DEPARTMENT OF ENVIRONMENTAL & OCCUPATIONAL HEALTH SCIENCES
UNIVERSITY of WASHINGTON · SCHOOL OF PUBLIC HEALTH

CELEBRATING

STUDENT RESEARCH DAY

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1:30 - 4:00 PM
South Campus Center 316

Abstracts

http://deohs.washington.edu/student-research-day

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The following abstracts are from the 2nd year Master of Science and Master of Public Health degree students in our Environmental Health, Occupational and Environmental Medicine, Occupational and Environmental Exposure Science, Toxicology, and Environmental and Occupational Health programs.

Method Validation for Bacterial and Viral Analysis of Geoducks

Victoria Balta
Environmental and Occupational Health, MPH
Preceptor: Scott Meschke

Background

The shellfish industry in Western Washington is an integral part of the State economy; with products being distributed in both domestic and international markets. Oysters and geoducks are two widely harvested shellfish in Western Washington, and ensuring clean growing areas with low levels of bacterial and viral contamination is essential for protecting consumers from disease. Microbiological methods for assessing viral and bacterial contamination in oysters have been established; however, similar testing procedures for geoducks have not been validated. Our study adapted viral and bacterial testing methods for oysters to better suit geoduck meat.

Methods

To validate our viral and bacterial testing methods, four trials were performed with MS2 coliphage and five trials were performed with E. coli CN-13 seeded into geoduck meat harvested in Western Washington. Each MS2 trial contained four seeding levels for which we calculated plaque forming units (PFU)/100g and percent recovery. MS2 recovery was analyzed using the double agar layer method. The E. coli CN-13 trials contained three seeding levels with the most probable number (MPN) calculated for each. MPN was assessed using the APHA's 5-tube fermentation method. Fermentation on seeded geoduck meat was first performed in Lauryl tryptose broth (LST) and then passaged into EC broth and EC-MUG medium. In addition, six unseeded field samples were also processed using these methods to evaluate ability of the method to detect naturally occurring levels of E. coli and male-specific coliphage.

Results

The average percent recoveries for MS2 trials ranged from 106.7% to 146.6%, with higher recoveries occurring at more concentrated seeding levels. Recoveries of over 100% are likely due to MS2 aggregation. The average recovery ratios for E. coli CN-13 trials were greater than 1, with higher recoveries also occurring at more concentrated seeding levels. Recovery ratios greater than 1 are likely due to background coliform levels and potential bacterial replication in geoduck meat. All geoduck meat used in the E. coli trials was shown to have prior levels fecal coliforms but tested negative for E. coli. In unseeded geoduck, male-specific coliphage levels, though typically low, ranged from 9.55 to 139.39 PFU/100g and E. coli levels ranged from .20 to 79.0 MPN/g.

Conclusion

Our findings suggest that, with modifications, the current oyster viral and bacterial testing methods can be applied successfully to geoduck meat. The percent recoveries and MPN ratios indicate that both methods provide good assessments of bacterial and viral contamination in geoducks.

Assessing Infectious Disease Risk and Response Capabilities in the Asia Pacific Region

Victoria Balta
Environmental and Occupational Health, MPH
Preceptor: Charles Treser

The Asia Pacific region is one of the most densely populated regions in the world and, therefore, one of the most at risk regions for disease outbreaks. Despite their large and dense populations, a number of nations in the region suffer from significant deficiencies in their public health infrastructures. To support potential interventions in the region that promote on the ground public health capacity building, Metabiota, along with U.S. Government partners, has developed a long-term engagement strategy within the Asia Pacific region to identify and characterize risks posed by pathogens of concern. The final product of this effort was a large survey report that discussed the current disease landscape of the Asia Pacific region as well as the capacity of regional public health and state leaders to handle infectious disease outbreaks. The engagement strategy report also examined the current gaps in public health outbreak response, and discussed why these gaps deserve increased resources and manpower. Lastly, the engagement strategy report discussed comprehensive techniques and potential areas for intervention that would most efficiently and effectively minimize these deficiencies. The results of this project remain to be seen, as discussions about the final report are currently ongoing. Should future public health interventions come to fruition, appropriate monitoring and evaluation systems will need to be put in place to measure the efficacy of U.S. efforts in the region.

Preliminary Indoor UV and Blue Light Exposure Assessment in Marijuana Growing Facilities

Maximilian Chmielinski
Occupational and Environmental Exposure Science, MS
Preceptor: Edmund Seto

Background: Little is documented for UV exposure to 'grow' lights used by indoor farms as well as the cannabis industry. The purpose of this study was to characterize UV light exposure in nursery and grow rooms in two medical cannabis production facilities using area and personal sampling.

Methods: Three different light spectrums were assessed: UV-Broadband (180 to 400 nm), UVA (315 to 400 nm) and blue light (305 to 700 nm). The radiometer hub supported one spectral sensor at a time, therefore the spectrums were assessed consecutively rather than simultaneously. Area surveys were accomplished by consecutively mounting the spectral sensors on a tripod at a fixed height of 1.6 meters for several minutes per sample. In grow rooms, the tripod was systematically moved to 32 to 37 locations; in nurseries samples were taken from 4 to 6 locations. Personal sampling utilized sensors consecutively mounted on a helmet worn by the worker. In each facility, one worker wore each sensor for 20 minute periods in the grow room.

Results: In both area and personal sampling, the ACGIH TLV (American Conference of Governmental Industrial Hygienists, Threshold Limit Value) for UV Broadband exposure was exceeded. For area sampling in grow rooms, 8 of 69 (12%) samples exceeded the UV Broadband TLV of 0.003 J/m 2 in under 8 hours, and all (n=10) area nursery room samples exceeded this TLV. In area grow room and nursery samples, the average number of exposure-minutes resulting in a TLV exceedance was 318 and 61 minutes, respectively. Personal grow room sampling in the UV Broadband spectrum resulted in a mean (SD) effective irradiance of 0.0001 (3.807e-5) Eff mW /cm 2 over a 20 minute interval. At this mean exposure level, the worker did not exceed the UV Broadband TLV during the 20 minute sample but would be projected to exceed the TLV in 446 minutes (less than 8 hours). No sample from any facility or room type exceeded the ACGIH TLVs for UVA or blue light.

