages, and tobacco smoke are risk factors for breast cancer, and hormone disruptors, solvents, and PAHs/nitro-PAHs cause mammary gland tumors in rodent studies. Exposure biomarkers for potential human breast carcinogens can facilitate study of breast cancer risk and evaluation of public health initiatives to reduce exposure. Methods We performed structured literature searches for biomonitoring methods and exposure information for 102 rodent mammary carcinogens and summarized analytical methods and exposure sources. To evaluate the relevance of rodent test results to breast cancer, we compared laboratory and epidemiologic findings for agents that have been evaluated in both. Finally, we summarized cohort studies that have information about breast cancer outcomes as well as archived biological samples, in which these exposure methods could potentially be applied. Results We identified methods to measure exposure to 64 of the mammary carcinogens via parent compounds, metabolites, and adducts in human blood and urine. Twenty-three of them are included in CDC's NHANES or planned for inclusion. We grouped many of the chemicals based on common sources of exposure, including gasoline, vehicle exhaust, flame retardants, stain-resistant textiles, paint removers, and drinking water disinfection byproducts. Carcinogenicity in humans and rodents is generally consistent, although fewer agents have been studied in humans. We identified 44 relevant cohort studies with a total of over 3.5 million enrolled women. Conclusions This study provides a road map for breast cancer prevention by identifying high-priority chemicals and evaluating tools to measure exposure. These tools suggest new directions for epidemiology and support exposure surveillance and reduction

Keywords: A-biomarkers, A-biomonitoring, A-sampling methods, A-workplace, A-epidemiology

We-P-33
Modeling Children's Exposure to Manganese in Ambient Air: A Case Study from Marietta, Ohio

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Abstract: Manganese is a documented neurotoxin and exposure to manganese (Mn) in excessive amounts is associated with central nervous system effects. The body of research on children's exposure to manganese demonstrates that exposure is occurring and impacts are detectable. Yet the environmental levels, the duration of exposures and the most crucial pathways of exposure that pose the greatest risk to children are still uncertain. Increasing the understanding of exposure scenarios for children is a critical step in developing strategies to mitigate or eliminate contact with harmful levels of manganese. The Communities Actively Researching Exposure Study (CARES) in Marietta, OH provides an opportunity to gain a greater understanding of the link between concentrations of ambient air Mn and children's exposure. Marietta, Ohio is a potential hotspot for Mn exposure due to the location of a ferromanganese refinery which is the largest US emitter of airborne Mn. The CARES study collected data, biological and environmental samples for a study cohort of 7-9 year old children. The logistics and cost of monitoring for personal ambient Mn exposures was prohibitive. However, modeling exposures may provide a viable alternative. Ambient Mn concentration values were modeled using US EPA's air dispersion model AERMOD for the year 2009 based on emissions from the

ferromanganese refinery. Modeled Mn concentrations were compared to monitored Mn levels obtained from a centrally located stationary air sampler that collected air samples in 48 hour intervals three times per week. The Index of Agreement for modeled versus monitored data was 0.34 (48 hour levels), and 0.78 (monthly levels). Fractional Bias for 48 hour levels was 0.02 and for monthly levels was -0.02. Given the overall agreement of modeled to monitored levels, the use of modeled Mn concentrations as exposure values for study subjects is a viable and cost effective alternative to personal air monitoring.

Keywords: A-exposure models, B-metals, D-children

We-P-34
Comparison of Chemical and Microbial Contaminants in Tap and Bottled Water in a U.S.-Mexico Border Community

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Abstract: Bottled-water use is steadily increasing in the United States because of increased advertising by bottled-water purveyors and fear that municipal tap water might be contaminated. In Nogales, Arizona, some water purveyors have received drinking-water violations, but it is not clear whether local tap and bottled water differ in quality. The purpose of this study was to assess possible significant differences in the quality of municipal tap water and bottled water in Nogales. Water samples were collected from thirty homes and assayed for chemical and microbial contaminants regulated by the U.S. Environmental Protection Agency. Bottled water included small (0.5 L) and large (3.8 L), individually sealed water bottles as well as water purchased in reusable containers from self-service vending machines or from water stores. There were no significant differences in the concentration of chemical contaminants between tap and bottled water. Fecal coliforms were confirmed in 2/30 of tap- and 16/30 of bottled-water samples. Bottled water stored in reusable large containers (n=17) had the highest concentration of fecal coliforms, which were detected in 14 samples. Families who reported cleaning large reusable water containers with soap or hot water had significantly lower fecal coliforms (p=0.003) in their drinking water than those who rinsed with only water. Water samples collected directly from stores and sealed bottles contained no detectable coliforms, with the exception of one sample collected directly from a vending machine. Results suggest that secondary contamination in the home might contribute to higher levels of coliforms in water stored in reusable containers. These results are from grab samples and additional samples would be needed to understand fluctuations over time. Interventions can be implemented to educate families on keeping reusable water containers clean and on the quality of local tap water.

Keywords: D-community, A-environmental regulation, C-water, B-microbial agents, A-sampling methods

We-P-35
Variability and Uncertainty of Intake Fraction as a function of Distance from Source

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Abstract: The intake fraction (iF) is now a commonly used metric to assess exposure of outdoor emissions. It is therefore important to assess the variability of this metric and its sensitivity to both spatial and non-spatial parameters. We developed Pangea, a flexible, spatial, multi-scale, multimedia, fate and exposure model, which allows computing the spatial distribution of iF associated with emissions of pollutants. An important output of this model is the variation of iF as a function of distance from source (radial summary). We performed studies assessing the variability of iF based on Monte-Carlo analysis (MC) for non-spatial parameters, the influence of the model grids resolution, and the variability of iF for multiple sources (e.g. 117 solid waste incinerators throughout the USA). We present MC for 80 non-spatial parameters (physic-chemical parameters involved in parameterizing all media and transfers, BAFs, etc), for an emission of 6 relevant pollutants, located in the North-East of France. Results show the percentage of global iF which happens locally (50km radius around source). They show in particular that only 3-8% of the intake of Benzene through inhalation happens within local radius, and that 75-99% of the intake of B[a]P through ingestion happens within the same radius. Uncertainty on the fraction of intake that is local is much higher for TCDD and PM2.5 which have intermediary transport distances. Variations in iF between source locations are substantially higher for "local" substances (more than 2 orders of magnitude for B[a]P) than for the longer range chemicals (less than an order of magnitude for Benzene). These

studies show moreover that the approach implemented in Pangea, which decouples spatial model parameterization (GIS, a few hours per spatial configuration) and non-spatial parameterization (MATLAB, a few seconds/minutes per run), is essential for having enough flexibility to implement uncertainty analysis.

Keywords: A-exposure models, C-multimedia, A-geospatial analysis/GIS, multi-scale, uncertainty, multi-scale, uncertainty

We-P-36
Aircraft Measurements of Gaseous Pollutants and Particles in Beijing: Classification and Distribution
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Abstract: Measurements of gaseous pollutants, including ozone (O_3), Sulfur dioxide (SO_2), nitrogen oxides ($NO_X = NO + NO_2$), carbon monoxide (CO), particle concentration (5.6-560 nm and 0.47-30 μm), and related meteorological information (T, RH, P) were conducted in Beijing and Surrounding Region during Aug. 27-Oct. 13 in 2008. Total 18 flights (70 h flight time) from the surface to 2100 m were obtained with a Yun-12 aircraft with a cruising speed of about 180 km h-1 during the latitude range of 38 N-40 N and longitude range of 114 E-118 E, the southern surrounded area of Beijing city. This measurement was to characterize the regional variation of air pollution during and after the Olympics of 2008, the impacts of different transport direction and possible influencing factors. Results suggested that four different groups of transport sources influenced the pollution level of pollutants with the consideration of the backward trajectory analysis, including: (1) the pollutant transport of the southern direction with higher pollutants level; (2) the cleaner long-range transport of the northern or northwestern direction with lower pollutants level; (3) the transport from the eastern direction with characteristics of sea sources, i.e. middle level of gases pollutants and higher particle concentration; (4) the transport of mixing directions, i.e. lower altitudes from the pollutant transport direction or local pollution but higher altitudes from the clean transport direction.

Keywords: C-air, B-particulate matter

We-P-37
Variation of Secondary Inorganic Ions During the Multi-day Heavy Pollution Episodes in January, 2013 in Beijing, China
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Abstract: The city of Beijing and surrounding area is one of the important city agglomerations in China, accounting for 10.9% of national GDP and 7.8% of national population in 2010. As a result of economic development, the structures of air pollution sources and fuel consumption have constantly been changing. Owing to direct emissions from motor vehicles and secondary formation by photochemical reaction, the great increase of sulfate, nitrate, ammonium, and chlorine of PM2.5 during heavy pollution episodes were shown special concern due to its significant positive associations with cardiovascular, or respiratory mortality, as more polluted and hazy days have appeared more and become increasingly conspicuous in Beijing. The multi-day heavy pollution episodes occurred in January, 2013 in Beijing, China, and the chemical species of water soluble inorganic ions were measured during the multi-day heavy pollution episodes. Total 8 ions with 1-hour time resolution of data were analyzed with online monitoring and analysis system for particulate and gaseous ions(URG 9000 series) on the roof of a third-floor building in Chinese Academy of Environmental Sciences. Results showed that sulfate, nitrate, chloride and PAN were observed peak values on 10th-11th, 13th-14th, 23rd-24th and 29th-30th, indicating consistency variation with PM2.5 concentrations. For the cations, only K+ showed accordance with anions. The peak of NH4+ was observed only in 13th-14th, indicating different sources and different forming mechanisms during different heavy pollution episodes. Ca2+ and Mg2+ decreased sharply in the end of January, indicating the strong cleaning effects from northwestern transport direction. The decay of anions showed the contribution of carbonate or organic anions in Beijing, by the calculation of equivalent ratio between cations and anions.

Keywords: B-particulate matter, C-air, Sulfate, Nitrate, Ammonium

We-P-38

Reducing Exposures to Household Air Pollution from Kerosene Stoves for Pregnant Women in an Urban West African Setting

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Abstract: Household air pollution from solid fuel use is estimated to cause more than 3 million premature deaths each year. The use of solid fuels for cooking and heating is the third largest risk factor for morbidity and mortality in the global burden of disease analysis sponsored by the World Health Organization. Preliminary results from a randomized control trial using an ethanol cookstove intervention study in Ibadan Nigeria will be used to evaluate the effectiveness of an ethanol stove to reduce exposures to household air pollution and improve birth outcomes. Three hundred women in the early second trimester of pregnancy are being recruited from Primary Care Hospitals in Ibadan, Nigeria. The women use wood or kerosene as their primary cooking fuels. Half of the study population will receive an ethanol cookstove and fuel for cooking. This study is unique in that it focuses on an urban population in sub-Saharan Africa using a mixture of wood and kerosene, living in multi-family dwellings. The exposure assessment plan quantify continuous exposures to fine particulate matter (PM2.5) and carbon monoxide (CO) and integrated polycyclic aromatic hydrocarbon concentrations of (PAHs) in two 72-hour monitoring periods, once in the second and third trimester. Stove use monitoring with low cost temperature sensors will provide an objective measure of intervention adoption as well as direct method to measure the impact of stove usage on personal exposure to PM2.5 and CO. The preliminary results show that the ethanol cookstove reduces both mean and maximum exposures to PM2.5 and mean exposures to CO in comparison to kerosene cookstoves on average by 40%. Mean 72-hour personal exposures to PM2.5 for women who exclusively cook with kerosene are 58% higher (135.4 μg/m3 vs 58.2 μg/m3) than women cooking with ethanol stoves. These results will be shown in comparison to a global review of in-field cookstove interventions with published exposure data.

Keywords: A-indoor environment, A-global health, B-particulate matter

We-P-39

Impact of Air Pollution by Fine Particles on Children's Pulmonary Function

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Abstract: Introduction: Air pollution continues to pose a significant threat to health worldwide in developed and developing countries. In developing countries the roadside dust is one of the most important contributors towards overall atmospheric pollution. This problem becomes even more significant when we consider it in relation to the poorly maintained roads loaded with ever increasing motor vehicle traffic. Material and methods: A cross sectional survey was carried out by measuring evels of air pollution by fine particles, as well as pulmonary function of 180 children living and attending schools in urban area and in 80 children of suburban area. The purpose of this survey was to study impact of air pollution in pulmonary function of children. To collect data on age, gender, current respiratory symptoms, allergy diagnosed by the physician, parent education, smoking habit of parents, presence of animals, synthetic carpets and moulds in their houses is used a standardized questionnaire. The selection of schools, and children was done by randomized method. Results: Obtained data have shown that the concentration of PM10 oscillated 10.24-97.00 mcg/m3 and of PM2.5 2.82-71.94 mcg/m3. The data resulted from measurements of pulmonary function have shown significant differences between two groups of children, regarding pulmonary function FVC (P=0.0001), FEV1 (P=0.0003), and PEF (P<0.0001), whereas OR regarding main symptoms were: cough 1.58 (CI1.09-3.35) and phlegm 1.12 (CI 0.95-1.89). Conclusions: The results of this survey have shown significant differences in values of pulmonary function of the two groups of children. The average concentration of PM10 and PM2.5 in air exceeded recommended TLVs.

Keywords: D-children, A-epidemiology, B-particulate matter, A-biomarkers, C-air

We-P-40
Identification of Urinary Human Biomarkers of the UV-filter Octyl Methoxycinnamate After Oral Dosage
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Abstract: Octyl methoxycinnamate (Octinoxate, OMC) is widely used as a UV-filter in personal care products (e.g. lipsticks, sunscreen lotions, night-creams, etc.) in concentrations of up to 10% in the European Union. Due to exposure of the general population, OMC was selected as a substance of interest by the cooperation project between the German Federal Ministry for Environment (BMU) and the German Chemical Industry Association (VCI), which has the aim to provide biomarker based exposure data for fifty emerging substances of concern. We investigated metabolism and urinary excretion of OMC after oral dosage to human volunteers. We collected all consecutive urine samples by their full volume over a period of 48 hours post dose. Potential urinary metabolites were determined via online LC-MS/MS using custom synthesized standard substances or characteristic fragmentation patterns. We identified several specific metabolites of OMC (and de-methylated OMC) with oxidative modifications (hydroxy, oxo and carboxy) at its alkyl side chain. However, these metabolites represented only a minor share of the applied dose in urine (less than 0.1%). Instead, we identified p-methoxy hippuric acid (PMHA) as a major metabolite of OMC in urine representing approx. 40% of the applied dose. PMHA is a multi-step breakdown metabolite of OMC and we are currently investigating its specificity as biomarker for OMC. We also detected p-methoxy cinnamic acid (PMCA), a precursor of PMHA, albeit at considerably lower concentrations than PMHA itself. The major share of all the above metabolites was excreted within the first 24 hours post dose. Currently we are searching for additional, specific urinary OMC metabolites. With this study we will provide first data on human OMC metabolism and a set of urinary OMC metabolites to be used as biomarkers in future biomonitoring studies for exposure and risk assessment.

Keywords: A-biomarkers, A-biomonitoring, C-personal care products

THURSDAY, OCTOBER 16, 2014

Th-O-A1: Environmental Epidemiology - II

Th-O-A1-01

Toxicological and Epidemiological Studies of Effects of Airborne Fibers: Coherence and Public Health Implications

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Abstract: Airborne fibers, when sufficiently biopersistent, can cause chronic pleural diseases not caused by their chemical components, as well as excess lung cancers. Mesothelioma and pleural plaques are caused by biopersistent fibers thinner than ~0.1 μm and longer than ~5 μm. Excess lung cancer and pulmonary fibrosis are caused by biopersistent fibers that are longer than 15 μm. While biopersistence varies with fiber type, all amphibole and erionite fibers are sufficiently biopersistent to be highly toxic, while the greater in vivo solubility of chrysotile fibers makes them less toxic for lung diseases, and much less toxic for pleural diseases. Most synthetic vitreous fibers (SVFs) are more soluble in vivo than chrysotile, and pose little pulmonary or pleural health risk, but some specialty SVFs are sufficiently biopersistent to be toxic. These conclusions are based my literature review on: 1) epidemiologic studies that specified the origin of the fibers by type, and especially those that identified their fiber length and diameter distributions; 2) laboratory-based toxicologic studies involving fiber size characterization and/or dissolution rates, and long-term observation of biological responses; and 3) the largely coherent findings of the epidemiology and the toxicology. The strong dependence of effects on fiber diameter, length, and biopersistence makes reliable routine quantitative exposure and risk assessment impractical in some cases, since it requires TEM examination of representative membrane filter samples for statistically sufficient numbers of fibers longer than 5 and 15 μm, and thinner than 0.1 μm, by fiber types.

Keywords: A-epidemiology, A-exposure factors, A-risk assessment, B-particulate matter, D-occupational

Th-O-A1-02

Development and Application of a Markov Chain Model for Predicting Influenza Exposure in Indoor Environments

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Abstract: Exposure to airborne pathogens such as influenza remains a significant threat to public health. However, influenza transmission and control in indoor environments remains poorly understood, as it is not clear which routes of transmission (fomite, inhalation, or direct spray) are dominant. The transmission risk associated with each route in indoor environments is a function of many variables, including, ventilation rates, the number of infector individuals and their cough and breath frequency, the concentration and distribution of pathogens in exhaled air, human activities, deposition, and removal by HVAC filters. To improve our knowledge of predominate pathways of influenza transmission, we developed and applied a Markov chain model to estimate the intake dose of influenza viruses in the respiratory tract and mucous membrane of 24 susceptible individuals in a 500m2 hypothetical office environment assuming one infector and 8 hours exposure time. We explore the sensitivity of intake dose to each variable using existing ranges from the literature. Most importantly, we predict the dominant infection transmission pathways by separating the portions of intake dose for each pathway. The results show the direct spray is likely the dominant transmission pathway of influenza viruses in the hypothetical office space. Therefore, human activity patterns and the number concentrations and distribution of infectious particles in exhaled breath and cough have the largest impact on influenza infection risk. The median infection risk was estimated to be ~11.5%, which interestingly, yielded an equivalent quanta generation rate in a transient Wells-Riley model of 125 per hour, which is generally in line with assumptions from the literature. Overall, the model can be used to further explore dominant pathways for influenza transmission in indoor environments under a variety of assumptions and to investigate the effectiveness of control strategies such as filtration, ventilation, and UVGI.

Keywords: A-Infectious disease, A-exposure models, A-risk assessment, transmission pathways, control strategies

Th-O-A1-03

Confronting the Health Burden of Fine Particulate Matter Exposures in Product-Oriented Impact Assessment

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Abstract: Fine particulate matter (PM2.5) is one of the most important environmental factors contributing to global human disease burden. However, lacking a clear guidance on how to address health effects from PM2.5 exposure in a product life cycle perspective, practitioners often fail to report life cycle impacts for this category. To address this need, a task force was initiated to build a PM2.5 health impact framework and exposure factors. Existing literature was reviewed and expert input was collected and discussed in an initial Guidance Workshop. Subsequent work combined existing models and methods based on a set of defined criteria to develop initial guidance and recommendations for quantifying health effects from PM2.5 exposure. Recommendations include: (1) the framework proposed by Humbert et al. (doi:10.1021/es103563z) provides an assessment starting point; (2) intake fraction can be used as exposure metric with breathing rate linking air concentration and intake; (3) disability-adjusted life years without age-weighting and discounting can be used as a health metric; (4) archetypes can account for aspects influencing intake fractions; (5) spatial differentiation should be established for all archetypes; (6) emission-weights are needed in all cases where emission and/or exposure conditions are unclear; (7) the 2010 Global Burden of Disease Study provides a useful starting point for effect assessments; (8) cause-specific mortality can provide an informative basis as metric, but disability weights need further analyses; and (9) it remains to be discussed how to address non-linear exposure-response. There is insufficient evidence to differentiate between different PM2.5 sources or particle sizes regarding toxicity. Our study constitutes a first step towards providing guidance for how to account for health effects of PM2.5 exposures in product-oriented impact assessments. However, some inconclusive aspects require further analysis.

