Human Exposure Biomarkers to Oil Spills

Clementina Mesaros, PhD
Trevor Penning, PhD

Abstract

The Deepwater Horizon Oil spill was the largest in US history and one-third of the oil has not been accounted for. The human health hazard most associated with oil spills is exposure to petrogenic polycyclic aromatic hydrocabons (PAH). Petrogenic PAH are unique to oil spills because they are heavily alkylated and or oxygenated and differ from pyrogenic PAH that arise due to incomplete combustion of fossil fuels e.g. benzo[a]pyrene B[a]P. Benzo[a]pyrene B[a]P is a known human carcinogen and must be metabolically activated to exert its carcinogenic effects but little is known about the metabolism of petrogenic PAH. This pilot project extends studies that were co-jointly funded with the P30 Environmental Health Sciences Core Center at UTMB to study the “Toxicology of Petrogenic PAH” which was supported by the GC-HARMS consortium: “Gulf Coast Health Alliance; health Risks related to the Macondo Oil Spill funded by NIEHS. “ GC-HARMS is a community-based participatory research project in which gulf-communities have continued concern about seafood safety due to its possible contamination with petrogenic PAH. This concern stems from mistrust in estimates of the safety of the sea-food that were based on measurement of pyrogenic PAH in sea food. As part of the GC-HARMS consortium we elucidated the metabolic fate of six alkylated petrogenic PAH and three oxygenated petrogenic PAH in human hepatoma (HepG2) cells and human small intestine (CaCO2) cells to mimic pathways of exposure due to ingestion. We identified a number of unique metabolites, which could act as signatures of human exposure to oil spills. These metabolites were detected in the urine of a convenience set of ten human subjects from a longitudinal cohort of individuals that may have been exposed to contaminated sea-food. These metabolites were absent from archival urine samples from non-exposed individuals. These metabolites were 1-methyl-phenanthrene-trans-dihydrodiol, O-bis-methyl-retene-biscatechol, and either tetrahydroxy-5-methyl-chrysene-1,2-dione or tetrahydroxy-5-methyl-chrysene-7,8-dione and were detected using LC-Q-Exactive hybrid quadrupole HRMS. Receiver operator curves gave estimates of specificity and sensitivity of > 90% to distinguish between the two groups. These metabolites have the potential of being the first human biomarkers of exposure to oil spills. The proposed pilot will conduct a replication study to detect these biomarkers in the urine of 40 exposed individuals from the UTMB cohort at time of first collection; and in samples from the first 10 subjects that have been collected longitudinally to determine whether changes have occurred over time. Authenticated synthetic standards synthesized at UTMB will confirm the identity of the biomarkers and provide the foundation to develop a quantitative LC-MS/MS biomarker assay using [13C]-labeled internal standards. The proposed pilot will utilize the Translational Biomarker Core (TBC) of the CEET and the Synthetic Core of the P30 center at UTMB. In this application funding for the TBC portion is requested. UTMB will request funding for their component through their own pilot project mechanism. This inter-center pilot project has the potential to generate further funding from NIEHS or the National Academies Gulf Research Program.