Conclusion: While data is limited for the three light spectrums surveyed, the UV Broadband spectrum did have samples that exceeded the ACGIH TLV. Nurseries had more UV Broadband exposure than grow rooms. Additional assessment, particularly personal sampling, is needed to more fully characterize cannabis workers' exposure to UV light. Further research is needed to establish validated UV light sampling methods, to examine the effectiveness of protective equipment, and to establish employer best practices.

Assessing Potential Laser Strike Protection Engineering Control for United States Coast Guard Aircraft

Joe DeLauter
Occupational and Environmental Exposure Sciences, MS
Preceptor: Mike Yost

Background: There has been a tenfold rise in the number of reported laser strikes onto aircraft during the last decade; over 90% of which being caused by green lasers. Laser strikes on aircraft can cause a number of hazardous conditions for the crew, passengers, and people on the ground. Eye damage, such as flash blindness, loss of night vision, retinal lesions, and temporary/permanent blindness may occur, not to mention the possibility of skin burns or even crash landings.

Aim: This study assessed the viability of a thin film coating, specifically design to absorb/reflect green laser light as a potential engineering control to protect the people on-board the aircraft. Three factors were tested for: the coatings ability to prevent green laser light transmission, magnitude of glare production, and magnitude of color distortion.

Methods: The light transmission of a green laser and a white light source through aircraft window test samples and a 532nm notch filter were measured by each light source's photometric intensity, power level, and spectral graph. Photographs of green laser strikes upon aircraft window test samples and a 532nm notch filter were analyzed, via photographic software color histograms, comparing the magnitude of green light wavelengths to measure glare production. Photographs were also taken of various aircraft scenarios and a color reference card to analyze the magnitude of color distortion, via photographic software color histograms, of a white light source transmitting through aircraft window test samples and a 532nm notch filter.

Conclusions: Thin film coatings developed to absorb/reflect 532nm green laser light can be a very effective means to protect aircraft crews and passengers from the associated hazards of laser strikes. However, this engineering control is only most effective when the laser beam is normal to the coated aircraft window. As the angle of attack for the laser strike increases, the coating's effectiveness decreases. However, there does seem to be a correlation between a decrease in light transmission and an increase in angle of attack. Yet, there does not seem to be a difference in the amount of light transmission between flat and curved window surfaces. Further research is needed to develop an engineering control designed to protect against laser strikes, such as the development of a plexi-glass coating, a comparative study of coated and uncoated glass and plexi-glass aircraft window samples, and the viability of coating designed to shift the laser light away from the visual spectrum.

Temporal and Spatial Analysis of Groundwater Quality and Unconventional Gas Well Density in Washington County, Pennsylvania

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Preceptor: Peter Rabinowitz

A total of 265 household water supply samples were collected from 154 houses in Washington County, Pennsylvania between 2012 and 2014. The inorganic and anion constituent concentrations were compared to active unconventional gas well density relative to each household. Cross-sectional, temporal, and spatial analytical techniques were employed to explore potential relationships between analyte concentrations or change in analyte concentrations and gas well density or change in gas well density. Overall, the groundwater in Washington County is of good quality and there was no evidence for systematic deterioration of water quality due to gas well density. Manganese and pH exceeded the United States Environmental Protection Agency (USEPA) and Pennsylvania Department of Environmental Protection (PADEP) secondary maximum contaminant levels (SMCLs) in ~12% of samples each, but these exceedances were expected due to the long history of acid mine drainage throughout the County. Eight analytes (Cr, Co, Li, Hg, Ni, K, Sn, and temperature) exhibited statistical significance when their initial and subsequent sample event medians were compared. There were seven analytes (Al, Cr, Fe, Pb, Li, Na, U) found to have significant relationships between the concentration or change in concentration and gas well density or change in gas well density. Lithium exhibited correlations in almost all statistical tests and had a median value (7.7 ppb) almost three times higher than the national median (2.8 ppb). Correlations for all analytes may be explained by various anthropogenic sources, both from unconventional gas extraction activities and from other unrelated activities. Further characterization of causal pathways is needed to clarify these relationships.

Ambient Air Pollution and Lung Cancer Risk in the Women's Health Initiative Observational Study

Shilpa Gowda
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Preceptor: Joel Kaufman

Background: Outdoor air pollution was recently classified as a human carcinogen by the International Agency for Research on Cancer. However, epidemiologic studies supporting this classification have focused on lung cancer mortality rather than incidence, and most previous studies have included relatively few women. Women in older age groups with higher incidence of lung cancer have been particularly underrepresented. New studies that address these limitations are needed to further explore and quantify the strength of the association between ambient air pollution and lung cancer.

Methods: We sought to evaluate this association, using data from the observational arm of the Women's Health Initiative (WHI) study, a large, U.S.-based cohort of post-menopausal women (final sample size after applying exclusions = 86,146, with 1,332 lung cancer cases). Mean follow-up time of participants was 11 years, with a maximum follow-up time of 15 years. We used previously validated state-of-the-art geospatial models to estimate exposures to fine particulate matter (PM2.5) and nitrogen dioxide (NO2), two major constituents of ambient air pollution, based on participants' residential addresses. NO2 is considered a proxy measure for traffic- related air pollutants. We also characterized participants' exposures to traffic-related air pollution by the distances of their residential addresses to a primary limited-access highway. Using Cox proportional hazards regression models, we calculated hazard ratios (HRs) for the risk of lung cancer in association with these exposure metrics. We adjusted for several potential confounders, including age, race, body mass index, region of residence (including urbanicity), smoking habits, and socioeconomic status. Furthermore, we conducted exploratory analyses restricted to never smokers, adjusting for second-hand smoke exposures. Separate exploratory analyses stratified lung cancer outcomes by major histological subtypes.