Keywords: A-life cycle analysis, B-particulate matter, C-air, intake fraction, health effects, intake fraction, health effects

Th-O-A1-04

Unravelling the Exposome through Health and Environment-wide Associations based on Large population Surveys

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Abstract: The exposome represents the totality of exposures from conception onwards, identifying, characterizing and quantifying the exogenous and endogenous exposures and modifiable risk factors that predispose to and predict diseases throughout a person's life span. Unravelling the exposome implies that both environmental exposures and genetic variation are reliably measured simultaneously. The HEALS methodology brings together a comprehensive array of novel technologies, data analysis and modeling tools that support efficiently exposome studies. In addition it collates environmental, socio-economic, exposure, biomarker and health effect data and puts in place the procedures and computational sequences necessary for applying advanced bioinformatics coupling thus effective data mining, biological and exposure modeling so as to ensure that environmental exposure-health associations are studied comprehensively. The overall approach will be verified in a series of population studies across Europe, tackling different levels of environmental exposure, age windows of exposure, and socio-economic and genetic variability. The main objective of HEALS is the refinement of an integrated methodology and the application of the corresponding analytical and computational tools for performing environment-wide association studies in support of EU-wide environment and health assessments. To achieve this aim, HEALS integrates a lot of novel applications for refining external exposure (use of satellite data, ubiquitous sensors, agent based models), internal exposure (life-spam internal dosimetry models). Understanding of the interaction between human biomonitoring (HBM) and exposure modeling (EM) is another key factor for elucidating the exposome. Finally, the effect of socioeconomic status (SES) on the several exposure variables will also be investigated. Examples of the HEALS approach to respiratory morbidity in Greek cities associated to energy poverty will be given in this work.

Keywords: A-aggregate exposure, A-biomonitoring, A-cumulative exposure, A-global health, A-epidemiology

Th-S-C1-01
Biological Contaminants in the US Green Housing Study
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Abstract: Direct effects of improved ventilation systems in low-income, multi-family homes in the Green Housing Study can lead to lower concentrations of indoor air chemicals; however, indirect effects could also lead to decreased humidity and subsequently lower levels of biological agents (e.g., fungi). We collected bed dust samples from homes (n=96) of children with asthma (ages 7-12 years) and measured ergosterol (a measurement of fungal biomass) in homes that received green renovations (i.e., green group) and homes that did not (i.e., comparison group) in two cities, Boston and Cincinnati. Homes were visited at three timepoints (1-month, 6-months, and 12-months post-renovation). At the baseline visit (1-month post-renovation), there was no significant difference in geometric mean (GM) of ergosterol concentrations for Boston [GM (geometric standard deviation, GSD): control homes=1,147 pg/mg (2.1); green homes=1,047 pg/mg (1.5)] or for Cincinnati [control homes=2,525 pg/mg (1.7); green homes=2,540 pg/mg (3.7)]. However, by the final home visit (12-months post-renovation) in Boston, green homes had lower concentrations than control homes [898 pg/mg (2.2) vs. 1,662 pg/mg (1.7)], although this was marginally significant (p=0.06). A similar decrease was not found in Cincinnati homes. This presentation will examine the association between repeated measures of ergosterol and green housing characteristics, as well as household behaviors that can affect these associations.

Keywords: B-microbial agents, A-indoor environment, D-children

Th-S-C1-02
Environmental Exposures and Biomarkers for VOCs in the US Green Housing Study
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Abstract: During the 1970's energy crisis, many homes were sealed without proper ventilation, and this led to higher levels of indoor air pollutants. One of the main aims of the US Green Housing Study (GHS) was to examine levels of VOCs inside green eco-friendly housing (e.g., low VOC materials) and assess whether renovations led to a change in indoor air pollutants. Low-income multifamily housing units in two study sites were the focus of the GHS. Green-renovated apartments and comparison apartments (non-renovated) were visited at three time points (e.g., baseline, 6- and 12-months). VOCs (including the carbonyl, formaldehyde) were measured by passive dosimetry in 96 homes (Boston n=45 and Cincinnati n=41). Passive badges were placed in a bedroom of each home and then sealed after exposure to the air for four days. We analyzed cross-sectional data from the baseline home visit for both study sites. For Cincinnati (n=7 control apartments and n=13 green apartments), we also had lab results from the repeated measures from follow-up visits at 6- and 12-months. For baseline measurements, median concentrations of the three most commonly-recovered VOCs were ethanol (160ppm), formaldehyde (0.019ppm), and isopropanol (150ppm). In addition, Boston had significantly higher levels of formaldehyde (geometric mean (GM=0.023ppm) than did Cincinnati (GM=0.016ppm, p<0.01), but concentrations in Boston green homes were not significantly different from those in control homes (0.021ppm vs. 0.029ppm, respectively). For all home visits in Cincinnati, there was no significant difference in formaldehyde levels between green and control homes; baseline visit (green=0.022 vs. control=0.021ppm); 6-month follow-up (green=0.020 vs. control=0.019ppm); and 12-month follow-up (green=0.021 vs. control=0.029 ppm). At this time, it does not appear that there are significant differences in green vs. control homes; however, there are some differences between study sites that warrant further investigation.

Keywords: B-VOCs, A-biomarkers, A-indoor environment

Th-S-C1-03
Phthalates in the US Green Housing Study
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Abstract: Phthalates are ubiquitous in the indoor environment and used in many building materials and consumer products. Phthalate exposures have been associated with altered reproductive development, and several epidemiological studies have suggested an association with allergic diseases such as asthma. To evaluate the impact of green renovations on residential phthalate levels, we measured phthalates in indoor air and urine from asthmatic children living in homes with and without green renovations as part of CDC's Green Housing Study. Air samples were analyzed for 6 phthalates (DEHP, BBP, DBP, DCHP, DEP, DINP) and urine samples were analyzed for 12 phthalate metabolites, which include metabolites of the phthalates measured in air. As in previous studies, we found phthalates in 100% of homes and participants. We found DBP and DEP, the more volatile phthalates, at the highest concentrations in air, and MEP, the monoester metabolite of DEP, at the highest mean concentration in urine. The parent-metabolite pairs of DEP-MEP and BBP-MBzP were significantly correlated in air and urine ($p<0.05$), indicating the home represents an important contribution to total exposure for these phthalates. We found significantly higher BBP and DEHP air concentrations in control versus green homes based on mixed-effects models for repeated measures, with households as random effects ($p<0.05$). Metabolites of BBP and DEHP were higher in children living in control versus green homes; however, the differences were not significant. The reduced air levels of BBP and DEHP in green units may be due to the presence of vinyl flooring in control but not green units. These data are some of the first measurements of phthalates in green-renovated homes and provide an opportunity to evaluate the impact of renovations on indoor environmental quality, which is critical since substantial investments in green housing should not have unintended consequences on exposures and health.

Keywords: B-phthalates, A-indoor environment, C-consumer products, D-children

Th-S-C1-04
Effects of Energy-efficiency Interventions in Multifamily Buildings in North-East Europe
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Abstract: Measurement data on indoor environmental quality (IEQ) parameters (including 24-hour monitoring of PM, CO and CO2; 1-week passive sampling of VOCs, formaldehyde, and NO2; 2-month monitoring of T and RH, and passive sampling of radon and settled dust) and questionnaire data from occupants have been collected, thus far, from 190 apartments in 36 buildings undergoing renovation in Finland and Lithuania. Whereas most measured parameters before renovation were within recommended limits, the baseline levels were different in each country. Post renovation data (only a few buildings measured so far) have indicated potential changes in the measured parameters. While continuing the data collection, the effects of renovation on IEQ and occupant health will be further analyzed. Based on the results a comprehensive assessment protocol will be developed. The protocol can then be used in future studies and renovation projects of different scales. Whereas energy audits and certificates have become mandatory in EU member states, our initial experiences are in favor of a parallel IEQ assessment to be recommended both before and after large-scale renovations. Such assessment helps to ensure maintaining or improving IEQ and is also useful for QAQC purposes. From the point of view of developing national policies to meet GHG emission targets, it appears useful to develop a routine monitoring scheme including assessment of energy consumption as well as other benefits (e.g. health). This would be recommended due to large investment capacity (both national and private) utilized in energy improvements. In this context, overview of the current results from before and after intervention measurements will be presented, and the implications on both IEQ and occupant health will be discussed.

Keywords: A-indoor environment, A-exposure factors, A-risk assessment, A-environmental policy, A-sustainability

Th-S-C1-05
Green Schools: What Does it Mean for the Health and Performance of Students?
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Abstract: More than 50 million students and 3.5 million teachers spend, on average, 1,300 hours per year in school buildings - more time than any other indoor environment outside their home. Measures of indoor environmental quality (IEQ) at schools, including ventilation, allergen and mold exposure, and indoor air quality, have found these factors to be associated with the respiratory health of students. Moreover, schools are frequently located near sources of environmental exposures including major roads. There have been few studies, however, which have examined these factors in relationship to the performance and achievement of students. As awareness of the importance of the school environment on the well-being and achievement of children and teachers increases, the design and construction of new and renovated schools increasingly incorporate elements of 'green' building design. This presentation will: 1) review previous studies of IEQ and its impact on health and performance of building occupants, 2) describe the elements of green building design which may improve school IEQ, 3) provide a rationale for studying green building design and its impact on health and performance.

Keywords: A-epidemiology, A-indoor environment, D-children

Th-S-D1: On-going International Harmonization of Analytical Methods and Quality Assurance in Studies of Children's Environmental Health

Th-S-D1-01
Background on the Environment and Child Health International Birth Cohort Group

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Abstract: Large scale multidisciplinary birth cohort studies are being designed and implemented in several countries around the world to examine the effects of the environment on children's growth, development and health. These studies feature investigation of behavioral, economic, environmental, genetic and psychosocial factors on child growth and development with the goal of better understanding how to improve the health of children. Study investigators will collect environmental samples and biospecimens, and administer questionnaires, conduct interviews, or make observations about household characteristics, lifestyle, medical care, social interactions, and parents' occupations. Investigators from several of the newer large-scale birth cohort studies (planned or ongoing in China, France, Germany, Japan, France, and the US) came together in 2011 to form the Environment and Child Health International Birth Cohort Group to coordinate efforts to harmonize core elements of their studies. Harmonization provides an opportunity to share expertise and to collaborate in the development of terminology, the selection of study visit measurements, and the collection and analysis of data for exposures and outcomes of mutual interest. Results may lead to the development of best practices and opportunities for additional international cooperation. This presentation will describe the background of the Environment and Child Health International Birth Cohort Group and outline its progress to date.

Keywords: A-epidemiology, D-children, A-biomonitoring, A-sampling methods, A-life cycle analysis

Th-S-D1-02

Human biomonitoring harmonization - lessons learned from COPHES and DEMOCOPHES

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Abstract: Introduction: A major objective of the European Environment and Health Action Plan 2004-2010 was the EU wide comparison of the population's exposure to chemicals by human biomonitoring (HBM). This required study harmonization. COPHES (COnsortium to Perform Human biomonitoring on a European Scale) systematically developed a harmonized approach to conduct HBM on a European scale, an essential prerequisite to get comparable data. Results: For all main aspects of study design and conduct alternatives were compared and discussed in a transparent decision making process that can also be applied to other studies. To reach acceptance of all involved partners, country specific aspects were always considered. During workshops and by discussing written materials all partners brought up their comments and became familiar with all instruments for fieldwork and methods for quality assurance (e.g., fieldwork manual, questionnaires, and check lists). However, study preconditions such as ethics requirements or acceptance of questionnaire components differed between countries, giving a taste of the limits of harmonization. Finally,17 of the 27 COPHES countries conducted the DEMOCOPHES survey (DEMOnstration of a study to COordinate and Perform Human biomonitoring on a European Scale) using the harmonized approach. Conclusions: The harmonized fieldwork instruments (basic questionnaire, urine and hair sampling) turned out to be of high value for future HBM studies. Harmonization requires detailed preparation but not necessarily in the same depth in each part of the project. The challenge is to determine which procedures indispensably need perfect harmonization and for which general guidelines are acceptable. Acknowledgements: We are grateful to the European Commission that funded COPHES (7th Framework Program No. 244237) and co-funded DEMOCOPHES (LIFE09 ENV/BE/000410) in addition to the Federal Environment Ministry (BMUB). We also thank all project partners (www.eu-hbm.info).

Keywords: A-biomonitoring, A-analytical methods, A-epidemiology, A-biomarkers

Th-S-D1-03

Harmonization of QA/QC Measures Among Large-scale Children's Environmental Studies

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Abstract: There is mounting interest in the impact of the environment on children's health and development. Recently, large-scale studies of children's environmental health, including both longitudinal and cross-sectional designs, have been planned and implemented in several countries. These studies, aiming to better understand how social, environmental and genetic factors affect children's health, put special emphasis on the effect of environmental stressors. Among a wide range of environmental stressors, the effect of chemical contaminants is one of the focus areas to be investigated. In order to examine the relationship between chemical exposure and children's health in longitudinal studies, individual exposure estimation is required rather than general information on the exposure of the population. Exposure assessment utilizes monitoring, modelling and questionnaires. Among these, biological monitoring (human biomonitoring) is one of the most powerful methods to investigate individual exposure to chemical contaminants. However, different studies employ different measurement methods, which hampers future data pooling and analysis among the studies. France, Germany, Japan, Shanghai (China) and the United States that are planning or conducting large-scale children's environmental health studies have gathered to form an international working group to harmonize outcome and exposure measurement methodologies. The group identified three major contaminants including mercury,

phthalates and organophosphates for the first step of the harmonization. The group started sharing information about sample collection, analytical methods, quality assurance procedures and data reporting formats for the three contaminants. Round-robin trials have also been conducted to identify key issues for further harmonization. The progress of the working group discussion and trials will be presented in the symposium. Acknowledgement: Environment and Children's Health International Birth Cohort Group

Keywords: A-biomonitoring, A-epidemiology, D-children, A-analytical methods

Th-S-D1-04
Standard Reference Materials for Quality Assurance Measurements
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Abstract: For over 25 years the National Institute of Standards and Technology (NIST) has developed a wide range of Standard Reference Materials (SRMs) that have values assigned for clinically important analytes, legacy organic pollutants, contaminants of emerging concern, and toxic metals. Examples of some SRMs include organic contaminants in human serum, human milk, and human urine, lead in caprine blood, elements in bovine liver and animal serum, arsenic species in human urine, and toxic elements in human urine. SRMs are useful to the global biomonitoring community by serving as target materials for quality assurance measurements and method development. In addition to producing SRMs, NIST has developed measurement methods for many compounds, and the results from the independent methods have been combined to provide certified concentration values for contaminants in the different materials. This talk will describe how SRMs can be used for quality assurance measurements and how exposure science can benefit from their inclusion in biomonitoring studies.

Keywords: A-biomonitoring, A-sampling methods, A-analytical methods

Th-S-D1-05
Harmonization of Quality Assurance and Quality Control Procedures in the Environment and Child Health International Birth Cohort Group
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Abstract: Harmonization of quality assurance and quality control procedures in the Environment and Child Health International Birth Cohort Group (ECHIBG) is a key step in the desire to harmonize data collection procedures and to combine data collected in individual cohort studies for subsequent analysis. Information about select environmental contaminants and outcomes of interest in each cohort study was compiled, summarized, and evaluated to highlight opportunities to harmonize procedures. Summaries described the characteristics of measurement methods and the frequency of data collection in each cohort study. For the selected contaminants (mercury, organophosphates, and phthalates), results showed differences in the schedule to collect biospecimens and environmental samples, and the content and mode of administration of questionnaires. Procedures used to collect and analyze biospecimens and environmental samples were sufficiently similar to harmonize quality assurance procedures for procurement of sample collection supplies, pre-screening sample collection materials, and alignment of analytical instrument performance specifications, including sourcing and exchange of analytical reference standards. For the 23 outcomes selected (including birth weight, length, Bayley III, and MCHAT), results showed differences in choice and mode of administration of assessments and reliance on medical records or clinical examinations to assign outcomes. Even in instances where the same outcome assessment method was administered, differences in the frequency and mode of administration, and the criteria used to assign the outcome occurred. Dissimilarities in the objectives, scope, design, and staffing of the cohort studies were determined to be the reasons for the observed differences, making it difficult to harmonize study visit assessment methods or quality assurance procedures for the selected outcomes.

Th-S-E1: Turning Gray to Green: Exploring the Public Health Benefits of Green Infrastructure

Th-S-E1-01
Weaving Natural Processes into the Built Environment with Green Infrastructure
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Abstract: Green infrastructure (GI) denotes a natural or living component in place of, or imbedded before or within traditional grey infrastructure. Working in harmony with natural processes requires an understanding of stormwater quality and the biogeochemical function of these complex systems to allow effective management and to achieve specific performance objectives. GI is typically designed to capture, retain, infiltrate or otherwise remove the stormwater component from a combined sewer system during normal or moderate precipitation events. Non-point source pollution can be funneled into GI assets, and may accumulate or become a point-source where and when flow exits a GI system. Extreme weather events may overwhelm the hydrologic capacity of GI assets and lead to runoff and the potential for impacts to surface waters downstream. Urban environments, where most investments in GI are being made, have specific and challenging stormwater concerns. Monitoring and evaluating performance of GI toward water quality objectives is therefore complicated by the urban setting, by the intermittent flow typical of GI assets, as well as by the increasing occurrence of extreme weather events and potential impacts from global climate change. In order to maximize the performance of the living or green components of GI, better information is needed regarding the impacts from urban stormwater on the GI assets themselves, and to manage these assets effectively toward water quality goals downstream.

Th-S-E1-02
Socio-economic impacts of Green Infrastructure
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Abstract: The implementation of green infrastructure, or low impact development, has a variety of effects - some that are intended and measurable and some that are not. This presentation will provide an overview of studies that have focused on estimation of the ancillary benefits of GI, including increased property values, increased community involvement and awareness, and positive changes in well-being. Once these benefits are quantified they can be incorporated into policy. To that end, I will also discuss adaptive management as an environmental management strategy that uses an iterative process of decision-making to improve environmental management via system monitoring. Central to adaptive management is engagement of stakeholders in a learning process that can help regulated communities achieve environmental quality objectives. We are using an adaptive management approach to guide a green infrastructure retrofit of a neighborhood in the Slavic Village Development Corporation area (Cleveland, Ohio). We are in the process of gathering hydrologic and ecosystem services data and will use this data as a basis for collaboration with area citizens on a plan to use green infrastructure to contain stormflows. Monitoring data provides researchers with feedback on the impact of green infrastructure implementation and indicates where improvements can be made.

Th-S-E1-03
Health Impact Assessment of the Boone Boulevard Green Street Project in the Proctor Creek Watershed of Atlanta, GA
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Abstract: Proctor Creek is one of the most impaired creeks in metro-Atlanta and has been placed on the impaired waters list due to exceedance of state water quality standards for fecal coliforms. The topography, prevalence of impervious surfaces in the watershed, and a strained combined sewer system have contributed to

pervasive flooding in the Proctor Creek communities and created environmental, public health, economic, and redevelopment issues. The City of Atlanta's Department of Watershed Management selected a green infrastructure (GI) project to implement in the Proctor Creek Watershed to address some of the previously mentioned issues. Green infrastructure uses natural hydrologic features to manage stormwater and provide environmental and community benefits. The City's pending decision to implement GI along a portion of Joseph E. Boone Street in the Proctor Creek Watershed provided the opportunity to raise awareness of direct and indirect health benefits of GI solutions. EPA partnered with stakeholders to conduct a Health Impact Assessment (HIA) of the Boone Boulevard GI project. HIA is a process that uses scientific data, health expertise, and stakeholder input to factor public health considerations into the decision-making process. The HIA examined potential health impacts in the community within one-half mile of the project, which consists of predominately low-income and minority populations. Probable impacts of GI identified through the HIA included reduced localized storm flooding and pollutant loading, improved air quality, improved accessibility for walking and biking, increased social cohesion, improved disease vector control, and more opportunity for employment through construction and maintenance of GI. The HIA process developed recommendations that promoted the positive health effects and minimized any potential adverse health effects of the project.

Keywords: public health, A-environmental justice, A-built environment

Th-S-E1-04
Green Infrastructure Approaches to Mitigate Climate Change Effects on Vulnerable Populations
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Abstract: A changing climate can cause numerous adverse health outcomes that are especially detrimental for vulnerable populations. A comprehensive mitigation effort is required to properly address these climate related health impacts. Health outcomes (morbidity and mortality) of an extreme heat event (EHE) was studied and spatially analyzed within the Proctor Creek Watershed of Atlanta, GA. These health outcomes of the historic EHE were compared to a research informed Extreme Heat Vulnerability Index (EHVI). Much research has gone into how to identify vulnerable populations; the most prevalent metrics of a vulnerable population include age, economic level, race, education level, and social isolation. The EHVI uses these metrics among others to identify where the vulnerable populations are located. EPA worked to spatially layer the EHVI, the health outcomes of the EHE, as well as flood prone areas (using a GIS tool known as the Wetness Index) to identify where the areas of most concern are within the watershed. Once the areas of concern were identified, in accordance with the Intergovernmental Panel on Climate Change's (IPCC) recommendation to make climate change adaptation as local as possible, EPA worked to identify locally tailored green infrastructure solutions for the areas in question. Furthermore, the findings of this study were used to inform an Environmental District Concept under works at the City of Atlanta as well as a watershed wide Health Impact Assessment for the Proctor Creek Watershed.

Keywords: A-climate change, D-vulnerable, Extreme Heat Events, Green Infrastructure, Vulnerable Populations, Health Outcomes, Health Impacts, Public Health, C-water, A-ecological exposure

Th-S-E1-05
Green Infrastructure Implementation in City of Cincinnati - Ohio
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Abstract: The City of Cincinnati as part of its campaign to encourage green infrastructure (GI) in stormwater management has partnered with many stakeholders to construct, operate and maintain these GIs on their properties. These GIs through partnerships with both public and private entities can provide additional value and benefits which leads to greater understanding of sustainable infrastructure. To date MSDGC has entered into formal partnerships, through funding agreements or memoranda of understanding, with 13 public and private partners on 22 projects. The implementation of these GIs is part of the larger MSDGC Project Groundwork program effort to improve the quality of public's lives — through cleaner streams, improved protection of public health, and enhancements to the communities where we work, live, and play. Additionally, the program is designed to assess the impact of GI, whether alone or integrated with more traditional stormwater management approaches, on the reduction of combined sewer overflows in the MSDGC service area and the quality of life in the service area. Further implementing such infrastructure at these communities becomes the nucleus of other services and utilities to follow through and improve the life of the residents. The impact of constructing these GIs in MSDGC's service area proved to have a positive impact on the communities. The GIs became a focal point

and areas where people enjoy having and taking care of. They became educational and research driven sites. To name few of these sites, St Francis court apartments, St Antonio church, Cincinnati State Community college, Cincinnati Zoo, and Civic Garden Center.

Keywords: A-built environment, Community Development, C-water, C-streams

Th-O-C2: Emerging Chemicals of Concern

Th-O-C2-01
Introducing the 5th German Environmental Survey 2014-2016 Focusing on Emerging Chemicals of Concern

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Abstract: The German Environmental Surveys (GerES) are large scale population studies repeatedly been carried out since the mid-1980s. GerES I, II, and III focus mainly on adults, GerES IV and GerES V (2014/2016) on children and adolescents. GerES evaluates pollutant body burdens in population-representative samples, analyses the contribution of different media (air, water, food) to the overall exposure, and links human biomonitoring (HBM) to health data. GerES is conducted in cooperation with the National Health Interview and Examination Surveys (NHIES) performed by the Robert Koch-Institute. The GerES V pilot study was conducted in 2013 to validate instruments and field work procedures. GerES V comprises HBM, indoor and drinking water monitoring, and standardized interviews, tailored to exposure situation in Germany. GerES V focuses on emerging substances with potential health relevance and/or assumed exposure of the general population (e.g. plasticizer alternatives like Hexamoll® DINCH and di-2-propylheptyl phthalate (DPHP) or 4-tert-octylphenol, 4-nonylphenol, the solvents N-methyl- and N-ethyl-2-pyrrolidone (NMP/NEP), parabenes, and the vulcanization accelerator 2-mercaptobenzothiazole). Exposure data on chemicals of concern already measured in GerES IV like phthalates and other pollutants (i.a. metals, pesticides, PCB, cotinine) will be updated. The GerES V concept demonstrates current strategies for elucidating environmental exposures. The pilot study indicates comparatively low exposure to Bis(2-ethylhexyl) phthalate (DEHP).The highest sum of the DEHP metabolites 5OH- and 5oxo-MEHP measured in morning urine was 160 µg/L which is well below the health-based guidance value. The main study will answer the question whether a) plasticizer alternatives are nearly as omnipresent in children as in a first small sample of non-occupationally exposed adults and b) screenings on emerging chemicals in adults can advocate same analyses in studies on children and adolescents.

Keywords: A-biomonitoring, A-epidemiology, A-exposure factors, A-biomarkers, D-children

Th-O-C2-02
A Network to Address New Emerging Risks of Chemicals (NERCs) and New Opportunities for Policy Needs by the Identification of Human and Environmental Health Effect-related Signals

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Abstract: Aim Despite regulations on risks of chemicals, new risks continue to emerge. This presentation will demonstrate an interactive early warning platform to identify New Emerging Risks of Chemicals (NERCs) clarifying scientific and policy needs. Methods NERCs are identified by 1) Signal identification: screening scientific literature, news sites, databases, networks and outcomes of stakeholder interviews, 2) Causality assessment: linking chemical exposure to identified effect(s) via on-line expert-group consultations, and 3) Signal prioritization: based on the previous step, involved human and environmental risks, options for risk management, societal and ethical concerns, potential NERCs requiring follow-up will be listed. This may include derivation of safety limits, enforcement or inspection, using or modifying existing regulations (e.g. REACH, CLP), etc. Results The on-line NERCs platform is accessible by invited experts. The platform contains potential signals related to environmental effects. Early 2014, NERCs platform started with two signals: 1. Although concentrations of decabromodiphenyl ether (DBDE) and hexabromocyclododecane (HBCD) in environmental media are generally decreasing, the proportion of bird species exposed to DBDE and HBCD is still increasing, and 2. The presence of brominated flame retardant congeners in lipid tissue of sea birds is suggested to be related to non-dietary ingestion of plastics. The request for signal strengthening information during the on-line consultation resulted into informed decision-making options. Conclusions NERCs 1. speeds up action compared to other (regulatory) mechanisms, 2. offers opportunities to improve the effectiveness of regulatory frameworks

protecting human and environmental health. NERCs is welcoming new members. Acknowledgements This initiative is coordinated by the RIVM and financed by the Dutch Government. Special thanks to all network members.

Keywords: A-chemical prioritization, A-environmental regulation, A-emergency response, D-wildlife, A-risk assessment

Th-O-C2-03
Physiologically Based Pharmacokinetic Modeling of Cerium Oxide Nanoparticles by Inhalation Exposure in Rats
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Abstract: *In vitro* studies have reported toxic effects of cerium oxide nanoparticles (CeO_2 NPs) which can be used as a diesel fuel additive and released to the ambient air and then biodistribute in the body via inhalation exposure. Freshly generated CeO_2 NPs could also undergo an aging process with chemicals under sunlight, resulting in different characteristics that may influence their biodistribution. The aim of this study is to measure this biodistribution and to develop a physiologically based pharmacokinetic model of CeO_2 NPs, both fresh and aged, in rats. Our model has 10 compartments (blood, lungs, gastrointestinal tract, liver, kidneys, lungs, heart, brain, spleen, and rest of the body) interconnected via the blood circulation. Each compartment includes phagocytizing cells which may take up NPs in a saturable manner. We therefore exposed Sprague-Dawley rats by nose-only exposure to 12.9 mg/m^3 fresh CeO_2 NPs and 2.0 mg/m^3 aged CeO_2 NPs for 5 hours and measured concentrations in different organs over 14 days. In both experiments, lungs contained the highest amount of CeO_2 NPs while the amounts in other organs were three to four orders of magnitude lower. High concentrations of CeO_2 NPs were also found in feces after one day of exposure (7.3 mg/kg in the feces against 1.9 mg/kg in the lungs for aged CeO_2 NPs), but sharply decreased afterwards (0.18 mg/kg after 4 days for aged CeO_2 NPs). Without any major modifications to the model, the simulated time courses of NPs biodistribution agreed reasonably well with experimental data, yielding R^2 of 0.80 for the fresh CeO_2 NPs experiment and 0.58 for the aged CeO_2 NPs experiment. Further investigations are ongoing to study the sensitivity of the model parameters and to characterize phagocytizing cells dynamics based on *in vitro* experiments.

Keywords: A-exposure models, B-nanoparticles

Th-O-D2: Advances in Pesticide Exposure Assessment - IV

Th-O-D2-01
Pesticides, EcoHealth, and the Legacy of Rachel Carson
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Abstract: The publication of Rachel Carson's Silent Spring is widely acknowledged as a watershed event in our understanding of the interplay between human and ecosystem health. In recent years, however, Carson's work has been criticized as unscientific, fraudulent, and responsible for the deaths of millions of malaria victims. This presentation will examine the accuracy of these criticisms in regard to the state of scientific knowledge at the time that Silent Spring was written, and will consider the extent to which the views presented in Silent Spring are consistent with our current understanding of the impact of pesticides on human health and the environment. The primary criticisms of Silent Spring are generally not supported by scientific evidence; many appear to be ad hominem arguments guided by a general hostility to environmental regulations. The major themes of Silent Spring will be placed within the ecohealth framework, and key elements of Rachel Carson's legacy, including the establishment of the U.S. Environmental Protection Agency and the Stockholm Convention on Persistent Organic Pollutants will be discussed.

Keywords: B-pesticides, A-environmental policy, A-ecological exposure

Th-O-D2-02

Pesticide biomonitoring in residents living near agricultural land: Overview of study methodologyland: Overview of study methodology

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Abstract: In the UK, the use of pesticides is regulated to protect human health and the environment. The scientific paradigm underpinning the approval of pesticides involves the comparison of estimated highest potential human exposures with toxicological reference values levels, at and below which there is considered to be high confidence that there will be no adverse health effects. The regulatory risk assessment is therefore generally considered to be based on a conservative estimate of exposure. Our study aimed to assess exposure to pesticides for residents living within 100m from the edge of agricultural land during the spraying season and assess whether the exposure models used for regulatory risk assessment produce sufficiently conservative estimates. Determining resident's exposure to pesticides is challenging for a number of reasons e.g., the relatively short biological half-life of pesticide compounds or their metabolites, inherently unpredictable farming practices, generally no communication between farmers and residents about spraying activities and so an individual may not realise that a neighbouring field has been treated with pesticide. We describe a study design that successfully addressed many of the inherent difficulties encountered with such projects. We will describe the use of community researchers in engaging farming and residential communities into the study as well as ensuring sustained appropriate biological monitoring data collection from these study populations. We will also discuss the data analysis and simple pharmacokinetic model used to predict the urinary metabolite levels obtained using the RRA procedures with the residents' pesticide metabolite levels. Results of the research project are currently unavailable however the project methodology has been judged successful in that 118 adults and 22 children provided at least one spray event urine sample during the spraying seasons, and a total of 523 spray event and 995 background urine samples were analysed for metabolites of captan, chlorpyrifos, chlormequat and/or cypermethrin to address the study aims and objectives.

Keywords: A-biomonitoring, B-pesticides, D-community, D-children

Th-O-D2-03

Organophosphate Pesticide Exposure among Children Living in Farmland: Evidence of Household Environment and Children Activities

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Abstract: Organophosphate pesticides (OPs) are widely used in agricultural sectors in Thailand because of their broad spectrum toxicity for pests. The children residing in agricultural areas of Northern Thailand have higher exposure to OPs than children living in other residential areas in the region. The objective of the study was to determine environmental conditions and activities that predict biomarkers of OP exposure among children living in Central Thailand farm areas. In October 2011, 6-8 years old children participants were recruited. Of the 53 participants, 24 were living in rice growing area where OPs are used on rice farms, while 29 were living in aquacultural area where shrimp were farmed and OPs were not used. Household environments and participants' activities were assessed using a parental structured interview. Urine samples were collected from participants for OP urinary metabolite (i.e. DAPs) analysis. Most of OP urinary metabolites in children living near rice farms were significantly higher than those living near shrimp farm aquaculture ($p < 0.05$). Younger participants had significantly higher OP concentrations than older participants. The linear regression analysis results revealed OP application in farms were significantly related to elevated OP metabolite levels in participants (TCPy, $p = 0.003$). Increasing TCPy levels were significantly related to rice farmer family ($p=0.001$), proximity to farm ($p=0.04$), playing on farm ($p=0.02$), being with parent on farm ($p = 0.02$) and amount of dirt on their body ($p=0.04$). In conclusion, children living on rice farms had higher concentrations of OPs urinary metabolites than aquaculture participants, suggesting higher exposures to OPs related to their environment and activities. Long-term low-level OPs exposures among children living in Central Thailand were found to be quantifiable. The extent that these exposures result in adverse health effects is not known and requires further investigation.

Keywords: A-biomarkers, B-pesticides, A-activity patterns

Posters

Th-P-01 - Withdrawn

Th-P-02
Excess Cancer Risks for Cook County, IL for Benzene and Formaldehyde: EPA Air Monitoring Data vs. EPA's NATA Model Data

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Abstract: Objective: The USEPA's National-Scale Air Toxics Assessment (NATA) is an ongoing evaluation of 177 Clean Air Act toxics and diesel particulate matter in the US. Evaluation of the 2005 NATA data was performed to determine quantity and source of emissions in Cook County. In addition, we compared cancer risks for benzene and formaldehyde based on measured data at three fixed-site air monitoring stations in 2005 to those based on EPA's modeled 2005 NATA estimates using both the traditional NATA approach and the EPA Superfund guidance approach. Methods: The 2005 NATA data were downloaded from the USEPA website for Cook County and were examined at the census tract level. Benzene and formaldehyde monitoring data, sampled at three Illinois EPA monitoring stations, were obtained from USEPA-Region 5. The modeled NATA cancer risks for benzene and formaldehyde were compared against predicted cancer risks based on measurement data collected at the three fixed-site monitoring stations using two different approaches: NATA approach and the EPA Superfund guidance approach. Results: Cook County had substantially higher emissions estimates than any other county in Illinois. The source category contributions indicated that point source emissions dominated in rural counties, while mobile source emissions dominated in urban environments. The benzene results based on all calculation techniques were similar, with the NATA model underestimating the risk in the Schiller Park location and overestimating the risk in the Chicago location. The risk estimates based on formaldehyde monitoring data in Schiller Park were substantially higher than NATA modeled risks. Conclusions: The results concluded that EPA's NATA should only be used to evaluate relative risks across different geographic areas. Underestimation of exposure concentration, dose and risk is of concern for both residents and workers in these areas since cumulative exposure is the appropriate metric for potential health effects including the two human carcinogens studied.

Keywords: NATA, Air Toxics, Cancer Risk, Benzene, Formaldehyde

Th-P-03
Dietary Exposure Assessment and Risk-Benefit Characterization of Mercury and Nutrient Intakes among First Nation Communities in the Deh Cho Region of the Northwest Territories

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Abstract: The aim of this study is to examine dietary mercury and nutrient intake among First Nations communities in the Deh Cho Region of the Northwest Territories (NT). Nutrients found in fish, particularly omega 3-fatty acids (n-3 FAs) and selenium (Se), promote health. However, methylmercury (MeHg), a contaminant commonly detected in fish, is known to induce adverse effects in the neurological, cardiovascular, and immune systems. Due to their subsistence diet and reliance on traditional food sources, Aboriginal populations living in Canada often face elevated exposures to MeHg, which may have negative implications on the quality of their health. The public health risk posed by MeHg in these traditional food sources is of when concern; however, it is important to recognize the need for public health authorities to design interventions and advisories to balance nutrient benefits and contaminant risks. Fish samples (n=163) were harvested from Ekali, Sanguez, and Trout Lakes within the Deh Cho Region in August 2013. The muscle portion of each fish was analyzed for total Hg (Milestone DMA-80), n-3 FAs (Varian 3900), and total Se (Agilent 7700x). Also, Deh Cho residents took part in a community-based dietary survey to quantify fish consumption. Food composition and consumption data will be integrated using Monte-Carlo simulations to generate probabilistic intake estimates for comparison to toxicological reference values and dietary reference intakes, respectively. Preliminary analyses indicate that n-3 FA of Deh Cho fish range between 471 mg/100 g (Northern pike, Ekali Lake) and 1710 mg/100 g (Lake trout, Trout Lake). Total Hg concentrations varied between 0.025 ppm wet weight (Lake whitefish, Trout Lake) to 3.16 ppm wet weight (Northern Pike, Sanguez Lake). Total Se results are currently under analysis. The goal of this

research is to develop risk communication strategies that promote traditional food use as a pathway to health equity.

Th-P-04 - Withdrawn

Th-P-05
Influence of Chemical Composition on the Oxidative Potential of PM$_{2.5}$

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Abstract: Besides urban air pollution, there is an increasing concern on indoor air quality, since people spend about 90% of their time in a built environment. Particulate matter (PM) is one of the "criteria pollutants" which serves as an indicator of air quality. Most epidemiological studies have shown associations between adverse health effects and different PM characteristics. Oxidative potential (OP) is a toxicologically relevant feature of aerosol particles. By comparing the chemical composition of PM with this metric, it is expected to get a better understanding of which components are driving its health effects. Sampling of PM$_{2.5}$ was performed at an urban site in the center of Budapest, Hungary between June 2010 and May 2013 and in European modern office buildings in the frame of the OFFICAIR project. Different PM$_{2.5}$ sampling strategies were applied in the office buildings in order to estimate the occupational exposure of employees to PM$_{2.5}$ during the daily work shift. The OP of the collected particles was determined through antioxidant (ascorbate and reduced glutathione) depletion using a synthetic respiratory tract lining fluid model. Depending on the amount of the collected PM mass, the combination of different analytical techniques such as proton-induced X-ray emission spectrometry, inductively coupled plasma mass spectrometry, ion chromatography and organic carbon/elemental carbon analyzer were applied for the chemical characterization of PM$_{2.5}$. Substantial temporal differences in OP and chemical composition of PM$_{2.5}$ could be observed during the 3-year long sampling period. In the case of office buildings, the oxidative activity showed spatial variation. The indoor/outdoor OP ratio was higher than the unit in several cases which indicates that indoor particles may have a higher adverse effect on human health. Both ascorbate and glutathione oxidation were associated with mainly traffic related air pollutants (i.e., Cu, Fe).

Th-P-06
Role of solid-liquid separation method on the bioaccessibility of metals and metalloids in contaminated soil

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Abstract: The characterization of human exposure to soil metal contaminants typically relies upon the default assumption of 100% bioavailability; however, this assumption is overly conservative in many scenarios. In vitro gastrointestinal (GI) models offer exposure assessors a rapid and affordable tool to decrease this source of uncertainty through the surrogate endpoint of bioaccessibility. In vitro bioaccessibility, which is operationally defined according to the GI model parameters, represents the percent of a soil-bound contaminant that is solubilized into simulated GI fluids. Different GI models have varying approaches (e.g. centrifugation, microfiltration, ultrafiltration) by which the solid-phase is separated from the liquid-phase following in vitro extraction. The objective of this research was to explore the bioaccessibility of numerous metals (e.g. V, Mn, Co, Ni, Cu, As, Se, Sr, Cd, Sb, Hg, U, Tl, and Pb) within two test materials (Montana Soil: NIST2711; Mine Site Overburden: YK1) using centrifugation (5000 g; 12000 g), microfiltration (0.45 µm), and ultrafiltration (1000 kDa; 50 kDa; 30 kDa; 10 kDa; 3 kDa). Results indicate that the use of syringe filtration will generally yield the same bioaccessibility as the use of centrifugation and that the speed of centrifugation does not typically affect metal bioaccessibility. However, ultrafiltration yields a significantly lower bioaccessibility than the use of centrifugation and microfiltration. There are rarely any differences between bioaccessibility estimates generated using a low resistance (1000 kDa) and a high resistance (3 kDa) ultrafiltration membrane. The primary exceptions to these trends were observed for Pb in NIST2711 (5000 g > 12000 g > 0.45 µm > ultrafiltration) and for Tl in NIST2711 and YK1 (5000 g ~ 12000 g > 0.45 µm > ultrafiltration). These results provide valuable information to researchers attempting to expand the use of in vitro bioaccessibility beyond soil Pb and As.

Keywords (≤ 5): Bioaccessibility; Bioavailability; In vitro; Metal; Soil

TH-P-07 - Withdrawn

Th-P-08
Determination of mercury and selenium bioaccessibility and bioavailability in Inuit Traditional Foods from Nunavik, Québec using the *In Vitro* Gastrointestinal (GI) Model

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Abstract: This study will use *in vitro* techniques to evaluate mercury (Hg) exposure and selenium (Se) intake *via* traditional foods (TFs) among Inuit communities in Nunavik, Québec. The consumption of TFs provide cultural and economic benefits for Inuit communities. They are an excellent source of essential nutrients including Se. However, environmental contaminants like Hg are present in elevated levels in TFs. Mercury causes harmful health effects disturbing many organ systems however, prior research has shown Se and other nutrients (e.g. antioxidants) can moderate the detrimental effects of Hg; these mechanisms are poorly understood. We will assess the total concentration, speciation and bioaccessibility of Se and Hg these TFs. The objectives are as follows: (1) evaluate the total concentrations of Hg and Se present in TFs, (2) assess the chemical forms of Hg and Se in TFs, and (3) estimate the bioaccessibility of Hg in TFs when co-consumed with TFs rich in Se. We used the *In Vitro* Gastrointestinal (GI) Model to analyze the fraction of bioaccessible Hg and Se in TFs. Preliminary bioaccessibility results show that Ringed seal meat has the highest %Hg bioaccessibility and Arctic char has the lowest. For %Se bioaccessibility, Caribou has the highest and Ringed seal liver has the lowest. Sculpin eggs have the highest Se Health Benefit Value. We will co-digest high Hg TFs (e.g. ringed seal muscle, ringed seal liver, beluga meat etc.) with TFs that may serve as functional foods (such as berries and seaweed) to modify Hg bioaccessibility. We will run a univariate statistics analysis (p-value<0.05) to evaluate if the interaction between Hg and Se is statistically significant and if Se mitigates Hg. These bioaccessibility results will be inputted into an exposure assessment completed by Monte-Carlo simulations to inform public health messaging, risk assessment, and mitigation options for Hg in Inuit foods.