Results: In our primary analyses, no significant associations were observed. For example, when comparing the highest quartile of PM2.5 exposure (>14.59 μg/m3) to the lowest quartile (≤10.58 μg/m3), a HR of 0.91 [95% Confidence Interval (CI): 0.61-1.34] was observed. There were no consistent relationships seen between distance to roadway and lung cancer. There were also no significant associations observed in our exploratory analyses.

Conclusions: Overall, we did not observe an association between ambient air pollution and lung cancer risk. However, despite the large sample size, our results do not exclude effect sizes seen in some previous studies. Additional years of follow-up and inclusion of participants from the WHI clinical trial arm would enhance study power and may make results more informative.

Non-invasive Diagnosis of Pediatric Tuberculosis

Jenny Lohmiller
Environmental Health, MS
Preceptor: Gerard Cangelosi

Pulmonary tuberculosis (TB) is typically diagnosed by analysis of sputum samples. Sputum is a reliable specimen for TB diagnosis, but it has limitations. Requiring ill patients to cough up sputum can put health care workers at risk. The viscosity of sputum makes it difficult to work with. There are also patients, such as young children, who have difficulty producing sputum on demand.

Oral swabs could provide a quick, simple, non-invasive alternative to sputum sampling. In a pilot study, swabs were collected from 20 adult TB cases confirmed by Cepheid's GeneXpert (PCR) analysis of sputum. Eighteen of these subjects yielded swabs that were positive for Mycobacterium tuberculosis (MTB) DNA in a manual quantitative PCR (qPCR) analysis. Healthy control samples were 100% negative.

To improve the sensitivity of oral swab analysis (OSA), this study evaluated alternatives to the qPCR method used in the pilot study. Swabs were "spiked" with cultured MTB cells. Three systems were compared for their abilities to detect MTB: Qiagen's DNA Mini Kit followed by manual qPCR, Claremont BioSolution's semi-automated Purelyse Kit followed by manual qPCR, and Cepheid's fully automated GeneXpert.

Qiagen's kit is the fully manual method used in the pilot study. Changes to the precipitation and elution steps improved analytical sensitivity, resulting in stronger signals (2- to 4-Cq values) with an estimated limit of detection below 100 cfu. The fully automated Cepheid system was less sensitive than the optimized Qiagen protocol. Further adaptation may improve sensitivity. The PureLyse kit achieved poor results using the Whatman OmniSwabs. However an alternative swab brand (Puritan PurFlock) worked well with this system, delivering sensitivities comparable to those of the Qiagen system.

Samples were collected from children aged 0-5 years who visited a clinic in South Africa with TB-like symptoms. The children were clinically diagnosed with TB (improved after treatment) or not TB (improved without treatment). Swabs were analyzed in our Seattle laboratory using the optimized Qiagen protocol. MTB was detected in approximately 4% of the samples. In this same population, PCR analysis of induced sputum detected 5% of the TB cases.

The results show that M. tuberculosis can be detected on oral swabs using a variety of popular molecular analytical platforms. When conducted on children, OSA delivered a diagnostic yield that was comparable to that of the more invasive induced sputum method. Non-invasive OSA has the potential to transform TB care and control.

Analysis of an Intervention to Reduce Truck Drivers' Exposure to Whole Body Vibration

Thomas Louwers
Occupational and Environmental Medicine, MPH
Preceptor: Peter Johnson

Analysis of an Intervention to Reduce
Truck Drivers' Exposure to Whole-Body Vibration

Louwers, TD1,2; Johnson, PW1; Davies HW3; Martin, GJ2; Vedal, S1; Wang, F4; Du, B5; Hughes, M1

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Introduction. The high prevalence of low back pain in drivers of commercial motor vehicles is well-documented. A number of interventions have focused upon the factors of support of the lumbar region of the spine, sedentary work, long hours, and exposure to whole-body vibration (WBV).

Objective. An intervention to be evaluated is an air-filled ballistic seat pad designed to reduce exposure to WBV. The effectiveness of the seat pad in motor vehicles has not yet been established. Results from a previous pilot study involving 12-ton and 16-ton vibratory rollers used by Seattle Public Utility drivers suggest that the seat pad is not effective at very low speeds (1-3 mph).

Methods. The current study compares WBV exposures in nine truck drivers at their existing air-suspension seat and at the seat pad which sits on top of their seat. This study uses a Wilcoxon signed rank test to compare the seat pad's effectiveness in reducing WBV exposures relative to their existing air-suspension seat.

Results. Overall, the truck drivers' vibration exposures were above daily vibration action limits and the air-filled ballistic seat pad did not significantly reduce WBV exposure.

Conclusions. The question of whether the air-filled ballistic seat pad may significantly reduce the incidence, prevalence, or severity of low back pain in drivers of commercial motor vehicles remains, particularly with respect to varying road types and driving conditions. The answer may lie in a future analysis of the power spectral densities. Buses produce more high frequency energy, where the air-filled seat pad was shown to be effective. Trucks produce less high frequency energy, which may diminish the air-filled seat pad's effectiveness.