Keywords: Inuit, Bioaccessibility, Risk Communication, Mercury Toxicity, Traditional Foods

Th-P-09
ChemView: EPA's One-Stop Site for Information on Toxic Substances Control Act Chemicals

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Abstract: EPA's Office of Chemical Safety and Pollution Prevention designed, created and implemented an innovative conceptual approach to improve chemical safety and streamline access to information on chemicals regulated under the Toxic Substances Control Act (TSCA) by developing a publicly-accessible, easy-to-use online database called ChemView (www.epa.gov/chemview). ChemView allows users to view information in both summary form and in detail, including links to documents provided to EPA by the regulated community and others, significantly enhancing access to chemical information in a one-stop shop venue. The information made available in ChemView will be useful for assessing exposures to chemicals, as well as the hazards chemicals pose to human health and the environment. The database can help businesses, individuals and others make more informed decisions about the chemicals they use. The initial phase focused on providing easy access to thousands of documents previously accessible only via paper dockets or EPA's files. This information includes: data submitted to EPA by industry (e.g., health and safety data); EPA-developed assessments of chemicals (e.g., hazard characterizations and safer alternative assessments); EPA regulatory actions (e.g., Significant New Use Rules); and manufacturing (including import), processing, use and release data collected by EPA (e.g., Chemical Data Reporting and Toxics Release Inventory data). Pre-defined templates were developed to capture key details from source documents, including information on chemistry, ecotoxicology, and human health endpoints. Summary results provide links to original studies or documents which contain more detailed information. ChemView also links to other Agency databases with key information on TSCA chemicals including EPA's Integrated Risk Information System, and Toxics Release Inventory database. ChemView does not contain any Confidential Business Information. While the current version of ChemView contains a substantial

amount of information, when fully populated, ChemView will contain data for thousands of chemicals regulated under TSCA.

Keywords: Toxic Substances, Chemical Information, Consumer Products, Human and Ecosystem Health

Th-P-10
Estimation of cancer risks of chefs exposed to polycyclic aromatic compounds and aldehydes in cooking oil fumes

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Abstract: Recent researches have reported the association between an increasing cancer risk in chefs and the deep-frying cooking activity. The International Agency of Research on Cancer categorized emissions from high temperature frying into the group 2A. This revealed that emissions from cooking activities had a cancer potential. Therefore, the objectives of this study were to investigate professional chef exposure concentrations of two chemical groups (polycyclic aromatic compounds (PAH) and aldehydes) in cooking oil fumes (COFs) and to estimate corresponding cancer risks of these exposures. Chefs, who performed the cooking styles of deep frying, were included in this study. Sixteen PAHs and seven aldehydes, which are frequently present in COFs, were analyzed. Personal air samples were placed in breathing zone of each chef. The sampling media for PAHs were a Teflon filter (37 mm) and a PUF tube for measuring particulate- phase and gas-phase PAHs; and those for aldehydes were a DNPH-coated glass fiber filter (25 mm) and a 2,4-DNPH cartridge. After sampling, PAH and aldehyde samples were extracted and analyzed by a GC/MS system and a HPLC/UV system. Total PAH mean concentration was 6.499 µg/m^3, including a particulate-phase concentration of 0.303 µg/m^3 and a gas-phase concentration of 6.196 µg/m^3. Abundant PAHs were naphthalene, phenanthrene, dibenz(a,h)anthracene, and benzo(g,h,i) perylene. Total aldehyde mean concentration was 981.0 µg/m^3, including a particulate-phase concentration of 655.2 µg/m^3 and a gas-phase concentration of 325.8 µg/m^3. Abundant aldehydes were acetaldehyde, t-2-heptenal, and t,t-2,4-decadienal; the latter two aldehydes were characteristic chemicals in COFs and had revealed adverse health effects in several animal studies. Increased cancer risks of chefs exposed to total PAH, formaldehyde, and acetaldehyde were 1.76×10^{-5}, 8.12×10^{-6} , and 1.2×10^{-5}. It summed up the total cancer risk of 3.77×10^{-5}. This suggested several chemicals in COFs posed potential cancer risks. Control measures should be implemented to reduce exposure.

Keywords: cooking oil fumes; t,t-2,4-decadienal; particulate-phase; gas-phase

Th-P-11
Personal exposure to PM2.5, PAHs and BC in Ostrava, Czech Republic

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Abstract: Personal exposure to airborne particulate matter ≤ 2.5 µm (PM2.5), carcinogenic polycyclic aromatic hydrocarbons (cPAHs) and black carbon (BC) were measured in Ostrava Czech Republic as a part of CITI-SENSE project creating the citizens observatory community for improving quality of life in cities. Non-smoking volunteer citizens in most polluted part of Ostrava, Radvanice and Bartovice participated in the first (of three planned) biomonitoring campaign in 2013. All participants completed a personal questionnaire and time-location-acitivity diary. The outdoor concentrations of PM2.5 and cPAHs were also measured. The biomonitoring campaign were held in the end of November 2013 and the average outdoor concentrations were 35.4 µg/m^3 of PM2.5 and 5.3 ng/m^3 of benzo[a]pyrene (B[a]P). Average personal exposures were 68.8 µg/m^3 of PM2.5 and 5.5 ng/m^3 of B[a]P. Correlation between outdoor PM2.5 and B[a]P was significant R=0.8, P<0.001. High correlation was found between personal B[a]P exposure and PM10 from stationary outdoor monitoring R=0.8, P<0.001. Because air quality data at personal level are scarce we would like to raise citizens awareness of their environment and increase their ability to recognize and change both their contribution and their exposure to air pollution. With the use of low-cost sensors we plan to create easy-to-use citizens observatory to boost the cooperation between science, citizens and other stakeholders to increase the environmental health governance to improve the quality of life.

Keywords: Air pollution, personal exposure, PM2.5, benzo[a]pyrene, citizen participation

Th-P-12

Risk assessment of roadside PM2.5 using air dispersion model by hybrid approach of CMAQ and CALPUFF in Seoul, Korea

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Abstract: Exposure to these traffic-related air pollutants can contribute to adverse health effects. CMAQ model was subjected to detailed modeling of units of 50m grid in the target Seoul all regions. The emission of air pollutants mobile pollution source that is used in CALPUFF model, using the data of the road network, it is calculated in detail resolution units 50m grid. PM2.5 contribution road deaths that target population of the entire Seoul was calculated via the PM2.5 concentration occurring by road PM2.5 concentration ratio are exposed to the entire population. Result of the analysis of the report of the floating population of Seoul entire city, near the 15 region Dongdaemun-gu measurement network, and was the most frequent in the 301,090 person-months average, and near Seongbuk-gu, internal circulation path measurement network, 30,730 man-months average in the fewest. The result of the number of deaths was calculated chronic death toll of the average of one month in accordance with the PM2.5 concentration by the results of modeling. Excess mortality was calculated via the density due to the PM2.5 concentration ratio roadside analyzed. PM2.5 contribution target road mortality of Seoul whole was about 16 percent. Mortality of PM2.5 by hybrid model of top 10 points on the road contribution concentration was about 28%. Hourly results, Contribution road death toll was the highest in 53 people between 9:00 to 8:00 of attendance time zone. Closing hours of 17:00 and 19:00, respectively 41 people, 46 people with a relatively high number of deaths predicted. Floating population of am 1:00 ~ 4:00 was one that contributed to the death toll road. Result of hybrid modeling Seoul whole, concentration control of the pollutants that are contributing to the road, in the case of PM2.5, the number of deaths has declined every month became 565 people in Seoul.

Keywords: Risk Assessment, Vehicle Emission, CMAQ, CALPUFF

Th-P-13

Homegrown produce consumption among urban community gardeners and household members

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Abstract: Urban community gardens can provide affordable, locally grown, healthy foods and many other benefits, but urban soils can contain lead (Pb) and other contaminants that may pose risks to human health. To evaluate the role of produce consumption as an exposure pathway for contaminants, it is necessary to understand patterns of consumption among urban community gardeners and their households. We asked NYC community gardeners to answer questions about produce consumption and to estimate their total annual harvest for individual crops (in pounds) as well as the percentage of each crop consumed by themselves and other household members. Gardeners also provided independent estimates of daily vegetable consumption and fractions of vegetable intake grown in their own gardens and in other urban gardens. For gardeners, the median estimated consumption of produce they had grown was 0.66 g/kg-day based on harvest estimates and 0.54 g/kg-day based on serving estimates. Overall consumption estimates for adults were in line with values recommended by US EPA for use in risk assessments, while estimates for children tended to be lower than recommended values. Our produce consumption data can help support detailed exposure estimates that consider how consumption of urban community garden produce varies by crop type (e.g., gardeners' median consumption of fruiting vegetables is nearly twice that of leafy vegetables) and by population (e.g., gardeners reported more than twice as much homegrown produce as other adult household members (median 0.66 vs. 0.28 g/kg-day)).

Keywords: Urban agriculture, community garden, produce consumption, lead (Pb) exposure

TH-P-14
Estimated lead (Pb) intakes for urban community gardeners

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Abstract: Urban community gardens can provide affordable, locally grown, healthy foods and many other benefits associated with urban green space, opportunities for recreation and community-building activities, and reduced environmental impacts of food transport and large-scale production. However, urban garden soils can contain lead (Pb) that may pose risks to human health, and associated exposures and risks remain poorly defined. To help evaluate the potential risks, the Healthy Soils, Healthy Communities partnership of Cornell University, Cornell Cooperative Extension, the New York State Department of Health and the New York City (NYC) community gardening organization GreenThumb addressed community concerns through collaborative research to inform the development of education and public health action strategies. We collected information for NYC community gardens on concentrations of Pb in soil, vegetables and chicken eggs as well as vegetable consumption and time spent in the garden. Based on this information, we estimated Pb intakes using deterministic and probabilistic methods for adult gardeners, children who spend time with their parents in the garden and adult household members. Central tendency Pb intakes were all below provisional total tolerable intake (PTTI) values for adults and children, although reasonable maximum exposures exceeded the PTTI. Children visiting the garden had exposures driven by higher soil and dust ingestion rates and exposure to soil between the beds. Adult gardeners' Pb intakes were comparable to children's (in µg/day) but were dominated by vegetable consumption. Household members who did not visit but ate produce from the garden had the lowest exposures. Consumption of garden-raised chicken eggs generally accounted for less exposure than the other pathways. Our results suggest that healthy gardening practices for reducing Pb exposure should target the vegetable consumption pathway for adult gardeners and the soil ingestion pathway for visiting children.

Keywords: Urban agriculture, community garden, urban soil, lead (Pb) exposure

Th-P-15
Characterization of Personal PM$_{2.5}$ Carbonaceous Fraction Exposure of Children, Tianjin

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Abstract: Particulate matter has already been the primary pollutant of most cities in China. Among PM, PM$_{2.5}$ has a closer relationship with human (especially the elderly, children and other vulnerable population) health effect. Considering the exposure error using ambient PM$_{2.5}$ data as surrogate, personal PM$_{2.5}$ sampling was likely to evaluate the characterization of personal exposure precisely. In this study, 36 children in Tianjin were volunteered to collect personal PM$_{2.5}$ exposure samples during non-heating period and heating period in 2010. Carbonaceous fraction of samples was analyzed and potential sources of carbonaceous composition were described. The average concentrations of organic carbon (OC) and element carbon (EC) were 29.16±12.62 and 3.25±1.70 µg/m^3 in non-heating period, 37.56±18.48 and 8.73±4.13 µg/m^3 in heating period. The concentration of secondary organic carbon (SOC) was calculated to be 20.20 and 26.47 µg/m^3, which accounted for 68% and 70% of OC during two monitoring periods. Weak correlations between OC and EC were obtained in both periods, and the ratio of OC and EC (OC/EC) distributed in the range of 2.3~16.0, with the average values of 9.6 and 5.2 in the two periods, respectively. Thus, OC and EC of personal PM$_{2.5}$ exposure were derived from different sources. The average concentrations of OC1, OC2, OC3, OC4, EC1 and EC2 in the non-heating season and heating season were 8.49, 5.66, 7.44, 3.59, 6.75, 0.47µg/m^3 and 5.56, 7.99, 11.44, 7.65, 13.36, 0.25 µg/m^3, respectively. The significant difference ($p < 0.05$) of OC1 was found between the two monitoring periods, which was influenced by the biomass burning in Tianjin. The characteristic ratio of PAHs showed that coal burning and vehicle emission were the main sources of personal PM$_{2.5}$ exposure.

Key Words: PM$_{2.5}$, Personal Exposure, Carbonaceous fraction, Children

Health risks from the exposure of children to As, Se, Pb and other heavy metals near the largest coking plant in China

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Abstract: Background: Coking influences environmental quality and poses high risks to human health as large amounts of heavy metals and metalloids are emitted into the environment from coal during the coking process, particular for Chinese coals, which have higher contents for most heavy metal(loid)s when compared to those from other countries. Health risks of heavy metal(loid)s depend heavily on multi-pathway and element-specific exposures, which have, unfortunately, been rarely studied in the vicinity of coal-related industrial areas. The objectives of this paper is to 1) quantify the exposure levels of children to heavy metal(loid)s and their contribution from each medium and 2) estimate the children's health risk to heavy metal(loid)s exposures according to the Hazard Index and cancer risk. **Methods:** Children's health risks and exposure levels to As, Se, and heavy metals (Pb, Cd, Cr, Ni, Co, Zn, Cu, Mn, V and Sb) in the water, soil, dust, air and locally produced food were studied based on field sampling and questionnaire-based surveys around the largest coking area in China. **Results:** The environmental media were slightly polluted in the vicinity of the coking plant. The non-carcinogenic risks to children mainly resulted from Cr, Mn, Pb, As and Sb, the levels of which were 3 to 10 times higher than the acceptable levels (1.0×10^{-6}). The carcinogenic risks to children were 30 to 200 times higher than the safe level (1.0×10^{-6}-1.0×10^{-4}), which could be attributed to Cr, As and Ni pollution. The estimated risks mainly came from the pathway involving the ingestion of locally produced food, accounting for more than 85% in total for most elements. For As, the food ingestion and air inhalation exposure pathways both contributed approximately 50%, respectively. **Conclusion:** The high risks in this study highlight the attention paid to the health of children who live in the vicinity of coking activities and the importance of site-specific multi-pathway health risk assessments and food safety to protect potentially exposed children.

Key Words: children, heavy metals, coking plant, exposure, health risk

Exposure to PM$_{2.5}$ and health effects: a cross-sectional analysis

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Abstract: Taiwan (R.O.C.) Environmental Protection Agency (EPA) promulgated new National Ambient Air Quality Standards for PM$_{2.5}$. It included 35 µg/m^3 for PM$_{2.5}$ 24-h standard and 15 µg/m^3 for annual standard in reference to the air quality standard. These new restrictions aroused considerable attention due to lack of information on actual human exposure to PM$_{2.5}$ in Taiwan. Although substantial monitoring data have been collected and analyzed, this project aimed to understand the quantitative relationships between outdoor measures of airborne PM and actual personal exposure to PM. Furthermore, this project also explored the exposures to biologically important constituents and specific characteristics of PM that cause responses in the general population. Our general objective was to assess the relations between personal exposure to ambient PM$_{2.5}$ and health effects (pulmonary and cardiovascular disease markers, inflammation and oxidative stress markers, antioxidant enzymes and genotoxicity markers). For this longitudinal study, we recruited 94 subjects from 2 different areas (Area A [residential and commercial area] and Area B [industrial area]) in Taipei Metropolitan at baseline. We used personal samplers to collect 24 hours PM$_{2.5}$ exposure samples. The study population underwent an interview and a health examination on the next day morning, where blood and urine samples were collected. All of subjects were repeated measured after two months for two times of follow-up. Our current aim was to investigate pulmonary and cardiovascular disease markers, inflammation and oxidative stress markers, antioxidant enzymes and genotoxicity markers at baseline. Results: We found the geometric mean PM$_{2.5}$ levels from personal sampling were 23.5 (GSD 0.2) and 52.6 (GSD 0.5) µg/m^3, in Area A and B, respectively. While geometric mean PM$_{2.5}$ levels from monitoring station were 11.2 (GSD 0.1) and 49.4 (GSD 0.5) µg/m^3 at baseline (February, 2014). A positive correlation between outdoor monitoring station measures of

airborne PM and actual personal exposure to PM was found (r=0.645, p<0.05). After adjusted for confounders, Area A subjects have higher urinary 8-OHdG levels and lower antioxidant enzymes compared to that of Area B. While Area B subjects have higher urinary N^7-MeG levels compared to that of Area B. Lung function test parameters and cardiovascular markers (vascular cell adhesion molecule [VCAM-1], Hs-CRP, Fibrinogen, SDNN, RMSSD, WBC, Platelet) were not associated with different areas at baseline period. Conclusions: Our preliminary data showed there was positive correlation between outdoor monitoring station measures of airborne PM and actual personal exposure to PM. Subjects exposed to higher $PM_{2.5}$ have higher genotoxicity levels. Further analyses are needed to explore individual variability in the repair of DNA and relation with $PM_{2.5}$ exposure.

Keywords: $PM_{2.5}$, pulmonary and cardiovascular markers, inflammation and oxidative stress markers, antioxidant enzymes

Th-P-19
Toxidromes - A decision-making tool for early response to chemical mass exposure incidents

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Abstract: A common language to describe and recognize clinical manifestations of toxic chemical exposures is essential for emergency responders and hospital first receivers to be prepared to provide rapid and appropriate medical care for victims of industrial chemical mass exposures and terrorist attacks. In these situations, when the identity of the chemical is not known, first responders need a tool to rapidly evaluate victims and identify the best course of treatment. Military and civilian emergency response communities use a "toxic syndrome" (toxidrome) approach to quickly assess victims and determine the best immediate treatment when information on chemical exposures is limited. Toxidromes can be defined by a unique group of clinical observations, such as vital signs, mental status, pupil size, mucous membrane irritation, and lung and skin examinations. Data on over 20 toxidrome systems were evaluated to identify salient features and develop a consistent lexicon for use by state, local, tribal, territorial, and federal first responders and first receivers. A workshop of over 40 practitioners and experts in emergency response, emergency medicine, and medical toxicology developed names and definitions for 12 unique toxidromes that describe and differentiate the clinical signs and symptoms from exposures to chemicals. These toxidromes focus on acute signs and symptoms caused by inhalation and dermal exposures. Each toxidrome is characterized by exposure routes and sources, organs/systems affected, initial signs and symptoms, underlying mode of action, and treatment/antidotes. Toxidrome names and definitions are designed to be readily understood and remembered by users. Communication in a crisis requires accurate and succinct terms that can quickly convey the health conditions of patients. These toxidromes lay the foundation for a consistent lexicon, that if adopted widely, will improve response to chemical mass exposure incidents.

Keywords: First responders, Toxidromes, Terrorism, Risk Communication, Mass Exposure Incidents

Th-P-20
Multiple imputation for assessment of to drinking water contaminants: Evaluating with the Atrazine Monitoring Program

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Abstract: Drinking water may contain pollutants that harm human health. The frequency of pollutant monitoring may occur quarterly, annually or less frequently, depending upon the pollutant concentration and community water system. Birth and other health outcomes, however, are associated with narrow time-windows of exposure, such that infrequent monitoring impedes linkage between water quality and health outcomes for epidemiological analyses. The objective of this study is to evaluate the performance of multiple imputation to fill in water quality values between measurements in community water systems. The multiple imputation method was implemented in a simulated setting using data from the Atrazine Monitoring Program (AMP, 2006-2009 in five Midwestern states). Values were deleted from the AMP data to leave one measurement per month. Four patterns reflecting drinking water monitoring regulations were used to delete months of data in each water system. Three patterns were missing at random and one pattern was missing not at random, and deleted 65-92% months of atrazine observations. Synthetic health outcome data were created using a linear and Poisson exposure-response relationship with five and four levels of hypothesized association, respectively. The multiple imputation method was evaluated by comparing the exposure-response relationships estimated based on

multiply imputed data with the hypothesized association. Even with the high rates of missing information, our procedure was able to recover most of the missing information for missing at random patterns and for missing not at random patterns with low-to-moderate exposure-response relationships. Multiple imputation appears to be an effective method for filling in water quality values between measurements.

Keywords: Multiple imputation, atrazine, drinking water, environmental public health tracking

Th-P-21

Quantifying the entrainment of carbon black nanoparticles from surfaces by impinging air jets

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Abstract: The removal and inhalation of particles from nanoparticle coatings is a growing concern in the environment. In order to better understand the effects of these released nanoparticles on human health, the particles must be quantified in both their size and concentration distributions. To simulate conditions in the environment, a fine layer of carbon black aerosol nanoparticles was deposited onto a glass substrate through diffusional deposition of a low flow of air containing carbon black particles. The resulting aggregates ranged from approximately 40 nanometers to 20 micrometers. The substrate was passed through a series of air jets, and the amount of remaining carbon along the center of the surface was measured each time. By finding the surface area coverage at a location on the slide measured by scanning electron microscopy and assigning it to the intensity fraction at the same location measured by the optical setup, the optical readings were calibrated. The calibration data was used to interpolate the surface coverage based on further optical measurements. Preliminary experiments have indicated a removal of about 0.5 percent surface coverage. As experiments continue, the procedures for each setup are further refined to allow for greater sensitivity in capturing the removal of carbon black particles from the surface. In addition, these data will be used for modeling the size and concentration distributions of particles given re-entrainment parameters.

Keywords: nanotechnology, nanotoxicology, indoor air quality, reentrainment, adhesion

Th-P-22

The association of socio-demographic status, lifestyle factors and dietary patterns with total urinary phthalates in Australian men

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Abstract: Objective: To investigate the associations between socio-demographic status, lifestyle factors, dietary patterns and urinary total phthalate concentration in a cohort of South Australian men. **Method:** We randomly selected 1527 males aged 39 to 84 from wave two of the Men Androgen Inflammation Lifestyle Environment and Stress (MAILES) study. Total phthalate concentration was examined in fasting morning urine samples. Socio-demographic and lifestyle factors were assessed by questionnaire. Food intake was assessed by food frequency questionnaire (FFQ). Dietary patterns were constructed using factor analysis. **Results:** Total phthalates were detected in 99.6% of the urine samples. The overall geometric mean (95% CI) of total phthalate concentration was 112.5 (107.7-117.6) ng/mL. The least square geometric means (LSGMs) of total phthalate concentration were significantly higher among people who were obese (126.2 ng/mL), consuming less than two serves fruit per day (124.7 ng/mL) and drinking more than one can (375mL) of soft drink per day (137.0 ng/mL). Two dietary patterns were identified: a prudent dietary pattern and a western dietary pattern. Both the western dietary pattern (p=0.002) and multiple lifestyle risk factors including smoking, obesity, insufficient physical activity and the highest quartile of the western dietary pattern ($p<0.001$), were positively associated with total phthalate levels. There was no significant relationship between total phthalate concentration and socio-demographic status. **Conclusion:** Phthalate exposure is ubiquitous and positively associated with lifestyle risk factors in urban dwelling Australian men.

Key words: urinary total phthalates; dietary patterns; lifestyle; socio-demographic; Australian male adults

Th-P-23

SpaRTANZ: Spatial Saturation Monitoring for Fine Particulate Matter and Black Carbon across Auckland, New Zealand

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Abstract: Background: SpaRTANZ (Spatially-Resolved Technique for Source Apportionment in New Zealand) is a spatial monitoring campaign designed to capture intra-urban variability in fine particulate matter ($PM_{2.5}$) and black carbon (BC) across Auckland, New Zealand, where heavy traffic congestion, bus density, and port activities are common. A similar sampling approach previously occurred in Pittsburgh, where much pollution is regionally attributed. For Auckland, it is anticipated that the pollution is locally driven. **Methods**: Spatial distributions of pollution sources (i.e., total traffic, truck/bus traffic, and distance to port) were explored via geographic information systems (GIS). Sampling locations (n=12) were allocated to capture spatial and source variability across the Auckland domain (~5 km^2). Sampling occurred over 4 week-long Monday through Friday sessions in April 2014, in which air monitors were programmed to sample 7AM-7PM, in an attempt to capture work-related exposure hours. **Results**: We found temporally-adjusted mean $PM_{2.5}$ concentrations of 6.80 ± 1.73μg/m^3, and mean BC absorbance of 2.08 ± 1.02 abs. We found higher $PM_{2.5}$ concentrations at sites with high traffic, high bus/truck, and near the port (9.63 ± 0.18μg/m^3) compared to low traffic, low bus/truck, far from port (4.38 ± 0.39μg/m^3). We found similar results for BC absorbance values. In comparison to Pittsburgh, concentrations in Auckland were, on average, lower, possibly due to a lack of regional pollution.
Conclusions: Spatial variability in locally-derived $PM_{2.5}$ was found in the SpaRTANZ sampling campaign of work-week exposures in Auckland. Trace metals data will soon be analysed, and factor analysis performed. Land use regression (LUR) modeling of $PM_{2.5}$ will determine potential source covariates. In addition to this campaign, a 3-week day and night filter sampling approach was also performed in Christchurch, New Zealand, in an attempt to disentangle woodsmoke and traffic-related emissions.

Keywords: Black carbon, Fine particulate matter, Spatial saturation monitoring

Th-P-24
Approaches to Improving Professional Judgment

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Abstract: Professional judgment is guided by many inputs; some are subjective, e.g. 'mental models' and some are objective. How accurate are decisions guided by professional judgment, and do the inputs and the way in which they are incorporated into the assessment influence exposure judgment accuracy? Qualitative exposure judgment accuracy, based on subjective inputs is low (mean ~ 30%), motivating the development of a new tool, the "Qualitative Exposure Assessment Checklist Tool", providing objective input to professional judgment. Comprised of 3 heuristics, it is based on physical chemical principles and was refined empirically, through experience. The Checklist provides an ordered approach for applying these principles, and is applicable to volatile and semi-volatile vapor, fiber, aerosol and particulate exposure scenarios. Requiring only four pieces of information: the OEL, vapor pressure of the pure chemical (for vapors), the observed workplace control measures and the 'required level of control', the tool is easy to use and is freely available from the American Industrial Hygiene Association Exposure Assessment Strategies Committee. This influence of this tool on qualitative exposure judgment accuracy was evaluated in a series of workshops in which participants evaluated exposure scenarios, in the absence of personal exposure measurements. Judgments guided by the Checklist were significantly more accurate, ~60 % categorical accuracy, based on the AIHA Exposure Assessment Strategy, and ~ 70% accurate and accurate or overestimating by one exposure control category. The workshop results strongly support the use of this objective tool over other subjective inputs to professional judgment.

Keywords: Qualitative exposure assessment, Professional Judgment

TH-P-25
Control of respirable crystalline silica exposure from cutting fiber-cement siding
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Abstract: Workplace exposure to respirable crystalline silica can cause silicosis, a progressive lung disease marked by scarring and thickening of the lung tissue. Fiber-cement products can contain as much as 50% crystalline silica and cutting this material has been shown to cause excessive exposures to respirable crystalline silica. NIOSH scientists conducted this study to develop engineering control recommendations for respirable crystalline silica from cutting fiber-cement siding. Detailed characterization of the dust generated from cutting fiber-cement siding was conducted in a laboratory setting. Respirable dust was sampled and analyzed using a variety of instruments. The dust size distribution and the silica distribution in the dust of different sizes were analyzed in detail for cutting fiber-cement siding from four major manufacturers. The generation rate of respirable dust was analyzed and compared for cutting fiber-cement siding using different power tools (a power shear, four miter saws, and three circular saws), different blades, differing saw cutting feed rate, and cutting different numbers of boards in the stack. The results from the laboratory evaluation suggested that connecting a dust-collecting circular saw to a basic shop vacuum with built-in air filters had the potential to provide a simple and low-cost engineering control measure for the dust generated from cutting fiber-cement siding. Four field surveys were conducted to validate the effectiveness of the engineering control measure. The survey results showed that the 10-hour time weighted average (TWA) exposure to respirable crystalline silica for the workers who mainly cut fiber-cement siding on the job sites was well under control, with the 95% upper confidence limit being only 24% of the NIOSH Recommended Exposure Limit (REL) of 0.05 mg/m3. This engineering control measure effectively reduced occupational silica exposures, and provided an effective, simple and low cost solution for workers cutting fiber-cement siding.

Keywords: respirable dust, crystalline silica, fiber-cement, engineering control

Th-P-26

A comparison study of location and activity monitoring for exposure studies

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Abstract: The proliferation of smartphone applications (apps) and fitness monitors provides new and less expensive methods for tracking participant time-location-activity patterns in exposure studies. As part of the Health and Environment-wide Associations based on Large population Surveys (HEALS) project, this study examines the feasibility of using the Moves app and two commercially available fitness monitors – the Fitbit Flex and Activ8 – for tracking people's location and activities. Four participants per city (Edinburgh and Zeist) wore these devices along with a GPS device and Actigraph for comparison for a week. A temperature logger was also worn to detect changes between indoor and outdoor conditions. A time-activity log was filled out on paper by participants for each day. A preliminary trial shows high correlation between two Fitbit devices and a lower correlation between Moves and Fitbit step counts. Moves enables both tracking of location and activity, but because it requires an individual to carry a phone at all times, tends to give lower step counts than Fitbit, which is worn on the wrist. Further analysis will compare the Moves, Fitbit, and Activ8 data with GPS and Actigraph data for participants in several European cities under varied climate conditions. This investigation will provide information on the utility of several commercial devices as modular add-ons to exposure studies.

Keywords: time-activity, GPS

Th-P-27

Diffusive Monitoring - A Cost Effective and Quantative Approach to Workplace Monitoring

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Abstract: Diffusive monitoring is widely used in Europe of personal monitoring and has been the method of choice for replacing solvent extraction techniques. By eliminating the requirement for a sampling pump, diffusive monitoring provides a simple and cost effective method of collecting the large number of samples required in many air monitoring programmes.

Key applications include:
• personal exposure monitoring
• large-scale environmental studies
• indoor air monitoring

Many types of diffusive sampler are available for monitoring and the decision on the type of sampler depends on the monitoring scenario. Early diffusive samplers were badge type designs, with large cross sectional areas and short path lengths and they suffered from severe restrictions because of air speed effects at the surface of the badge. The stable conditions required for diffusion according to Fick's Law could never effectively be established. Badges are also unsuitable for analysis by thermal desorption/gas chromatography. In 1979 Working Group 5 of the UK Health and Safety Executive specified a 3.5 inch x 1/4 inch O.D. tube-type diffusive monitor, compatible with thermal desorption, that has now been accepted as an 'Industry Standard'. The first keynote publication detailing the design was published in 1981[1].

This paper will discuss the principles of diffusive monitoring, different types of samplers available; focusing on sorbent selection and details of deployment in real personal monitoring situations.

[1.] Brown, R. H., Charlton, J., Saunders, K. J. (1981) The development of an improved diffusive sampler. Am. Ind. Hyg. Assoc. J. 42(12), 865-869.

Th-P-28

Mercury in Ecological Media and Human Biomarkers in Ghana: A Review

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Abstract: Artisanal and small-scale gold mining (ASGM) is the largest source of anthropogenic mercury emissions to the atmosphere. Numerous studies have aimed to characterize the extent of mercury (Hg) pollution in ASGM communities, miners, and the surrounding environment. Though less frequently studied, other metals, such as arsenic (As), lead (Pb), and cadmium (Cd), which may be associated with gold ore, may pose an additional hazard. In Ghana, the second largest producer of gold in Africa (10.5% of which is from ASGM), the data on mercury and other heavy metals in humans and the environment have not yet been synthesized. This paper will synthesize available datasets concerning Hg, As, Pb, and Cd in ecological media (soils, sediments, water, seafood, and plants) and human biomarkers (urine, hair) across Ghana. To date, 62 papers have been found and reviewed. In brief, concentrations of Hg in soils and sediments are higher in mining areas than non-mining areas, and in many cases exceed US EPA guidelines. Several studies found elevated As in soil and sediment. Hg concentrations are below WHO standards in water samples, but some studies found Pb, As, and Cd concentrations above WHO standards. In general, fish species at high trophic levels show higher Hg concentrations than those at lower trophic levels. Approximately 25% of fish samples exceeded EPA guidelines. Concentrations of Hg, Cd and As in edible plants are elevated in some mining areas. In humans, urinary As exceeded US reference values in two studies. Urinary and hair Hg concentrations vary greatly among miners and mining communities and in most cases exceed reference values. Some non-miners had urinary Hg concentrations far greater than those of miners. Given elevated levels of several heavy metals in various media in ASGM areas, further research and interventions should be considered to minimize ASGM-related metals exposure.

Keywords: heavy metals, mercury, small-scale gold mining, Ghana

Th-P-29

Developing Community-Engaged Results Report-back Materials for an Environmental Exposure Study in a Rural Arizona Community near a Superfund Site

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Abstract: In the past, biomonitoring and multimedia exposure studies have developed individual results report-back materials with varying levels of participant and stakeholder input. By not involving participants and stakeholders, study organizers may overlook the environmental health interests of the study participants and their community, culminating in report-back materials that are less relevant or informative for those most affected by the results. To ensure our study report-back materials were tailored to environmental health interests of participants and community members in a rural Arizona town near a Superfund-designated mining waste site, we involved participants as well as community and government stakeholders in developing report-back materials. The Metals Exposure Study in Homes tested for metals, previously found in high concentrations at the Superfund site, in biological (i.e, urine, toenails, blood) and environmental (i.e., water, yard soil, house dust) samples in 70 children from 34 homes from the surrounding community. During the study, participants received two printed household-specific report-back packets. The first packet, sent only to participants, compared their household's individual results to environmental and health guidelines. After each participating household received the first packet, the study manager contacted the household to address any concerns and ask how the packet could be more helpful and informative. After sampling ended, a participants-only meeting was held to address additional concerns and solicit feedback on content and graphics for a second report-back packet that would summarize study findings. For this second packet, the community advisory board and relevant state and federal environmental health officials suggested changes in layout and the creation of environmental exposure infographics, for which there were no preceding examples. By consulting participants, community leaders, and government stakeholders, we customized the study report-back materials to include environmental health information of interest to participants and community members that may not have been included otherwise.

Keywords: report-back, environmental exposure, community-engaged research, Superfund, arsenic

Th-P-30

Childhood Respiratory Illness Prevalence and Geographic Risk Factors in Southern Arizona

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Abstract: Objectives: Lower respiratory illnesses (LRIs) are the leading cause of death in children, and LRIs and asthma are associated with numerous morbidities. Although environmental and social risk factors have been identified for these diseases, few studies have examined them together. We analyzed relationships between counts of emergency room (ER) visits with a diagnosis of asthma and LRIs in children ages 0-4 years by census tract and geographic risk factors, including lower socioeconomic status (SES), poorer housing conditions, and increased air pollution. Methods: ER visits for asthma and LRIs (i.e. bronchitis, pneumonia, bronchiolitis and croup) were summed to create principal diagnosis case counts by census tract for Maricopa and Pima Counties, Arizona during years 2005-2009. Because individual variables are often highly correlated, we developed geographic risk factor indices for SES, housing conditions and air pollution by conducting principal component analyses of 2005-2009 American Community Survey and 2005 EPA National-Scale Air Toxics Assessment data. We assessed relationships between asthma and LRI counts and these factors using multiple negative binomial regressions with an offset of the log transformed population of children ages 0-4 years for each tract.   Results: In 829 census tracts, the median of ER visits was 1 (range: 0-16) for asthma and 49 (range: 0-943) for LRI diagnoses. ER visits for LRIs were significantly associated with lower SES (IRR=1.08, 95%CI 1.06-1.10) and increased air pollution (IRR=1.02, 95%CI 1.01-1.02), but not with poorer housing conditions (IRR=0.99, 95%CI 0.94-1.05). Model residuals exhibited significant spatial autocorrelation (p=0.002). Conclusions: Lower SES and increased air pollution exposure are independently associated with ER visits for asthma and LRIs in children ages 0-4 years. Poorer housing conditions were not associated with these diagnoses after accounting for SES or air pollution. However, additional exposures should be considered to explain excessive rates of childhood respiratory disease and residual spatial autocorrelation.

Keywords: respiratory illness, environmental exposure, geographic risk

Th-P-31

Intake risk assessment of heavy metals in Korea – marine & agricultural products

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Abstract: According to several news reports on food contamination in Korea, the general population is exposed to potential ingestion of heavy metals from marine and agricultural products on the domestic market. Koreans' dietary habits of consuming internal organs and raw vegetables increase their dietary ingestion risk of heavy metals. The objectives of this study were to estimate the intake doses of heavy metals(Pb, Cd, Hg, As, Al) and to assess potential health risks posed by agricultural and marine products on the Korean market, considering food consumption patterns by age groups. The ultimate aim is to identify dietary patterns that may reduce the risk of ingestion of heavy metals. The total average daily intake of Pb in marine&agricultural products was 0.203 µg/kg-day, and the total average daily intake of Cd was 0.302 µg/kg-day, and the total average daily intake of Al was 5.996 µg/kg-day, and the total average daily intake of Hg was 0.068 µg/kg-day, and the total average daily intake of As was 3.636 µg/kg-day. The intake of Pb, Cd, Al, and As via ingestion of marine products was high, with seaweed and mollusk mainly responsible for the high intake. And the intake of Cd, As, and Hg via ingestion of agricultural products was high, with Cereal and Vegetable mainly responsible for the high intake. The percent of intake to the PTWI of Pb, As(includ Inorganic As), Hg and methyl-Hg were below about 20%. However, in case of Cd, marines products(specially mollusks) and agriculturals products have the slightly high contribution rate. And in case of Al, agriculturals products(specially vegetables) have the slightly high contribution rate. The concentration of Cd and Al in food were higher than that of other metals. The daily ingestion doses of Pb, Hg and As in food were below 20% of the PTWIs, respectively. And the concentration of Al in food were higher than that of other metals from the agriculturals products. Steps are needed to prevent the ingestion of heavy metals via consumption of marine and agricultural products. In the marine products group, consumption of mollusks was mainly responsible for exposure to heavy metals. Caution is needed with regard to the intake of food by sensitive groups. In the case of agricultural products, rice is primarily responsible for exposure to heavy metals due to characteristic Korean dietary habits. A mixed diet containing various cereals is recommended to ensure an adequate intake of nutrients.

Keywords: Food intake, heavy metal, risk assessment, marine and agricultural products

Th-P-32
Examining Environmental and Social Predictors of Asthma Hospitalization in the St. Louis Region
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Abstract: Background - The St. Louis region has a number of industrial operations and an extensive network of interstates and roads, all of which contribute to air pollution and public health outcomes. Disparity in exposure to pollutants in combination with access to preventive care and management can contribute to poor health outcomes, such as elevated emergency room visits for asthma in the region. **Methods -** This TRI University Challenge Project used public data from the EPA's TRI and NATA databases to map and analyze toxic emissions sources alongside key health and sociodemographic factors for the metro region. Locations and air releases (lbs) for all facilities reporting respiratory-health related releases to TRI in all ZIP codes in the eight-county region were analyzed and mapped for 2010. Sociodemographic indicators from the 2010 Census and the 2011 American Community Survey 3-year estimates were mapped at the ZIP code level. Asthma hospitalizations by ZIP code (ages 15+) for the year 2010 came from Missouri and Illinois state health departments. Spatial analysis using GIS and linear regression analysis was conducted to determine any significant environmental or social predictors of asthma hospitalization in the region. **Results -** Significant clustering of asthma hospitalization rates was found in ZIP codes in north St. Louis City and north St. Louis County in Missouri, and western Madison, Monroe, and St. Clair Counties in Illinois. 2005 point-source emissions accounted for only 2% of the respiratory risk from air emissions in the region, while mobile sources and secondary sources accounted for over 97%. **Conclusions -** Results are consistent with previous research showing higher rates of asthma hospitalization in minority and low-income communities. Further research should examine asthma hospitalizations over time, as well as mobile sources of pollution and patterns of air dispersion in the region, which could affect secondary source formation.