Toxicokinetics of Domoic Acid in Nonhuman Primates

Rebekah Petroff
Environmental Toxicology, MS
Preceptor: Thomas Burbacher

Domoic acid (DA), a potent neurotoxin produced by algae from the Pseudo-nitzschia family, presents an emerging threat to public health. Human consumption of shellfish contaminated with large doses of DA may result in Amnesiac Shellfish Poisoning, a syndrome with symptoms including short-term memory loss, seizures, and death. Though studied in rodent models, the disposition characteristics of human ingestion of DA near the EPA's Tolerable Daily Intake, 0.075 mg/kg, are principally unknown. Thus, as part of a larger reproductive and neurodevelopmental study, we worked to determine the bioavailability and distribution kinetics of a low dose of DA in a species closely related to humans to potentially model and predict human dose-exposure relationships. Three healthy, adult, female Macaca fascicularis were intravenously injected with 0.005 mg/kg of DA in our initial study. In a follow-up study, the same 3 females were administered oral doses of 0.15 mg/kg DA. Blood plasma was collected up to eleven time points over 48 hours, and DA concentrations were measured via LC-MSMS. The i.v. study produced data consistent with findings from previous work, with no visible observed side effects. The disposition of DA displayed two-compartmental kinetics with a terminal half-life of one hour and levels below detection limit (0.05 ug/mL) at four hours. Additionally, the clearance of DA closely matched the glomerular filtration rate in macaques, suggesting primary excretion via renal clearance. Following oral administration, a prolonged exposure with a terminal half-life upwards of 18 hours was observed. The oral bioavailability of DA was 9-12%. From the pattern of DA disposition observed in these studies, we hypothesize that DA will accumulate when administered chronically despite low doses and minimal oral bioavailability. Studies using chronic exposures are currently underway to test this hypothesis. The first of its kind, this study not only demonstrated a higher oral bioavailability in primates than previously hypothesized, but also revealed that DA displays oral flip-flop kinetic patterns, possibly resulting in plasma accumulation of DA during chronic dosing.

Quantifying Heat Stress and Strain in Summer Tree Fruit Harvesters in Yakima Valley, Washington

Grant Quiller
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Preceptor: June Spector

Outdoor workers who perform heavy physical labor in hot conditions are at increased risk for developing occupational heat-related illness. Seasonal harvesting of certain tree fruits in Washington occurs during summer months. In addition to environmental heat exposure, harvesting involves internal heat generation from physical work. We sought to characterize heat stress and physiological effects of heat stress (heat strain) in outdoor tree fruit workers performing harvest activities. During the summer of 2015, 46 pear and apple harvesters participated in a cross-sectional study in Yakima Valley, Washington for one work shift each during warmer periods in August (n=34) and cooler periods in September (n=12). Heat stress and strain were characterized using American Conference of Governmental Hygienist (ACGIH) guidelines, which recommend thermal Action Limits and Threshold Limit Values based on several factors, including: environmental conditions, metabolic rate of task, and clothing ensembles. Heat exposure was measured near individual workers using hand-held Wet Bulb Globe Temperature (WBGT) monitors, metabolic rate was estimated using field observations and personal hip-mounted accelerometers, and research staff observed workers' clothing. Heart rate and core body temperature were monitored over the course of the work shift using heart rate monitors and wireless ingestible core body temperature sensors. Surveys of the workers indicated that 24 (52%) had experienced symptoms of heat-related illness and only 13 (28%) received training on working in the heat. For the 34 participants who worked in pear harvest in August, 25 (74%) exceeded the ACGIH Action Limit (WBGT 25^{o} C), and 16 (47%) exceeded the Threshold Limit Value (WBGT 28^{o} C) for a moderate work task (300 Watts). Work during the month of September did not exceed the Action Limit, assuming a moderate work task. Using personal accelerometer data (n=39), 12 (31%) exceeded the Action Limit and four (10%) exceeded the Threshold Limit Value. The 12 participants exceeding the Action Limit, based on accelerometer data, underwent heat strain assessment using both ACGIH guidelines and the physiological strain index. Of these 12 participants, nine (75%) exceeded the recommended maximum heart rate (180-age), and five (42%) exceeded the recommended maximum internal core body temperature of 38.5°C. Under current environmental and work conditions, workers are being exposed to hazardous thermal environments. Effective approaches for reducing heat exposure and/or promoting biological adaptation to heat are needed to prevent heat-related illness in vulnerable working populations.

Association Between In-Utero Exposure to Diesel Exhaust and N-acetyl-cysteine Supplementation in Hyperlipidemic Pregnant Mice and Development of Atherosclerosis at Multiple Vascular Sites in the Offspring

Divya Ravi
Environmental and Occupational Health, MPH
Preceptor: Michael Rosenfeld

Background: Cardiovascular disease is a leading cause of mortality in the world, accounting for an estimated 17.5 million deaths (WHO 2015 factsheet). Recent studies on the influence of environmental factors have shown an association between air pollution and heart disease, with diesel exhaust emission having a significant impact. Several mechanisms by which diesel particulate matter affect heart disease have been proposed, but the exact molecular mechanism involved remains unclear. This study was proposed to evaluate the association between in-utero exposure to diesel exhaust (DE) emission +/- maternal N-acetyl cysteine (NAC) supplementation and the development of atherosclerosis in the offspring later in life.

Methodology: In this study, pregnant hyperlipidemic apolipoproteinE (apoE -/-) deficient mice were randomized into one of four exposure groups: DN (DE + NAC), DC (DE + control water), FN (filtered air + NAC) and FC (filtered air + control water). The offspring born to these dams were nurtured in a controlled environment and sacrificed at 16 weeks of age. Various tissue specimens were isolated, including the innominate arteries (IA) which were examined microscopically for the presence of atherosclerotic lesions and morphological changes in the artery wall.

Results: Offspring born to DN dams recorded larger mean innominate atherosclerotic lesion areas and medial thickening. The prevalence of peri-adventitial fat in diesel exposed groups combined (DC and DN) was 1.49 times (95% CI 1.02-1.54) that of prevalence of peri-adventitial fat in the filtered air groups (FC and FN). No correlation was drawn between lesion development at the innominate artery versus the aortic sinus for a given exposure group. Lastly, an interesting trend which was observed was an increase in cumulative mortality between the 12th and 16th week for the DC group compared to the others.

Conclusion: The results obtained in this study suggest that in-utero diesel exhaust exposure is associated with peri-adventitial adipose tissue, but is largely not associated with vascular remodeling and atherosclerotic progression. More research is needed to better our understanding of the effect of environmental factors on ischemic heart disease and the role of protective agents in this disease process.

Addressing Household Air Pollution in Urban Shantytowns

Divya Ravi
Environmental and Occupational Health, MPH
Preceptor: Bill Daniel

Despite rapid economic progress, millions of lives in developing countries remain threatened by preventable health challenges resulting from poor environmental quality. Unprecedented rural-urban migration has left several cities in countries like India with pockets of densely populated regions lacking basic infrastructure. Individuals in these regions are often plagued with a large burden of air and water borne illnesses.
Human behavior also contributes significantly towards environmental quality which in turn influences disease occurrence and outcome. A vast majority of Indians still use biomass fuels like firewood, farm waste and kerosene to meet their daily household needs. These inefficient sources of energy are significant causes of air pollution and increase morbidity from non-communicable diseases like asthma, cataract, and cardiovascular disease.