Keywords: Asthma, TRI,

Th-P-33
Evaluation of a Population of Sex Offenders in Oakland, California, Using CalEnviroScreen Version 1.1: A Case Study
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Abstract: Low socioeconomic status (SES) neighborhoods bearing disproportionate pollution burdens have been referred to as environmental justice (EJ) communities. To identify EJ communities, California's Office of Environmental Health Hazard Assessment (OEHHA) developed a screening tool (CalEnviroScreen) incorporating data for social and environmental exposure metrics. The purpose of this study was to examine whether classified sex offenders, who comprise approximately ten percent of California inmates and who often locate to low SES neighborhoods upon release, resided in Oakland, California neighborhoods bearing relatively high pollution burdens on a selected date in April of 2013. To this end, publicly available residency data for registered offenders living in eleven Oakland zip codes was obtained. Using the CalEnviroScreen tool and 2010 census data, the distribution of registered offenders was examined. Two-sample tests for binomial proportions were performed to examine offender distribution, and the likelihood of offenders to live in zip codes characterized by high pollution burdens was considered. Offenders tended to be overrepresented in lower income zip codes and, overall, were unequally represented in eight of eleven zip codes (p < 0.05). As compared to the general population, significantly more offenders resided in zip codes having a pollution burden score (PBS) of at least 5 (out of 10) (p < 0.05). This information alone cannot be used to determine whether these individuals are at an increased risk of certain adverse health outcomes. However, the results support previous studies suggesting that individuals of low SES, including released sex offenders, are disproportionately burdened by multiple pollution sources that could, in principle, put them at an increased risk of some adverse health outcomes. This study points to potential future uses of the CalEnviroScreen tool in chemical exposure assessment and environmental justice analyses of populations for whom publicly available residency data is available.

Keywords: environmental justice, exposure screening, socioeconomic status, pollution

Th-P-34

Assessing Risk of Exposure to Nickel by Environmental Air Pollution in Nova Scotia by Analyzing Toenail Nickel Content

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Abstract: Environmental air exposure to nickel (Ni) has been associated with a range of negative impacts on health. Ni has been identified as toxic and a possible human carcinogen. Ni exists in air by natural and human influenced processes. Though this heavy metal is potentially harmful to health it is not commonly measured in air. It has been previously assessed as a component of fine particulate matter ($PM_{2.5}$) which is a more commonly measured air pollutant. This project seeks to explore the association of Ni in air with $PM_{2.5}$ in order to identify the potential for $PM_{2.5}$ as a proxy measure for Ni exposure. It will also identify the relationship with Ni in the body, as estimated by toenail Ni content. To explore these objectives the Pearson correlation between air Ni and $PM_{2.5}$ will be performed to identify the appropriateness of $PM_{2.5}$ as a proxy indicator for Ni exposure from air pollution. Further, linear regression will be used to examine the relationship with $PM_{2.5}$ in air and Ni in the body. Environmental (geology, precipitation, and urban development) and individual variables (smoking, tap water Ni, and body composition) will be included in the analysis as co-variables. Some studies have shown that $PM_{2.5}$ is correlated with Ni in air and thus will be an appropriate indicator. The relationship between Ni in toenails and $PM_{2.5}$ is expected to be positive and to improve with the addition of co-variables. The findings of this study will result in a greater understanding of the relationship of $PM_{2.5}$ and Ni in air and Ni in the body.

Keywords: Nickel; Particulate matter; Toenail; Air quality; $PM_{2.5}$

Th-P-35

Health Risk Assessment in Children Exposed to Low Arsenic Levels through Drinking Water from the Yaqui Valley, Sonora, Mexico

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Abstract: Chronic environmentally high arsenic exposure is associated with the syndrome of human arsenicism, including the central nervous system, peripheral nervous system, urinary system, integumentary system, gastrointestinal system, hematopoietic system, circulatory system and respiratory system. Studies of arsenic exposure to low levels in children (<100 μg As/L) through drinking water are scarce. Children are often considered the most vulnerable group to a variety of environmental contaminants, and they reflect present trends of environmental exposure more accurately than adults. Therefore, the aim of this study was to assess the health risk in children associated with the arsenic intake. The experimental design was cross-sectional, including 80 children from two Yaqui communities; 40 from Potam and 40 from Cocorit in the state of Sonora. First, questionnaires were applied to obtain sociodemographic and health information. Subsequently, the well water of each community was sampled and total As levels were determined by atomic absorption spectrophotometry, obtaining concentrations of 0.047 ppm for Potam and <0.010 ppm for Cocorit. According to the NOM-127-SSA-1994, it was observed that Potam exceeded 1.88 times this value. To determine the non-cancer risk, the methodology established by the US-EPA "Hazard Quotient" (HQ) was used, this calculation is based on the dose of daily As intake from water. The HQ in children from Potam had a mean value of 7.24 +/- 0.794, while for children of Cocorit the average was 1.37 +/- 0.183, finding statistically significant differences (p <0.05). It is important to emphasize that 100% of the HQ values for children from Potam were higher than the reference value (1.0) while for Cocorit children only 17.5% exceeded that value. Therefore we conclude that children from Pótam have higher risk for developing an adverse chronic health effect by exposure to this metalloid.

Keywords: Risk assessment, children, arsenic, drinking water

Th-P-36

Hogs and Health: Spatiotemporal Patterns of Hog Density & Hospitalizations due to Bacterial Pneumonia and Clostridium difficile

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Abstract: It has been demonstrated that individuals living near and working within industrialized livestock production facilities may be at increased risk for various negative health outcomes. Despite the prevalence of clostridium difficile (*c-dif*) and pneumonia-associated bacteria in and around industrial-scale hog facilities, neither *c-dif* associated disease (CDAD) nor community-acquired pneumonia has been analyzed in this context. For the years 1998 to 2002, records with ICD-9 code 482 for bacterial pneumonia and 008.45 for CDAD were abstracted from Center for Medicare and Medicaid Services (CMS) hospitalization database. Using annual hospitalizations and hog inventory data from United States Department of Agriculture (USDA) Censuses and Surveys, we tested the county-level association between hospitalizations and hog density within the Midwestern United States, while controlling for median income, population density and available climatic factors. Because population density may be spatially related to both hogs and disease, counties were first classified into four hog-human population density categories: those with high hog and high human (HH), high hog and low human (HL), low hog and high human (LH), and low hog and low human (LL). General Additive Models show that there may be a multidimensional relationship between population density, hogs and disease. Log linear regressions revealed inconsistent associations across different county classes. While hogs appeared to have a small negative effect on hospitalization rates in HH and LH counties, for LL counties, every additional 100 hogs per square mile resulted in an additional 4 cases of bacterial pneumonia hospitalizations per 1000 people annually. *C-dif* shared this pattern for LL counties, where even after controlling for climate and income, 100 hogs per square mile increases hospitalization by 1.4 per 1000 people annually. Significant interaction between hog density and population density for all classes highlights the complexity of these relationships, and it will require future research to understand more explicitly.

Keywords: CAFO, swine, livestock, bacterial pneumonia, clostridium difficile,

Th-P-37

Lung Cancer Risk from Asbestos Exposure in Petroleum Refinery Workers: A Systematic Review and Stratified Meta-Analysis

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Abstract: Petroleum refineries employ a variety of workers who historically experienced different potentials for asbestos exposure depending on job tasks. To examine the associations between petroleum refinery work and lung cancer related to occupational asbestos exposure, a systematic review and stratified meta-analysis was employed. Inverse variance weighting assuming random effects was used to combine SMR/SIR data separately for all male and female refinery workers, as well as SMR/SIR and RR/OR measurements for the subset of male maintenance workers, who may have been exposed to higher levels. Of 112 studies identified in the literature search, 71 studies were selected for qualitative review, of which 29 were used for meta-analysis. Of studies including risk estimates for maintenance workers at petroleum/petrochemical refineries, three studies controlled for smoking, the strongest risk factor of lung cancer, and of those none found a statistically significant increase for lung cancer risk. Males in cohorts consisting of all refinery workers, which included both blue and white collar workers, had a meta-Risk Ratio (mRR) of 0.80 (95% CI: 0.75-0.85) when compared to population controls, all female refinery workers had an mRR of 1.27 (95% CI: 0.86-1.87) when compared to population controls. Male maintenance workers exhibited an mRR of 0.88 (95% CI: 0.74-1.05) with population controls, and an mRR of 1.62 (95% CI: 1.30-2.03) when internally compared to other refinery workers. This large differential in risk estimates for the same population could be related to sampling biases in opposite directions: population controls are subject to the "healthy worker effect", while internal comparisons may differ from maintenance workers in both socio-economics and smoking rates. Due these potentially confounded and conflicting results, no conclusion could be drawn regarding lung cancer risk for refinery workers. Accurate quantification of lung cancer risk for refinery workers will depend on addressing these issues.

Key Words: Refinery, Lung Cancer, Meta-analysis, Asbestos, Occupational Epidemiology

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Aylward, Lesa	Mo-S-A3-04, Tu-O-C4-03
Azeff, Melanie	Mo-P-21
Azimi, Parham	Su-P-18, Th-O-A1-02

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Bader, Michael	Tu-P-18, Tu-O-C3-04
Bai, Zhipeng	Su-P-21, Su-P-31, Mo-P-19, Mo-O-A4-03, Mo-O-A4-05, We-P-36, We-P-37, We-O-G2-02
Baker, Warren	We-S-D1-01, We-S-D1-03
Bakker, Joost	Th-O-C2-02
Bakker, Martine	Mo-O-G2-02, We-O-B2-04
Balachandran, Siv	Mo-S-D4-01
Baldauf, Richard	We-S-D4-03
Balshaw, David	Mo-S-C2-02, Mo-S-C3-01
Bange, Adam	We-S-B4-01
Banks, Lyndsey	Mo-P-35
Barber, M. Craig	Mo-S-D1-02
Barbero, Ana M.	Tu-S-C1-02
Bare, Jane C.	We-P-13
Barker, Matthew	Tu-P-12

Barr, Dana B.	Su-P-01, Mo-P-02, Tu-O-E1-02, We-S-A3-03, Th-O-D2-03
Barratt, Benjamin	Mo-P-24, We-S-D4-05
Barres, James	Su-P-17, Th-O-C2-03
Bartell, Scott	Su-P-07, Mo-O-F2-02, We-O-C3-02
Bartels, Michael	Tu-P-07
Bartonova, Alena	Tu-P-27
Barzyk, Timothy	Tu-O-G3-01, We-S-D4-03
Batt, Angela	Mo-S-F3-05
Batterman, Stuart	Mo-S-F4-02, Mo-S-F4-03, Mo-S-F4-04, Mo-S-F4-05, Tu-O-G2-05
Bautista, Eddie	Mo-S-B2-02, Mo-S-B2-03, Mo-S-B2-04, Mo-S-B2-05
Baxter, Lisa K.	Mo-S-D4-01, Mo-O-E3-02
Beamer, Paloma	Su-P-35, Su-P-48, Su-P-49, Mo-P-36, Mo-O-D2-03, Mo-S-B3-04, We-P-27, We-P-28, We-P-34
Beane Freeman, Laura E.	Tu-P-33
Beauchamp, Stephen	Mo-O-E2-04
Beaver, Melinda	Tu-S-B2-01
Bechle, Matthew	Mo-S-B4-02
Becker, Allan	Mo-S-D4-05
Beckmann, Gwendolyn	Tu-O-F2-04, Tu-O-F3-04, We-O-B2-04
Beelen, Rob	Mo-S-B4-03
Bekö, Gabriel	Tu-S-C2-02
Bennett, Debbie H.	We-S-F1-03
Bennett, Deborah	Tu-S-E3-02, Tu-S-E3-03, Tu-S-E3-04, Tu-S-E3-05, Tu-O-C4-01, Tu-O-C4-04
Bennett, Patty	Tu-S-G4-03
Benson, Bob	Mo-S-F3-05
Bereznicki, Sarah	Mo-S-F4-01, Mo-S-F4-02, Mo-S-F4-03
Bergeson, Lynn L.	We-S-C4-01
Berman, Jesse D.	Tu-P-02
Bernert, John T.	Mo-S-C4-01, Mo-S-C4-05
Bernstein, Jonathan	We-S-C2-04
Berrio, Paola	Tu-P-10
Bessagnet, Bertrand	Mo-O-E3-03
Betterton, Eric	Mo-S-B3-04
Bevan, Ruth	Mo-S-A3-04
Bevington, Charles	Mo-P-17, Mo-S-A3-02
Bhowmik, Swati	Tu-P-31
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Biales, Adam	Mo-S-D1-01
Biesterbos, Jacqueline W.	Mo-O-G2-02, We-O-B2-04
Bigler, Jeff	Mo-O-C1-03
Bills, Elizabeth	Tu-S-C1-03
Binnington, Matthew J.	Tu-O-C4-02
Biot, Pierre	Th-S-D1-02
Birch, Eileen	Tu-S-B3-01, We-S-D2-02
Birnbaum, Linda	Mo-O-G4-01
Biro, Frank M.	Su-P-47, Tu-O-E1-01, We-P-24, We-P-25
Biswal, Shyam	We-S-C4-05
Blackburn, Elizabeth	Mo-S-E4-03
Blanchard, Eric	Mo-O-E2-04
Blangiardo, Marta	Mo-S-B4-01
Bloemen, Louis	Th-S-D1-02
Blount, Ben	Mo-S-C4-05, We-S-E2-04
Blount, Benjamin C.	Mo-S-C4-01, We-P-19
Bob, Alex G.	Su-P-27, Tu-O-G1-02
Bobb, Jennifer	Mo-S-E4-01
Boehmer, Tegan	Tu-S-D4-02
Boffi, Roberto	We-S-E2-03
Bohac, David	We-S-E2-02
Bokkers, Bas	Mo-O-G2-02
Bonnard, Roseline	Mo-P-09, Mo-O-E3-03
Boone, Scott	Su-P-20, Mo-O-F1-02, Mo-S-F3-05
Boor, Brandon	Mo-O-G2-04
Bornschein, Robert	Su-P-47, Tu-O-E1-01, We-P-24
Boulvert, Emmanuelle	Mo-O-E3-03
Boyle, Elizabeth B.	We-P-19
Bradham, Karen	Tu-P-15
Bradman, Asa	Tu-O-E1-02
Brandes, Adam R.	Tu-S-B3-03
Brantley, Halley	We-S-D4-03
Braubach, Matthias	Tu-O-F2-05
Brauer, Michael	Mo-S-D4-05, Mo-S-B4-04
Brazile, William J.	We-P-09
Breen, Michael	Mo-S-F4-04
Breysse, Patrick N.	Su-P-02, Mo-O-D2-02, Tu-P-02, Tu-O-D2-01, Tu-O-D2-04, We-S-C4-05, We-S-A4-04
Brody, Julia	Tu-O-C3-05, We-P-32
Brokamp, Cole	Su-P-05, Tu-P-28
Brook, Jeff	Mo-S-D4-05

Brook, Jeffrey R.	We-S-D4-01
Bross, Monika	Tu-S-A2-05
Brown, Kenneth	Tu-S-B3-03
Brown, Steve	Mo-S-F4-02
Bruce, Nigel	Mo-O-D2-01
Brugge, Doug	Su-P-27, Tu-O-G1-02, Tu-O-G2-02
Bruinen de Bruin, Yuri	Th-O-C2-02
Brüning, Thomas	Mo-P-28, Tu-P-01, Tu-O-C3-01, Tu-O-C3-03, Tu-O-C3-04, We-O-B1-01, We-P-40
Buckholz, Jeanette M.	We-P-24, We-P-25, We-P-26
Buckley, Brian	Su-P-13, Mo-P-12
Buckley, Timothy J.	Su-P-13, Mo-O-C1-01, Mo-P-12, Mo-O-G4-03, Tu-S-E2-01
Bunge, Annette L.	Tu-S-C2-01
Burger, Joanna	Tu-S-D3-05
Burgess, Jefferey	Mo-S-B3-01, We-P-34
Burke, Janet	Mo-S-F4-01, Mo-S-F4-02, Mo-S-F4-03, Mo-S-F4-04, Mo-S-F4-05, Tu-O-G1-03, Mo-O-E3-02
Burns, Carol J.	Tu-P-07, We-S-A4-03
Bury, Daniel	We-P-40
Buxton, Herbert T.	Mo-S-C2-04

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Cabrera, Nolan L.	We-P-34
Cai, Ting	We-S-D2-03
Calafat, Antonia	Mo-O-B1-02, Mo-O-G2-01, Mo-O-G3-05, Mo-S-C4-03, We-P-24
Calderon, Leonardo	We-S-D1-02
Calvert, Geoff	Tu-S-A4-02, Tu-S-A4-04
Camann, David	We-S-A1-01, We-S-A1-02
Camann, David E.	We-S-A1-03
Cambal, Leah	Su-P-33, Mo-O-E1-01, Mo-P-33, Mo-P-34, Tu-P-06, We-S-D4-02
Canady, Richard	Mo-S-A3-03
Canales, Robert	Su-P-48, Su-P-49, We-P-27, We-P-28
Capel, Jim	We-P-18
Carlin, Danielle	We-P-23
Carpenter, Taylor	Tu-O-G3-02
Carr, Greg	Mo-P-25
Carr Shmool, Jessie L.	Su-P-33, Su-P-50, Mo-O-E1-01, Mo-P-33, Mo-P-34, Mo-S-E4-01, Mo-S-E4-04, Tu-P-06, Tu-P-11, We-S-D4-02

Carrasquillo, Olveen	Mo-P-03
Carter, David R.	Mo-P-05
Castaño, Argelia	Th-S-D1-02
Casteleyn, Ludwine	Th-S-D1-02
Castillo Quñones, Javier Emmanuel	Mo-O-E2-03
Castranova, Vincent	We-S-C4-02
Caudeville, Julien	Mo-P-09, Mo-O-E3-03
Ceballos, Diana	Mo-S-C2-05
Cely-García, María F.	Su-P-02, Tu-O-D2-01, Tu-O-D2-04
Chaimongkol, Ubonwan	Mo-P-40
Chaisson, Christine F.	Mo-S-B2-02, Mo-S-B2-03, Mo-S-B2-04, Mo-S-B2-05
Chambers, Janice E.	Tu-P-40
Chambliss, Sarah	Tu-O-G2-05
Chan, Chang-Chuan	Su-P-03, Mo-P-04
Chan, Hing M.	Tu-O-C4-02
Chang, Daniel	Mo-O-G2-05, We-P-12
Chang, Shih Ying	Su-P-10, Tu-P-30
Chang, Yan	Su-P-44, Tu-P-09
Chapizanis, Dimitrios	Tu-P-20
Chari, Ramya	Mo-S-B2-02, Mo-S-B2-03, Mo-S-B2-04
Charisiadis, Pantelis	Mo-O-G3-01, We-S-F4-02
Charles, Marie-Aline	We-S-F1-02, Th-S-D1-01, Th-S-D1-03, Th-S-D1-05
Chartier, Ryan T.	Tu-P-10
Chatara, Somporn	Su-P-01, Mo-P-02
Chatfield, Dale	Tu-O-F2-03
Chatterjee, Kanistha	Su-P-54, Tu-P-17
Chavez, Ryan	Mo-S-B2-01, Mo-S-B2-02, Mo-S-B2-03, Mo-S-B2-04
Chen, Aimin	Su-P-09, Mo-O-E2-02, Tu-P-29, Tu-O-C4-05, We-O-F2-04
Chen, Chen	Mo-O-D2-02
Chen, Fu-lin	Tu-O-G1-03, We-P-31
Chen, Mei-Lien	We-P-20
Chen, Shu	We-S-D1-01
Chen, Tsun-Hsuan	We-O-C3-03
Chen, Vivian Xianyu	Tu-O-E1-02
Chen, Yi-Ting	Su-P-03, Mo-P-04
Chen, Yu Chuan	We-O-B2-01
Cheng, Kai-Chung	Su-P-08, Tu-O-F2-01, We-S-E2-01