The kitchen, an integral part of most households, serves an opportunity to address some of these health challenges at the individual and community level. PATH is building on its previous health initiatives to plan and implement a pilot intervention project that will provide a compact household kit to address the issue of indoor air quality in lower socio-economic households in the urban shantytowns of Mumbai. This kit would comprise of essential household tools such as a clean fuel cookstove, a compact ceramic water filter and a solar lamp. The project is aimed at creating value for bottom of the pyramid (BOP) households, while generating positive health and environmental impact. The student practicum focused on understanding this burden of household air pollution in urban India and perform literature review on fuel usage patterns, demographics and cultural influences to refine the components of the proposed kit.

Design of a Problem-Based Learning Case Series on Community Resilience

Jane Vaccaro
Environmental and Occupational Health, MPH
Preceptor: William Daniell

Title: Design of a Problem-Based Learning Case Series on Community Resilience

Background: The National Health Security Strategy defines Community Resilience (CR) as "the sustained ability of communities to withstand and recover - in both the short and long term - from adversity." CR represents an evolution in the disaster preparedness field, moving from a focus simply on traditional first responders to a "whole community" approach; this approach emphasizes engagement and partnership across public and private sectors. Reflecting its importance, federal-level initiatives and policies endorse CR inclusion in emergency management and public health preparedness programs. Several governmental agencies and preparedness experts identify a need and desire for training in CR that sustains knowledge and skill. Training approaches in disaster conventionally rely on lecture, drills, and on-the-job experience.
Problem-based learning (PBL) offers an alternative instructional method well-suited to training emergency and public health preparedness professionals. These professionals face rapidly changing situations with potentially serious consequences; cross-sector cooperation is critical. PBL uses credible scenarios, staged to use participant experience, and identify key issues and information required for collaborative problem-solving.
Project Goal: This project addresses the need for training resources on CR, a relatively new concept in the disaster management field. As part of a hazardous materials clean-up and disaster preparedness training program funded by the National Institute of Environmental Health Sciences, a PBL case series on CR was developed. This training tool designed for working professionals: builds awareness of CR, its' relevance to their practice, and ultimately will improve community capacity to withstand adversity. This CR PBL case series will serve as a contribution to a larger nation-wide clearinghouse of training resources available to others offering disaster preparedness training across the country.

Methods: In order to construct an informed and useful PBL case series on CR, the following steps occurred. First, a workshop at the University of Delaware provided a design framework for PBL. Subsequent literature review on CR and PBL informed problem/case design. A Logic Model helped establish work components, and conformity with the desired outcomes. Case design included writing learning objectives, selecting crucial content and resources, drafting authentic scenarios, staging case progression, and crafting assignments.

Outcomes: A series of 5 PBL case-based scenarios on CR for working professionals in emergency and public health preparedness. The series progresses from baseline knowledge of CR, to examples of community application, and finally an application exercise. Key concepts include: partnership building, community engagement, and collaborative problem-solving.

Future Directions: Next steps include an instructor guide, expert review, pilot testing, course evaluation, and revision.

Building Emergency Response Capacity with Northwest Tribes

Jane Vaccaro
Environmental and Occupational Health, MPH
Preceptor: Butch de Castro

MPH Practicum Abstract

Title: Building Emergency Response Capacity with Northwest Tribes

Issue: Geographic isolation, climate change vulnerabilities, historical economic disadvantage and cultural connectedness to the environment place Northwest Tribal members at increased risk for poor outcomes in a disaster. Throughout Pacific Northwest history, disasters both natural and man-made have disrupted the lives of Tribal communities. The capacity and readiness of individual Tribes to withstand, respond to, and recover from disaster events is limited in part because of a lack of resources and training. The Northwest Tribal Emergency Management Council (NWTEMC) identified the development of Tribal-based Medical Reserve Corps (MRC) units as important to build response capacity in a culturally-sensitive manner for each unique tribe and with an understanding of Tribal Sovereignty.

The MRC is a national network of local groups of volunteers, with a mission to engage the volunteers in activities that strengthen public health, reduce vulnerabilities and susceptibilities, lessen disaster risk, improve emergency preparedness, response and recovery capabilities, and build community resilience. NWTEMC hosts a collaborative Regional MRC Unit #1273 established in 2007. This regional unit is a valuable resource for both large and small tribes through consultation, outreach, and resource sharing.

Practicum Activities included:
Served as the Unit #1273 MRC Coordinator, consulted with Tribal representatives regarding Tribal MRC units, presented on MRC at the 12th Annual Northwest and National Tribal Emergency Management Council conference, and developed a toolkit to assist Tribes to start and maintain MRC units. The student-led annual Technical Assistance Review with the Federal Region X MRC Coordinator and the Washington State Department of Health resulted in a significant increase in the unit's compliance score and a clear outline of the required next steps to address gaps.

Recommendations include: secure funding for a Regional Tribal MRC Coordinator position, provide the toolkit to Tribal members, and broaden the scope of the Tribal MRC to address both traditional emergency response activities, and broader public health goals and initiatives aligned with national MRC objectives.
Funding: In August 2015, NWTEMC began participating with The University of Washington DEOHS Continuing Education Department through a CDC-NIOSH Education and Research Center grant #2T42OH008433-11, and, NIH-NIEHS Worker Health and Safety Training Cooperative, Worker Education and Training Program grant #U45ES006173-24 to provide training focused on emergency preparation and response.