Cherrie, John	Tu-P-26, Th-O-D2-02
Cherrie, John W.	Tu-P-23, Tu-S-F4-02, Tu-S-F4-05
Chevillotte, Grégoire	We-P-08
Chew, Ginger	Th-S-C1-01
Child, Jessica	Mo-O-F2-01
Cho, Seung-Hyun	Mo-O-F2-01, Tu-S-E2-04, Tu-S-D4-02
Christensen, Bryan	Mo-O-D2-04
Christensen, Bryan E.	Mo-O-D2-01
Christensen, Krista	Mo-O-G4-01, Mo-O-G4-02
Chubb, Lauren G.	Su-P-33, Mo-P-33, Mo-P-34, Tu-P-06, We-S-D4-02
Chung, Kian Fan	Su-P-44, Mo-P-24, Tu-P-09, We-S-D1-01, We-S-D1-02, We-S-D1-03, We-S-D2-01
Cinalli, Christina	Mo-P-17, Mo-S-A3-02
Clapp, Richard	We-S-F4-04
Clark, Maggie	Tu-O-G3-02
Clark, Nancy	Tu-S-D4-03
Claus Henn, Birgit	Mo-S-C3-02, Mo-S-C3-04, Mo-S-C3-05
Clausen, Geo	Tu-S-C2-02
Clausen, Per A.	We-S-F3-03
Clifton, Matthew	We-O-C1-02
Clougherty, Jane	Su-P-33, Su-P-50, Mo-O-E1-01, Mo-P-33, Mo-P-34, Tu-P-06, Tu-P-11
Clougherty, Jane E.	Su-P-22, Su-P-51, Mo-P-20, Mo-S-E4-01, Mo-S-E4-04, Tu-P-13, We-S-D4-02
Cockburn, Myles	Mo-O-F2-02
Cocker, John	Mo-S-A3-04, Th-O-D2-02
Cohn, Sebastian	Tu-O-F1-01
Cole-Hunter, Thomas	Tu-P-27
Colt, Joanne	Mo-O-A4-01
Comiskey, Damien	Mo-S-A1-01, Mo-S-A2-05
Conerly, Octavia	Mo-S-F3-05
Conmy, Robyn N.	We-S-C2-01
Conner, Teri	Mo-S-F4-01
Connor, Thomas H.	Mo-S-F3-01, Mo-S-F3-02
Conrad, André	Mo-O-B1-01, We-S-F1-01, We-S-E3-03, Th-O-C2-01
Contrerès, Juliette	We-P-02
Cornelis, Christa	Tu-S-F4-04
Correll, Taylor	Mo-O-E2-03
Cory-Slechta, Deborah	Mo-S-E4-02
Costa, Max	Tu-S-D3-04

Couch, James	Mo-S-F3-03
Coughlin, Tiara	Mo-S-C4-02
Coull, Brent	Mo-S-C3-02, Mo-S-C3-04, Mo-S-C3-05
Couvidat, Florian	Mo-O-E3-03
Covaci, Adrian	Tu-O-C3-05
Cowie, Hilary	Tu-P-27
Crawford, Joanne 0.	Tu-P-27
Croghan, Carry	Mo-S-F4-01, Mo-S-F4-02, Mo-S-F4-04, We-S-F3-01
Crow, John A.	Tu-P-40
Crowder, Janell	We-S-B4-03
Crowley, Matthew	Tu-S-A2-01
Csiszar, Susan A.	Mo-S-A2-02, Mo-O-G3-03, We-S-A2-02
Cui, Xiaoxing	Su-P-44, Tu-P-09, We-S-D2-01
Cullinan, Paul	Mo-P-24
Curren, Meredith S.	Tu-O-C4-02
Curriero, Frank C.	Mo-O-D2-02, Tu-P-02

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D'Andrea, Christopher	Tu-S-D4-03
Dacunto, Philip	We-S-E2-01
Daher, Nancy	Su-P-24, We-P-04
Dahm, Matthew	Tu-S-B3-01
Dallmann, Timothy	We-P-05
Dalloul, Mudar	Mo-O-G3-04
Daly, Ej	Mo-S-A1-01, Mo-S-A2-05
Dasigi, Shalini	We-P-14
Daunert, Sylvia	Mo-P-03
Davey, Mark	Mo-P-35
David, Raymond M.	We-S-C4-04
Davis, Mark D.	Mo-O-B1-02
Davydenko, Ganna	Su-P-52, We-O-G3-03
Dawson, Jeffrey L.	We-O-C1-01
Day, Greg	Tu-O-D2-03
De Brouwere, Katleen	Tu-P-23, Tu-S-F4-04, We-S-F3-03
de Hartog, Jeroen J.	Tu-O-F3-04
de la Cruz, Armah	We-S-C2-05
De Marco, Cinzia	We-S-E2-03
De Roos, Anneclaire	Mo-O-A4-01
DeBord, D Gayle	Mo-S-F3-02
DeBord, Gayle	Mo-S-C2-03

deCastro, B. Rey	Mo-O-A4-02, We-S-E2-04
DeCastro, Rey	Mo-S-C4-01
Deddens, James	Tu-S-B3-01
Dederick, Elizabeth	Mo-S-B2-02, Mo-S-B2-03, Mo-S-B2-04
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Delamaire, Corinne	We-P-02
Delfino, Ralph J.	Su-P-24, We-P-04
Dell, Linda D.	Mo-S-D3-04
Dellarco, Michael	Th-S-D1-05
Dellarco, Michael J.	Tu-O-F3-01, We-S-F1-02, We-P-19, Th-S-D1-01, Th-S-D1-03
Delmaar, Christiaan	Mo-O-G2-02, We-O-B2-04
Demple, Bruce	We-O-B2-01
Denison, Lyn	We-S-E4-04
Dereumeaux, Clémentine	We-P-01, We-P-03
Deshmukh, Parikshit	We-S-D4-03
Destaillats, Hugo	Tu-O-F1-01
Deubner, David	Tu-O-D2-03
Devlin, Robert	Tu-P-37
Dey, Swatee	Mo-P-25
Deziel, Nicole	Mo-O-A4-01, Tu-P-33
Di Giulio, Richard	We-S-D2-01
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Dierkes, Georg	Mo-P-28, Tu-P-01, We-O-B1-01
Dietrich, Kim	Su-P-09, Tu-P-29
Dietrich, Kim N.	Mo-O-E2-02, Tu-O-C4-05, We-O-F2-04
Dionisio, Kathie	Mo-S-F4-03
Diskin, Kerry	Mo-S-B2-02, Mo-S-B2-03, Mo-S-B2-04
Djouad, Issam	Mo-O-E3-03
Dodson, Robin	Tu-O-C3-05, We-P-32, Th-S-C1-03
Dodier, Lizbeth	Mo-O-E2-03
Domesle, Alexander	Tu-S-G4-01
Dominici, Francesca	Mo-S-E4-01
Donohue, Maura	Mo-S-F3-05
Dotson Newman, Ogonnaya	Mo-S-E4-04
Duan, Xiaoli	We-S-E4-03
Ducamp, Stephane	Mo-P-26, Tu-P-25
Dudzina, Tatsiana	Mo-S-A2-04, Mo-O-G2-02, We-S-F3-02
Dufour, Alfred P.	Mo-P-11
Durant, John L.	Su-P-27, Tu-O-G1-02, Tu-O-G2-02

Durham, Phillip	Mo-O-F2-01
Duvall, Rachelle	Tu-S-B2-01
Dwyer, Natasha	Mo-S-B2-02, Mo-S-B2-03, Mo-S-B2-04

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Edrisi, Hamed	We-S-A1-01
Egeghy, Peter	Mo-S-A1-03, Mo-O-G2-05, Tu-S-E4-01, We-P-12
Egeghy, Peter P.	Tu-P-15
Egetter, David J.	Th-S-E1-04
El Orch, Zeineb	We-O-G2-04
Ela, Wendell P.	Mo-S-B3-02
El Yamani, Mounia	Tu-P-25
Ellickson, Kristie	Tu-O-G2-03
Elovitz, Michael	We-S-C2-03
Elston, Beth	Mo-S-E4-01
Emond, Claude	Su-P-17, Th-O-C2-03
Epel, Elissa	Mo-S-E4-03
Erb, Samantha A.	We-P-09
Ernst, Kacey	Mo-O-D2-03
Ernstoff, Alexi	Mo-S-A2-02, Mo-O-G3-03, We-S-A2-02
Escobedoc, Loraine	Mo-O-F2-02
Eskenazi, Brenda	Tu-O-E1-02
Esswein, Eric	Mo-S-D3-03
Etzel, Ruth A.	We-S-F1-02, Th-S-D1-01, Th-S-D1-03, Th-S-D1-05
Evans, Amanda	Tu-S-B4-05
Evans, Douglas	Tu-S-B3-01
Evans, Elizabeth E.	Tu-S-A4-01, Tu-S-A4-03
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Fan, Zhi-Hua Tina	Tu-O-G3-01
Fan, Zhihua (Tina)	Tu-S-D3-03
Fantke, Peter	Mo-O-B1-03, Mo-S-A2-02, Mo-O-G3-03, We-P-35, We-S-A2-02, Th-O-A1-03
Fattman, Cheryl	Su-P-33, Mo-P-33, Mo-P-34
Favela, Kristin	We-S-A1-03

Fehrenbacher, Cathy	Mo-S-A3-02
Felix, Omar I.	Mo-S-B3-02, Mo-S-B3-04
Feng, Li-Ting	Tu-P-39
Fenske, Richard A.	Su-P-06, Mo-P-07, Tu-S-A3-04, Tu-S-A3-05, Th-O-D2-01
Fent, Kenneth W.	Mo-S-F3-04
Fernandez, Esteve	We-S-E2-03
Ficheux, Anne-Sophie	Tu-O-D1-02, We-P-07, We-P-08
Fiddicke, Ulrike	Tu-P-18, Th-S-D1-02, Th-O-C2-01
Fiedler, Nancy L.	Mo-S-G1-02, Th-O-D2-03
Fillol, Clémence	We-P-02
Finehout, Erin	We-S-B4-03
Finzi, Johnathan	Mo-P-35, We-O-G2-01
Fischer, Emily V.	Tu-S-D4-04
Flanders, W Dana	Mo-S-D4-02
Fokin, Vladimir	Tu-P-34
Franklin, Claire	Mo-S-B2-02, Mo-S-B2-03, Mo-S-B2-04
Frasch, H Frederick	Tu-S-C1-02
Freeman, Matthew	We-S-D4-03
Friesen, Melissa C.	Tu-P-33
Fruin, Scott A.	Tu-O-G2-01
Fu, Wenhua	Mo-P-01
Fulk, Florence	We-P-33, Th-S-E1-03
Fuller, Christina H.	Mo-P-05
Furlong, Edward	Mo-S-F3-05
Furuuchi, Masami	Mo-P-01
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Galea, Karen	Tu-P-23, Tu-P-26, Tu-P-27, Tu-S-F4-02, Tu-S-F4-05, Th-O-D2-02
Gallagher, Lisa	We-S-F4-01
Galvin, Kit	Su-P-06, Mo-P-07, Tu-S-A3-04, Tu-S-A3-05
Gamo, Masashi	We-S-E3-01
Garcia, Erika	Su-P-34, We-P-15
Garfunkel, Eric	We-S-D1-01
Garmestani, Ahjond	Th-S-E1-02
Garvey, Sam	Tu-S-B2-01
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Geer, Laura	Mo-O-G3-04
Geerts, Lieve	We-S-F3-03
Geh, Esmond	We-S-C2-04
Georgopoulos, Panos	We-S-D1-01, We-S-D2-03
Geraci, Charles	We-S-C4-02
Gerecke, Andreas	Mo-O-G2-03
Ghosh, Debajyoti A.	We-S-C2-04
Gianaros, Peter J.	Su-P-50, Tu-P-11
Gibson, Mark D.	Mo-O-E2-04
Gillespie, Andrew	Mo-S-D1-03
Gillooly, Sara	Su-P-22, Su-P-51, Mo-O-E1-01, Mo-P-20, Tu-P-13, Tu-S-D3-03, We-S-D4-02
Gingras, Veronique	Mo-O-E3-01
Giorgis-allemand, Lise	Su-P-28, We-O-G2-05
Glassmeyer, Susan T.	Mo-S-C2-04, Mo-S-F3-05
Glen, Graham	Tu-S-E4-01
Godderis, Lode	Tu-O-F3-04
Godwin, Christopher	Mo-S-F4-04
Golan, Rachel	Mo-S-D4-02
Goldsmith, Michael-Rock	Mo-S-A1-03, Mo-O-G2-05, Tu-S-E2-03, Tu-S-E4-01, We-P-12, We-S-A2-01
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Graham, Jennifer L.	We-S-C2-02
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Grajewski, Barbara	Tu-S-B4-02
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Noonan, Curtis	Tu-P-37
Norris, Gary	Mo-S-F4-01, Mo-S-F4-02, Mo-S-F4-04
Northcross, Amanda	Su-P-15, Mo-P-15
Northcross, Amanda L.	We-P-38
Novachek, Joshua	We-S-E2-02
Novoselac, Atila	Mo-O-G2-04
Nowack, Bernd	Tu-P-19
Nuckols, John R.	Mo-O-A4-01

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O' Mahony, Cian	Mo-P-13, Mo-S-A2-05, Tu-S-A3-01
O'Keefe, Margaret	Tu-S-G4-03
O'Mahony, Cian	Mo-S-A1-01, Tu-S-A2-04
Oakes, Michelle	Mo-S-D4-01, Mo-S-F4-01
Olea, Catalina	We-P-10
Oleko, Amivi	We-P-02
Ollison, Will	We-P-18
Olopade, Christopher O.	Su-P-15, Mo-P-15, We-P-38
Oluseye, John	Su-P-15, Mo-P-15, We-P-38
Onstad, Gretchen	Tu-S-A3-05
Orme-Zavaleta, Jennifer	Mo-S-C2-01
Ornelas, Yoshira	Su-P-35, Mo-P-36
Osorio, Juan C.	Mo-S-B2-02, Mo-S-B2-03, Mo-S-B2-04
Osterberg, Joshua	We-S-D2-01
Ott, Wayne	Su-P-08, Tu-O-F1-02, Tu-P-38, Tu-O-F2-01, We-S-E2-01, We-S-E2-05
Oudejans, Lucas	We-O-C1-02
Overton, Robert	Tu-P-14
Ozkaynak, Haluk	Tu-S-E4-01, We-O-C1-02, We-O-F2-05, We-S-F3-01
Ozonoff, David	We-S-F4-01

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Pachon, Jorge E.	Mo-S-D4-01
Page, Elena	Mo-S-C2-05
Palermo, Tia	Mo-O-C1-02
Palma, Ted	Su-P-10, Tu-P-30
Palmandez, Pablo	Su-P-06, Mo-P-07
Palmen, Nicole	Th-O-C2-02
Palmer, Raymond	We-S-A1-01, We-S-A1-02, We-S-A1-03
Panek, Mary	Tu-S-A2-04
Panuwet, Parinya	Tu-O-E1-02, Th-O-D2-03
Papadaki, Krystalia	Tu-P-23
Papautsky, Ian	We-S-B4-01
Paredi, Paolo	We-S-E2-03
Park, Ji Y.	Tu-O-D2-03
Park, Ju-Hyeong	Th-S-C1-01
Parker, Jennifer	Tu-P-16
Parvez, Shahid	We-P-21
Pasanen, Pertti	Mo-P-10
Patton, Allison P.	Su-P-27, Tu-O-G1-02, Tu-O-G2-02
Peckham, Trevor K.	Tu-S-C2-01
Peel, Jennifer	Mo-S-D4-01, Tu-O-G3-02
Pei, Xing	We-S-B4-01
Peltier, Rick	Su-P-42, Mo-O-E1-03, Tu-O-G2-04
Penn, Stefani	Su-P-20, Mo-O-F1-02
Pennise, David	Mo-O-D2-01, Mo-O-D2-04
Perkins, Jessica	Tu-O-G2-02
Perovich, Laura	Tu-O-C3-05
Perzanowski, Matthew	Tu-S-D4-03
Peters, Greg	We-S-A2-04
Peters, Junenette L.	Mo-S-E4-05
Petrosian, Arina	Su-P-52, Su-P-53, Tu-O-G1-03, We-O-F2-01, We-O-G3-03
Pfaller, Stacy	Mo-S-F3-05
Phillips, Linda	We-S-F3-01, We-S-E3-02
Pierce, Jeffrey R.	Tu-S-D4-04
Pilishvili, Pilishvili	Mo-O-D2-01
Pillarisetti, Ajay	Mo-O-D2-04
Pilorget, Corinne	Tu-P-25
Pinney, Susan M.	Su-P-47, Tu-O-E1-01, We-P-24, We-P-25, We-P-26
Poels, Katrien	Tu-O-F3-04

Poet, Torka	Tu-P-07
Polyiem, Watcharapol	Mo-P-40
Porter, Alex	We-S-D1-01, We-S-D1-03
Pouzou, Jane	Tu-S-A3-05
Pozzi, Paolo	We-S-E2-03
Prapamontol, Tippawan	Su-P-01, Mo-P-02, Mo-P-40
Pratt, Gregory C.	Tu-O-G2-03
Presto, Albert A.	Tu-P-32, We-P-05, We-O-G3-02
Pretty, Jack R.	Mo-S-F3-02
Price, Paul	Mo-P-31, Tu-P-07, Tu-S-A3-02, Tu-S-A3-03
Proctor, Susan	Tu-S-B3-02
Pycke, Benny F.	Mo-O-G3-04
Pécheux, Marie	We-P-03

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Qi, Hungye	Mo-P-01
Qian, Hua	Mo-S-A2-03, Tu-O-D2-05, Tu-S-E4-03
Quinn, Casey	Tu-O-G3-02
Quinn, Cristina	Tu-O-C4-02, We-O-B1-03
Quintana, Penelope J.	Mo-O-E2-03, Tu-O-F2-03

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Radomyski, Artur	We-S-E4-02
Ragas, Ad	We-O-B2-04
Ramanarayanan, Tharacad	Tu-S-A2-04
Ramirez Ortiz, Daisy	Mo-P-03
Ramirez-Martinez, Alejandra	Tu-O-D1-02
Ramos-Bonilla, Juan P.	Su-P-02, Tu-O-D2-01, Tu-O-D2-04
Rao, Marepalli B.	Su-P-05, Tu-P-28
Rashid, Audil	Tu-O-D1-03
Raspanti, Greg A.	Su-P-26, Mo-P-29
Raymer, James	Tu-P-37, Tu-S-D4-02
Reck, Mary	Tu-S-E4-03
Reed, Rustin	Mo-S-B3-05
Reed, Rustin J.	Mo-S-B3-03
Reijnaerts, Judith	Tu-O-F3-04
Reilly, Timothy	Mo-S-C2-04
Reina, Vittorio	We-S-E4-02
Reiner, Jessica L.	Th-S-D1-04, Th-S-D1-01
Relyea, George	Mo-P-08
Repace, James L.	We-S-E2-01

Reponen, Tiina	Su-P-54, Mo-P-10, Mo-O-E2-02, Tu-P-17, We-O-F2-04, Th-S-C1-01, Th-S-C1-02
Reynolds, Kelly	Su-P-35, Mo-P-36, We-P-34
Reynolds, Peggy	Su-P-34, We-P-15
Rice, Glenn	Tu-S-B4-05
Rice, Joann	Tu-S-B2-01
Richardson, Mark	We-S-E4-05
Richardson, Rudy	Mo-O-G3-03
Richter, Alexis	Tu-O-C4-05
Riley, Erin A.	Mo-P-35, We-O-G2-01, We-O-G3-01
Robertson, Shirley A.	Mo-S-F3-02
Robins, Tom	Mo-S-F4-05
Robinson, Allen L.	Tu-P-32, We-P-05, We-O-G3-02
Robson, Mark	Th-O-D2-03
Rodes, Charles E.	Tu-P-10
Rodriguez-Ventura, Jose Guillermo	Mo-O-E2-03
Roeleveld, Nel	We-O-B2-04
Rohitrattana, Juthasiri	Th-O-D2-03
Roman-Esteva, William	Mo-O-B1-02
Romanenko, Christina	Su-P-36, Tu-P-34,We-P-16
Romeo, Crystal	Tu-P-16
Roper, Courtney L.	Su-P-33, Mo-P-33, Mo-P-34, Tu-P-06, We-S-D4-02
Rosales, Ceclia	Su-P-48, Su-P-49, We-P-27, We-P-28
Rose, Cecile	We-P-09
Rosenow, Michael	We-S-C4-03
Rosofsky, Anna	Tu-P-05
Ross, Zev	Mo-S-E4-01
Roudot, Alain-Claude	Tu-O-D1-02, We-P-07, We-P-08
Royce, Steven G.	We-S-D2-03
Rubright, R. Tyler	Su-P-22, Su-P-51, Mo-P-20, Tu-P-13, Tu-S-D3-03
Ruby, Michael V.	Tu-S-C2-01
Rudel, Ruthann	Tu-O-C3-05, We-P-32, Th-S-C1-03
Ruprecht, Ario A.	We-S-E2-03
Rusinek, Cory	We-S-B4-01
Russel, Frans	We-O-B2-04
Russell, Armistead	Mo-S-D4-01
Russell, Ashley	Mo-S-F4-02
Ryan, Barry P.	Su-P-01, Mo-P-02, Th-O-D2-03
Ryan, Mary	We-S-D1-01, We-S-D1-03