Organotypic Modeling Platform for Adverse Outcome Pathways of Male Reproductive and Developmental Processes

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Preceptor: Elaine Faustman

In recent decades the number of men facing reproductive health and fertility problems has increased. Male reproductive dysfunction can be a result of exposure to chemicals during critical periods of testicular development. Multiple studies have shown that testis development is one of the most sensitive developmental processes and often drives risk assessment. The testis, however, is difficult to study and methods for assessing toxicity remain limited. This study addressed gaps in toxicity testing for this sensitive organ by building upon a cell culture method and framework for assessing toxicity outcomes in the developing testis. The present study 1. developed a systems biology platform for integrating normal and adverse responses across testis development in rodents in vivo and in vitro 2. leveraged a previously developed primary culture method to quantify baseline characteristics of the mouse culture in vitro and 3. used the primary mouse culture to evaluate adverse effects of cadmium treatment during a critical window of susceptibility. The systems biology platform was created by carrying out a literature search to create a framework for anchoring proliferation, steroid regulation and spermatogenesis processes throughout testis development. The co-culture for evaluating baseline and toxicant response to cadmium was initiated by isolating testis tissue from immature mice on postnatal day (PND) 9. To evaluate the ability of the in vitro culture to capture dynamic developmental processes, we characterized long-term viability, testosterone production, protein expression and morphology up to 16 days in culture. Western blotting revealed expression of cell type-specific protein markers and microscopy indicated changes in morphology throughout time. Additionally, testosterone detected in the culture indicated a switch in testosterone production from fetal to adult Leydig cells. To evaluate testis response to cadmium, the culture was treated on days in vitro (DIV) 2, 6 and 15 and effects were measured 24 hours later. These time points were chosen based on sensitive developmental processes shown to be happening in vivo in the systems biology framework. Cadmium was introduced to the culture with 2.5, 5 and 10 µM concentrations. We observed a dose dependent disruption in Leydig cell proliferation and testosterone production as well as a decrease in spermatogenesis processes on DIV 7 and 16, 24 hours post cadmium treatment. These quantitative results have been interpreted within our systems biology platform and demonstrate the potential of our model to capture multiple adverse outcomes in proliferation, steroid regulation and spermatogenesis pathways of male reproductive development.

BEBTEH stands for Biostatistics, Epidemiologic and Bioinformatics Training in Environmental Health

The following abstracts are from PhD students whose research are funded by this training grant. The National Institute of Environmental Health Sciences federal training grant (ES015459) supports predoctoral and postdoctoral trainees from the Departments of Biostatistics, Environmental and Occupational Health Sciences, Epidemiology, and Genome Sciences who are pursuing quantitative training with environmental health science applications.

Investigation of Metabolites Related to Manganese Exposure in Puget Sound Metalworkers

Marissa Baker
Occupational and Environmental Exposure Sciences, PhD
Preceptor: Noah Seixas and Christopher Simpson

Background and objectives: Manganese (Mn) is an established neurotoxicant associated with cognitive and motor health outcomes, with overexposure most likely to occur in occupational settings. Research has focused on finding both exposure and disease biomarkers for Mn, but a reliable, inexpensive, and reproducible biomarker for use in an occupational setting has proven to be elusive. Global metabolomics methods are being explored as one method to identify and develop a readily accessible biomarker of Mn exposure.

Methods: Subjects were recruited from two worksites, with Mn exposed subjects (n=20) working at a Mn foundry and Mn unexposed subjects (n=17) working as crane operators in a metal recycling facility. A personal, full-shift, inhalable air sample was collected using an IOM sampler, and a single end of day urine sample was collected on the same day from each subject. Urine samples were prepared and analyzed using standard global metabolomics methods. Samples were preprocessed, and the final data set included p=1353 features in ESI+ mode and p=1231 features in ESI- mode. Prior to any statistical analyses, both the exposed and unexposed groups were divided into a training set and validation set. Using only the training data, relative abundances of all mass features were compared between exposed and unexposed workers using two-sided t-tests adjusted for multiple comparisons. Mass features found to be significantly different between the exposed and unexposed workers in the training group (adjusted p-value <0.1) were subsequently tested in the validation set.

Results: Results from air monitoring confirmed the exposure difference between the two worksites, with the mean inhalable Mn exposure at the foundry being 365 µg/m3 (SD: 300, range: 98.5, 1243) and the mean Mn exposure for the crane operators being 9.2 µg/m3 (SD: 36.5, range: 0.02, 150.8). The relative abundances of 34 mass features were found to be significantly different between exposed and unexposed workers in the training set. Six of these mass features remained significantly different between the exposed and unexposed workers in the test set and were determined to be unique.

Conclusions: Despite not knowing the identity of the mass features, work presented here represents a novel method for exposure assessment and potential biomarker development in occupational health studies, and the first time, to our knowledge, that metabolomics has been applied in an occupational setting as a means to distinguish between exposed and unexposed workers.

Multivariate Approaches in Marker-Trait Association Studies: Leveraging Detection of Pleiotropy and Genotype-By-Environment Interactions

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Preceptor: Bruce Weir

Background: Although many quantitative traits are multivariate and highly correlated, standard marker-trait association methods are univariate. One alternative approach includes a preliminary step to association testing using composite scores. Another approach refers to “step-two” multivariate analysis using Simes extended procedures (e.g. MGAS). Either way, for datasets that include environmental effects (or when there is pleiotropy) these procedures might still be a challenge due to the multiple components and high variation. Objectives: Our main objective was to evaluate multivariate approaches that will optimize the detection of marker-trait associations considering the data complexity of quantitative traits. Methods: In this work, we have taken drought-resistance as a model. Our dataset contained two treatments (well-watered and water-limited), four drought-related traits (leaf area index – LAI, normalized difference vegetation index - NDVI, canopy temperature - CT, and canopy height - CHT), measured twice a day from 2010 to 2012. Association was tested for 841 marker loci assigned to 117 linkage groups of cotton. Data were collected on the 95 TM- 413 1×NM24016 recombinant inbred lines population. Our analysis approach included the evaluation of both preliminary and “step-two” methods. For the preliminary association step, instead of using the standard composite scores, partial least square regression (PLSR), and principal component analysis (PCA) followed by multiple analysis of variance (MANOVA) were utilized. For the “step-two” methods LOD scores from the QTL inclusive composite interval mapping (ICIM) were converted into p-values, and then checked their suitability for MGAS. All the statistical analysis were performed using R statistical software version 3.2.4. Results: PLSR seems an informative method to detect and display correlation between and within markers and traits. Negative correlations in trait and marker responses for LAI (-0.95), NDVI (-0.82), CH (-0.85), and a positive correlation for CT (0.85) were found. PCA followed by MANOVA detected 22 markers significantly associated ($p<0.01$) with drought resistance. From these markers, SNP013222 (a neurochondrin family protein) on linkage group 22, and MUSB1117a (a ribosomal protein S25 family protein) on linkage group 45, were also detected by the univariate QTL ICIM mapping. The other makers related to ubiquinol-cytochrome C reductase hing, DWD hypersensitive to ABA, and uncharacterized proteins. The “step-two” intervention did not fit this dataset as two flanking markers at the time were considered for considered; fact that lead to spurious results. Conclusion: Due to the complexity of this dataset, PCA followed by MANOVA seemed to be the most informative approach for detecting marker-trait associations.

A Survey of Veterinary Antimicrobial Prescribing Practices, Washington State 2015

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Antimicrobial resistance is a growing global health issue. It is also a recognized problem in veterinary medicine. We set out to assess antimicrobial prescribing practices as well as factors affecting the ordering of culture and sensitivity (C/S) testing and overall concerns regarding antimicrobial resistance among veterinarians in Washington State. Between September and December 2015 we administered a cross-sectional survey. The survey assessed veterinary diagnostic and treatment practices for bacterial infections, including perceived barriers and facilitators. Two hundred and three veterinarians completed the survey, of which a majority (166, 82%) were engaged in small animal or exotic animal practice. Ninety-one percent of respondents agreed that antibiotic resistant infections are an important issue in veterinary medicine. Of the 155 veterinarians who reported ordering culture and sensitivity tests (C/S), 36% reported ordering such testing “often” or “always” when treating presumptive bacterial infections. Most respondents (65%) mentioned cost as the most common barrier to ordering a C/S. Beta-lactams, fluoroquinolones, and nitroimidazoles, were the most commonly listed antimicrobials. Sixteen (10%) of the155 respondents that reported ordering C/S tests reported having access to or utilizing a clinic-specific antibiogram. This survey demonstrated that while antibiotics are commonly used in veterinary practice, and veterinarians are concerned about antibiotic resistance, cost is a barrier to obtaining culture and sensitivity testing to guide antibiotic therapy. Efforts to promote antibiotic stewardship in a “One Health” manner should address barriers to the judicious use of antibiotics in the veterinary practice setting.

Measurement Error-Correction for Fine Particulate Matter Exposure and Low Birth Weight

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Background: Air pollution epidemiology studies frequently use a two-stage design, first building an exposure model and then using predicted exposures to estimate health effects in a second model. Predicted exposures can introduce measurement error in estimates from the second stage. For spatial exposures, bootstrap correction methods and ensuring spatial compatibility, meaning that the monitor and subject locations come from the same distribution, can account for measurement error from predicted exposures, but these methods have not been applied to spatiotemporal exposures.

Methods: We analyzed the association between fine particulate matter (PM2.5) and birth weight in the U.S. state of Georgia using records with estimated date of conception during 2002–2005 (n=403,881). We predicted trimester-specific PM2.5 exposure using a complex spatiotemporal exposure model. To reduce measurement error by improving spatial compatibility, we restricted to mothers residing in counties with a PM2.5 monitor (n=180,440). We accounted for additional measurement error via a non-parametric bootstrap.
Results: Third-trimester PM2.5 exposure was associated with lower birth weight in the uncorrected and bootstrap-corrected analyses. Results for the unrestricted analysis were attenuated.

Conclusions: This study presents a novel application of measurement error correction methods for spatiotemporal air pollution exposures. Our results demonstrate the importance of spatial compatibility between monitor and subject locations in the spatiotemporal setting and provide further evidence of the negative impact of ambient particulate matter exposure on birth weight.

Cadmium Exposure and Incident Cardiovascular Disease: A Work in Progress

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Preceptor: Polly Newcomb

Background: Experimental and observational evidence suggests that cadmium, a toxic heavy metal found in food, tobacco, and air, is a risk factor for cardiovascular disease (CVD) in the general population. However, non-occupational prospective studies with incident endpoints are limited, with only three prior incidence investigations assessing the associations between specific CVD events, such as coronary heart disease (CHD) or stroke, and lower cadmium exposure levels. In addition, only one of these three reports focused on postmenopausal women – a group that may be particularly susceptible to cadmium-related health effects. We are proposing to evaluate the relationship between dietary cadmium intake and risk of total and specific CVD, both fatal and non-fatal, in the large, well-characterized Women's Health Initiative (WHI). This proposal is still a work in progress.

Methods: The WHI is long-term national study of 161,808 postmenopausal women, aged 50-79 years, who participated in either an observational study (OS) or one or more of the randomized clinical trial (CT) arms. We plan to approximate dietary cadmium intake in two ways. First, we will estimate short-term intake using data from a food frequency questionnaire (FFQ), which was completed by all participants at baseline. Second, we will explore cumulative cadmium exposure using urinary cadmium measured in spot samples from approximately 1,500 women participating in the WHI Bone Mineral Density (BMD) Study. We will apply Cox regression to estimate adjusted hazard ratios (HRs) and 95% CIs for total and specific CVD endpoints, comparing quartiles of dietary cadmium intake and using separate models for our different measures of cadmium. All models will appropriately account for smoking and for other potential confounders.

Next Steps: Our final proposal will be submitted to the WHI Publications and Presentation (P&P) Committee.