Ryan, Patrick	Su-P-05, Su-P-54, Tu-P-17, Tu-P-28, Tu-P-31, Tu-S-B4-03, Th-S-C1-02, Th-S-C1-05
Rüther, Maria	We-S-F1-01

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Saari, Sampo	Mo-P-10
Sabaterie, Nicolas	We-P-01
Sacks, Dana E.	Tu-O-F1-03
Saez, Eduardo	Mo-S-B3-02, Mo-S-B3-04
Salazar, Domingo	Tu-S-A2-03
Salazar, Natalia	Su-P-02, Tu-O-D2-01, Tu-O-D2-04
Salmela, Anniina	Mo-P-10
Salthammer, Tunga	Tu-S-C2-02
Salverda, Joanne	Th-O-C2-02
Sameenoi, Yupaporn	Tu-S-D4-04
Sammons, Deborah L.	Mo-S-F3-02
Sanchez, Valery	Tu-P-10
Sandel, Megan	Mo-O-F1-01
Saoudi, Abdesattar	We-P-03
Sapkota, Amir	Su-P-26, Mo-P-29, Tu-P-16
Saravanabhavan, Gurusankar	Tu-O-C3-02
Sarigiannis, Denis A.	Tu-P-20, Tu-P-21, Tu-P-22, Tu-P-23, Tu-O-F2-05, Tu-O-F3-03, Tu-S-F4-01, Tu-S-F4-02, Tu-S-F4-05, We-O-B2-03, Th-O-A1-04
Sarkar, Srijata	We-S-D1-01
Sarnat, Jeremy	Mo-S-D4-02
Sasakura, Miyoko	Mo-P-35, We-O-G2-01, We-O-G3-01
Savage, Russell	Mo-O-G4-03
Savitz, David	Mo-S-E4-01
Sbihi, Hind	Mo-S-D4-05
Schaal, LaNae	We-O-G2-01, We-O-G3-01
Schaeffer, Blake A.	We-S-C2-01
Schaffer, Chris	Su-P-54, Tu-P-17
Schauer, James J.	Su-P-24, We-P-04
Schecter, Arnold	Mo-O-G4-01
Scheepers, Paul T.	Mo-O-G2-02, Tu-O-F2-04, Tu-O-F3-04, We-O-B2-04
Schenck, Kathleen	Mo-S-F3-05
Schichtel, Bret	Mo-O-E2-01
Schleibinger, Hans	Mo-O-E3-01
Schoen, Mary E.	We-S-A2-05

Schoeters, Greet	We-S-A3-03, Th-S-D1-02
Schowanek, Diederik	Tu-P-12
Schripp, Tobias	Tu-S-C2-02
Schroeder, Jane C.	We-S-A4-01
Schröter-Kermani, Christa	Mo-O-B1-01, Tu-O-C3-04, We-S-F1-01
Schubauer-Berigan, Mary	Tu-S-B3-01
Schuler, Christine	Tu-O-D2-03
Schulte, Paul A.	We-S-C4-02
Schultz, Brad	Su-P-10, Tu-P-30
Schulz, Christine	We-S-F1-01, Th-O-C2-01
Schwander, Stephan	Mo-S-D4-03, We-S-D1-01, We-S-D1-03
Schwedler, Gerda	Th-S-D1-02, Th-O-C2-01
Schümann, Michael	We-S-E3-03
Schütze, André	Tu-O-C3-01, Tu-O-C3-03, We-P-40
Scobie, Hugh	We-S-E4-04
Sears, Malcolm R.	Mo-S-D4-05
Seifert, Joanna	Su-P-44, Tu-P-09, We-S-D1-01
Seiwert, Margarete	We-S-F1-01, Th-S-D1-02, Th-O-C2-01
Sellers, Clarissa	Mo-S-B2-02, Mo-S-B2-03, Mo-S-B2-04
Sepai, Ovnair	Th-S-D1-02
Serjanaj, Besnik	We-P-39
Seryak, Liesel M.	Mo-O-G4-03
Seto, Edmund	Mo-S-B4-05
Shafer, Martin M.	Su-P-24, We-P-04
Shakya, Kabindra M.	Tu-O-G2-04
Shalat, Stuart	Tu-O-E1-03
Shannon, Kevin	We-S-A1-03
Sharpe, Bobby	Tu-S-B2-05
Shaw, Peter B.	Tu-S-B3-03
Shehadi, Maher	Tu-S-A1-03
Shelat, Shalu	We-O-C1-01
Shen, Heqing	We-O-B1-02
Shen, Huizhong	Mo-O-A4-04
Shendell, Derek G.	Tu-O-F1-03
Shepard, Peggy	Mo-S-E4-04
Sheppard, Lianne	Mo-P-35, We-O-G3-01
Shih, Regina	Mo-S-B2-02, Mo-S-B2-03, Mo-S-B2-04, Mo-S-B2-05
Shin, Hyeong-Moo	Su-P-07, Tu-O-C4-01, Tu-O-C4-04, We-O-C3-02

Shirai, Jeffry H.	Tu-S-C1-03, Tu-S-C2-01
Shlyapnikov, Dmitriy	We-P-06
Shoemaker, Jody	Mo-P-11
Shrestha, Laxman	Mo-O-D2-02
Shropshire, William	Mo-O-G4-01
Shupler, Matt	We-P-38
Shur, Pavel	Su-P-36, Tu-P-34, We-P-06, We-P-16
Shuster, William	Th-S-E1-02
Sijm, Dick	Th-O-C2-02
Silbernagel, Susan	We-O-B2-01
Simmons, Jane Ellen	Mo-S-F3-05
Simon, Matthew	Su-P-27, Tu-O-G1-02
Simpson, Christopher	Mo-P-35, We-O-G2-01, We-O-G3-01
Sinharay, Rudy	Mo-P-24
Sioutas, Constantinos	Su-P-24, We-P-04, We-S-E2-03
Sircar, Kanta	Mo-O-D2-01, Mo-O-D2-04
Siriwong, Wattasit	Th-O-D2-03
Siroux, Valérie	Su-P-28, We-O-G2-05
Sjodin, Andreas	Su-P-09, Mo-O-G2-01, Mo-S-C4-03, Tu-P-29
Slama, Rémy	Su-P-28, We-O-G2-05
Sleeuwenhoek, Anne	Tu-P-23, Tu-S-F4-02, Tu-S-F4-05
Sleiman, Mohamad	Tu-O-F1-01
Smigelski, Paul	We-S-B4-03
Smith, Charles	We-O-C1-01
Smith, Jerome P.	Mo-S-F3-02
Smith, Luther	Mo-O-E3-02
Smith, Rachel	We-S-D1-01, We-S-D1-03
Smolders, Roel	Mo-S-A3-04, Tu-P-23, Tu-S-F4-04
Snawder, John	Mo-S-F3-02
Snawder, John E.	Tu-S-B3-02
Snyder, Emily	We-O-C1-02
Snyder, Michelle	Mo-S-F4-03
Sobek, Edward	Tu-S-D4-03
Sobus, Jon	We-S-A3-03
Sohn, Michael	Tu-O-C4-04
Soo, Evelyn	Mo-S-C4-02
Sosnoff, Connie	Mo-S-C4-01, Mo-S-C4-05
Spaan, Suzanne	We-S-F3-03
Space, David R.	Mo-S-G1-02
Specht, Aaron J.	Su-P-30, Mo-P-32
Spengler, Jack	Mo-S-E4-04, Tu-S-A1-02

Stallings, Casson	Mo-O-E3-02
Stanton, Marcia	Tu-O-D2-03
Stapleton, Heather M.	Tu-S-C2-03
Starr, James	We-O-C1-02
Steenland, Kyle	Tu-P-10
Steeves, Doug	Mo-O-E2-04
Stepanova, Eugenia	Su-P-19, We-P-30
Stephens, Brent	Su-P-18, We-O-G2-04, Th-O-A1-02
Stevens, Caroline	Mo-S-D1-02
Stone, Kevin	Tu-O-G2-02
Stout, Daniel M.	We-O-C1-02
Strebel, Steven	Th-S-C1-02
Strittholt, Carrie	Tu-P-12
Stroud, Craig	Mo-O-E2-04
Strynar, Mark	Tu-P-15
Stuart, Amy	Tu-O-G3-02
Studabaker, William	Tu-P-37
Stumpf, Richard P.	We-S-C2-01
Sturtz, Timothy	Mo-O-E2-01
Subbarao, Padmaja	Mo-S-D4-05
Subraniam, Prasad	We-S-D1-01, We-S-D1-02
Succop, Paul	We-P-24
Sugeng, Anastasia	Mo-S-B3-04
Sugeng, Anastasia J.	Su-P-48, Su-P-49, We-P-27, We-P-28
Suk, Jung Soo	We-S-C4-05
Suk, William A.	We-P-23
Sukiene, Vilma	Mo-O-G2-03
Sullivan, Kate	Mo-S-D1-02
Sumner, Susan	Tu-P-37
Sundararajan, Madhura	We-P-21
Sunger, Neha	Mo-P-31
Sutan, Kunrunya	Mo-P-40
Svanström, Magdalena	We-S-A2-04
Svendsen, Erik	Su-P-19, We-P-30
Szapocznik, José	Mo-P-03
Szarka, Arpad Z.	Tu-S-A2-03
Szego, Emmanuelle	We-P-02

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Talgo, Kevin	Su-P-10, Tu-P-30
Tan, Yi	Tu-P-32, We-O-G3-02
Tan, Yu-Mei	We-S-A3-03
Tang, Ning	Mo-P-01
Tang, Robert	Mo-S-B4-01
Tao, Shu	Mo-O-A4-04, Tu-O-D1-03
Tapia, Vilma	Tu-P-10
Taylor, Anne	Tu-S-A2-03
Teedon, Paul	Th-O-D2-02
Teeguarden, Justin	We-S-A3-03
Tetley, Teresa	Su-P-44, Tu-P-09, We-S-D1-01, We-S-D1-02, We-S-D1-03
Thalji, Lisa	Tu-S-D4-02
Tharp Gilliam, Shannah	Su-P-22, Su-P-51, Mo-P-20, Tu-P-13
Thavornyutikarn, Prasak	Su-P-01, Mo-P-02
Thoma, Eben	Tu-S-B2-01, We-S-D4-03
Thomas, Kent	Tu-P-33
Thomas-Burton, Tami	Th-S-E1-03
Thorley, Andrew J.	We-S-D1-03
Thornburg, Jonathan	Mo-O-F2-01, Tu-S-D4-02
Thurston, Hale	Th-S-E1-02
Tibaldi, Rosalie	Tu-O-D2-05
Tielsch, James M.	Mo-O-D2-02
Toborek, Michal	Mo-P-03
Toftum, Jørn	Tu-S-C2-02
Toriba, Akira	Mo-P-01
Tornero-Velez, Rogelio	We-S-A3-03
Tozer, Sarah	Mo-P-13
Tripathy, Sheila	Su-P-22, Su-P-50, Su-P-51, Mo-P-20, Tu-P-06, Tu-P-11, Tu-P-13, We-S-D4-02
Tulve, Nicolle S.	We-S-F3-01
Tunno, Brett	Su-P-33, Mo-O-E1-01, Mo-P-33, Mo-P-34
Tunno, Brett J.	Su-P-50, Tu-P-06, Tu-P-11, We-S-D4-02
Tunsaringkarn, Tanasorn	Th-O-D2-03
Turley, Audrey	Tu-P-14
Turner, Dylan	Mo-S-B3-03, Mo-S-B3-05
Turos, Alla	Su-P-53, We-O-F2-01
Turos, Olena	Su-P-52, Su-P-53, Tu-O-G1-03, We-O-F2-01, We-O-G3-03
Turunen, Mari	Th-S-C1-04
Turvey, Stuart E.	Mo-S-D4-05

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Uddin, Ikhtiar   Tu-O-D1-03
Uhlik, Caren   Mo-S-C4-02
Ulrich, Nadin   Tu-O-C3-04
Underhill, Lindsay J.   Su-P-32, Mo-O-F1-01, We-O-G2-03
Uribe, Juliana   Su-P-02, Tu-O-D2-01

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Vacchi-Suzzi, Caterina   We-O-B2-01
Valencia, Alejandro   Su-P-10, Tu-P-30
Valentin-Blasini, Liza   Mo-O-B1-02
Valentín-Blasini, Liza   Mo-O-G2-01
Vallero, Daniel A.   Mo-O-G2-05, Tu-S-E4-01, We-P-12, We-P-13,
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Van den Eede, Nele   Tu-O-C3-05
van der Heijden, Stephan   We-O-B1-03
van der, Erwin   Tu-O-F2-04
Van Dyke, Mike V.   We-P-09
van Engelen, Jacqueline   Mo-O-G2-02
Van Holderbeke, Mirja   Tu-S-F4-04
van Hout, Stef   Tu-O-F2-04
van Tongeren, Martie   Th-O-D2-02
Varughese, Eunice   Mo-S-F3-05
Varughese, Sunil   Mo-P-21
Vdovenko, Vitaliy   Su-P-19, We-P-30
Veijalainen, Anna-Maria   Mo-P-10
Velovitch, Joseph   Tu-P-07
Vermeer, Kimberly   Su-P-32, Mo-O-F1-01, We-O-G2-03
Vesper, Stephen   Mo-S-F3-05
Vette, Alan   Mo-S-F4-04
Victory, Kerton   We-P-34
Vieira, Veronica   Su-P-07, We-O-C3-02, We-S-F4-01
Viet, Susan M.   Tu-O-F3-01, We-P-19
Villegas, Eric   Mo-S-F3-05
Virji, Abbas M.   Tu-O-D2-03
Vlasova, Elena   We-P-06
Volckens, John   Tu-O-G3-02, Tu-S-D4-04
von Goetz, Natalie   Mo-S-A2-04, Mo-O-G2-02, Mo-O-G2-03, Tu-
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von Götz, Natalie   We-O-B2-04

Voorhees, Robert T.   Tu-S-B3-03
Vu, Kennedy K.   We-P-10

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Wade, Erin L.   Mo-O-B1-02
Wagener, Diane   Tu-S-D4-02
Wagner, David W.   Mo-S-D3-05
Wagner, James   Su-P-17, Th-O-C2-03
Waits, Eric R.   Mo-S-D1-01
Waletzko, Evan J.   Mo-O-C1-01
Walker, Mike   Tu-O-C3-02
Wallace, Lance   Tu-P-38, We-S-E2-05
Wallace, Lance A.   Tu-O-F1-02
Wallace, Jr., John M.   Su-P-22, Su-P-51, Mo-P-20, Tu-P-13
Waller, Lance A.   Mo-O-E1-02
Walser, Tobias   We-S-A2-03
Wambaugh, John   Mo-O-G2-05, Tu-S-E4-02, We-P-12
Wang, Lanqing   Mo-S-C4-01, Mo-S-C4-05
Wang, Yujie   Mo-O-E1-02
Wania, Frank   Tu-O-C4-02, We-O-B1-03
Wannaz, Cedric   We-P-35
Ward, Kenneth D.   Mo-P-08
Ward, Mary   Mo-O-A4-01
Ward, Tony   Tu-P-37
Waring, Michael S.   We-O-G2-04
Warren, Nick   Mo-S-A3-04, Tu-S-F4-02, Tu-S-F4-05
Watts Hull, Rebecca   Mo-P-05
Waugh, David   Mo-O-E2-04
Webster, Glenys M.   Su-P-09, Tu-P-29
Webster, Thomas   We-S-F4-01
Webster, Thomas F.   Tu-S-C2-03, Tu-O-F3-02
Wei, Binnian   Mo-S-C4-05
Wei, Heng   We-P-14
Weinberg, Janice   We-S-F4-01
Weisel, Clifford P.   Su-P-13, Mo-P-12, Tu-O-E1-03, Mo-S-G1-02, We-S-A3-03, Tu-S-A1-01
Weiss, Tobias   Mo-P-28, We-O-B1-01
Weisskopf, Marc   Su-P-30, Mo-P-32
Weldon, Rosana H.   Tu-O-E1-02
Welles, Darrell   Mo-O-E2-04
Weschler, Charles J.   Tu-S-C2-02, Mo-S-G1-01

Wesolek, Nathalie	Tu-O-D1-02
Westerdahl, Dane	We-S-E2-03
Wetmore, Barbara	Tu-S-E3-02, Tu-S-E3-03, Tu-S-E3-04, Tu-S-E3-05
White, Ronald H.	Tu-P-02
Wilkins III, John R.	Mo-O-C1-01, Mo-O-G4-03
Wilkinson, Sarah	Mo-S-B3-04
Williams, Edward S.	Mo-S-A2-01
Williams, Ron	Tu-S-B2-01, Tu-S-B2-05, We-S-F3-01, We-S-D4-03
Wills, Robert W.	Tu-P-40
Wilson, Alan	Mo-O-E2-04
Wilson, Vickie	Mo-S-F3-05
Windler, Lena	Tu-P-19
Winter, Michael	We-S-F4-01
Wintermeyer, Dirk	We-S-F1-01, We-S-E3-03
Wolfe, Christopher	Tu-P-31
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Wones, Robert	We-P-26
Wong, Lee-Yang	Mo-S-C4-03
Woodruff, Tracey	Mo-S-E4-03
Wooldridge, Margaret	Su-P-17, Th-O-C2-03
Wright, David	We-P-19
Wright, J. Michael	Tu-S-B4-05
Wright, Michael	Tu-S-B4-01
Wright, Robert O.	Mo-S-C3-02, Mo-S-C3-04, Mo-S-C3-05
Wu, Chang-fu	Tu-P-39
Wu, Jun	Mo-O-F2-02, Mo-O-F2-03, We-O-C3-01
Wu, May	We-S-F1-03
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Xie, Mingjie	Mo-S-D4-01
Xu, Jia	Su-P-21, Su-P-31, Mo-P-19, Mo-O-A4-03, We-O-G2-02
Xu, Shu	We-S-D2-03
Xu, Xijin	Mo-O-E2-02, We-O-F2-04
Xu, Ying	Su-P-29, Mo-O-G2-04, Mo-O-G3-02, We-P-11
Xue, Jianping	Tu-O-G1-03, We-P-31, We-O-F2-05
Xue, Xiaobo	We-S-A2-05

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Yang, Wen	Mo-O-A4-05, We-P-36, We-P-37
Yang, Wenping	Mo-O-E3-01
Yao, Yixin	Tu-S-D3-04
Yau, Alice	We-S-A1-01, We-S-A1-02, We-S-A1-03
Ye, Sherry	Mo-O-G3-05
Ye, Xiaoyun	Mo-O-G2-01, We-P-24
Yeampierre, Elizabeth	Mo-S-B2-01, Mo-S-B2-02, Mo-S-B2-03, Mo-S-B2-04, Mo-S-B2-05
Yekeen, Taofeek A.	Mo-O-E2-02, We-O-F2-04
Yip, Fuyuen	Mo-O-D2-01, Mo-O-D2-04, Tu-S-D4-02
Yolton, Kimberly	Su-P-09, Tu-P-29
Yonas, Michael	Su-P-22, Su-P-51, Mo-P-20, Tu-P-13
Yost, Michael G.	Su-P-06, Mo-P-07, Mo-P-35, Tu-S-A3-04, We-O-G2-01, We-O-G3-01
Young, Bruce M.	Tu-S-A2-04, Tu-S-A3-03
Yu, Chang Ho	Tu-O-G3-01
Yue, Wei	We-S-B4-01
Yun, DongMin	Su-P-16, Su-P-37, Su-P-38, Su-P-39, Mo-P-16, Mo-P-37, Mo-P-38, Mo-P-39

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Zaleski, Rosemary	Mo-S-A2-03, Tu-O-D2-05, Tu-S-E2-01, Tu-S-E4-03
Zamore, Wig	Tu-O-G2-02
Zaouak, Olivier	Tu-S-B2-03
Zarate, Oscar	Th-S-C1-03
Zaros, Cecile	We-S-F1-02, Th-S-D1-03, Th-S-D1-05
Zartarian, Valerie	We-O-F2-05
Zeger, Scott L.	Mo-O-D2-02
Zeghnoun, Abdelkrim	We-P-01
Zelikoff, Judith	Tu-S-D3-05
Zenié, Alexandre	We-S-E4-02
Zhang, Hongmei	Su-P-09, Tu-P-29, Tu-O-C4-05
Zhang, Jie	We-O-B1-02
Zhang, Jim	Th-S-D1-01
Zhang, Jun Jim	We-S-F1-02, Th-S-D1-03, Th-S-D1-05
Zhang, Junfeng	Su-P-44, Mo-P-24, Tu-P-09, We-S-D1-01, We-S-D1-02, We-S-D1-03, We-S-D2-01, We-S-