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Evaluating the Use of Modeled Baseline for Estimation of an Exposure Effect on Rate of Change

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In estimating the effect of an exposure on an outcome's change from baseline, there is often debate on how to best control for the baseline value. A common approach is to control for the measured value of the baseline. However, if the baseline is measured with error, the calculated change from baseline may be very inaccurate. To minimize the effect of measurement error, another approach is to fit a model for the baseline measurement and then control for the modeled baseline rather than the actual measurement. In environmental epidemiology we are primarily concerned with the case of non-randomized studies where an exposure's effect on the outcome begins well before the study. In this setting, measurement error of the outcome has been shown to create bias in estimates of the exposure's rate of change coefficient if the regression model controls for the measured baseline. We replicate this result in simulations modeling air pollution exposure effect on coronary artery calcium (CAC), and establish the future framework to explore the opposite question of when a modeled baseline may fail. This work has implications for analysis in epidemiologic cohort studies such as MESA Air where the goal was to assess the effect of air pollution on progression of subclinical cardiovascular disease.

Differences in the Human Oral Microbiome Composition Are Associated with Agricultural Exposure

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Preceptor: Elaine Faustman

In an agricultural community cohort sampling of 65 farmworker and 52 control non-farmworker adults we investigated agricultural pesticide exposure associated changes in the oral buccal microbiota. Blood and buccal samples were collected concurrently from individuals in two seasons, summer 2005 and winter 2006. Mass spectrometry quantified blood concentrations of the organophosphate insecticide Azinphos-methyl. Buccal oral microbiome samples were 16S rRNA gene DNA sequenced and assigned to the bacterial taxonomy with compositional data proportional abundances of bacteria calculated per sample. Analysis of microbiota from individuals with and without Azinphos-methyl blood burden showed significant perturbations in common bacteria, including Streptococcus. Diversity and abundance between individuals' taxonomically assigned buccal bacteria read proportions was investigated by Principal Component Analysis (PCA) to reveal two primary clusters of individuals' microbiome types. The Azinphos-methyl "Exposed" cluster was significantly enriched for farmworkers and included included those who also had Azinphos-methyl detected in blood. Approximately one-half of the "Exposed" cluster were individuals without detected blood concentrations of Azinphos-methyl, suggesting previous exposure. Common genera proportions, including Streptococcus and the microbiome diversity are observed to be significantly reduced in the buccal microbiota of individuals from the "Exposed" cluster. Thus, we found an association between individuals with detected blood burden of the insecticide Azinphos-methyl and the microbiota composition of the buccal swab oral microbiome.

Spatial Distribution of Esherichia coli O157 by Phylogenetic Lineage

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Preceptor: Jonathan Mayer

Background: Shiga toxin-producing Escherichia coli (STEC) O157 is estimated to cause over 60,000 illnesses and 2,000 hospitalizations each year in the United States. The vast majority of STEC O157 infections are sporadic, with no clear link to a known outbreak, and non-food sources of infection have been recognized as increasingly important. Numerous studies have examined the spatial distribution of STEC O157 infections. These studies suggest variation in underlying risk and have linked sporadic cases to known outbreaks. By subdividing the pathogen into phylogenetic groupings, some of which have been associated with more severe disease outcomes, previous studies have also offered insight into the pathogen's likely path of evolution. This study explores the spatial distribution of STEC O157 by phylogenetic lineage at a smaller scale and with a more refined phylogenetic tree than previously done. The goals are to a) identify areas of increased risk for specific lineages to guide further investigations of lineage-specific risk factors, and b) provide evidence for or against the hypothesis that bacteria populations are being maintained locally.

Methods: A retrospective cohort of all reported, culture-confirmed STEC O157 cases in Washington State from 2005-2014 was used. Bacterial isolates from a sample of cases were analyzed using an established single nucleotide polymorphism (SNP) array to determine phylogenetic lineage. Lineage was assigned to non-typed isolates based on shared pulsed field gel electrophoresis (PFGE) profile with a typed isolate. Information on demographics, including county of residence, clinical course, and exposure characteristics was ascertained from Washington State Department of Health case report forms, which were completed as part of routine public health investigations.

Results: There were 1,160 reported, culture-confirmed STEC O157 cases during the study period. Isolates from over half the cases belonged to a single phylogenetic lineage, with two other clinically-associated lineages and a number of bovine-biased lineages making up the remainder. Children under the age of 10 made up 36% (418) of the cases. Hemolytic uremic syndrome (HUS), a severe clinical outcome of STEC O157 infection that can lead to kidney failure and death, occurred in 84 (7.2%) of cases. Six cases died during the study period. Two areas of the state showed higher incidence of STEC O157 than observed elsewhere, and there was variation by lineage.

Conclusions: Increased incidence in specific areas of the state may offer further insight into the epidemiology of specific STEC O157 lineages.

Nonparametric Estimation of Survival from Stratified Cross-Sectional Data

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Preceptor: Marco Carone

Follow-up studies are often based on observations obtained as a cross-sectional sample. Valid inference for survival in the target population must account for the truncated sampling scheme in addition to the well-known issue of right-censoring in the observed survival times. Nonparametric estimation of survival has been studied previously for this case. When the observations in such a study are not a simple random sample, so that certain demographic strata are overrepresented, naïve estimation of the survival curve from the full sample will be biased for the target population survival. Appropriate knowledge about stratification within either the target or the cross-sectional population is required to correct for the stratified sampling scheme.

We propose three estimators of survival that account for left-truncation, right-censoring and stratified sampling. The first two estimators are weighted averages of the stratum-wise survival curves utilizing, say, census information from either the target or the cross-sectional population to construct the weights.

A third estimator is constructed by using census information to construct representative cross-sectional subsamples that randomly exclude observations from the overrepresented stratum. Survival curves from the subsamples consistently estimate survival in the target population, but are inefficient due to the random exclusion of data. We thus propose that the final estimate of survival should be the average over independent realizations of the random exclusion procedure.

We present the results of simulation studies comparing the three candidate estimators. The results of these simulations suggest that the estimators are asymptotically equivalent provided estimation of the target population weights is stable. The random exclusion-based estimator is preferable in the sense that it avoids the instability encountered in estimating weights. We conclude by illustrating the efficiency of the random exclusion estimator at various numbers of independent subsamples, working towards guidelines for practitioners.