Vinyl Chloride and Health Research at the University of Louisville

The University of Louisville (UofL) is a national resource to study the health effects of environmental chemicals, especially airborne toxicants such as vinyl chloride. The studies conducted at the University of Louisville Superfund Research Center examine the cardiometabolic and hepatic toxicity of volatile organic compounds (VOCs) - vinyl chloride, benzene, acrolien, 1,3-butadiene, etc. UofL faculty, including physician liver specialists, Drs. Matt Cave and Craig McClain study the effects of vinyl chloride and structurally-related compounds on liver disease, especially Toxicant Associated Steatohepatitis-TASH. Drs. Sanjay Srivastava and Igor Zelko examine the cardiovascular and metabolic effects of vinyl chloride and other volatile organic compounds (VOCs).

UofL researchers are the pioneers of studying the adverse health effects of vinyl chloride. In the 1970's, community surgeons noted a cluster of hepatic hemeangiosarcoma (a rare form of liver cancer that is always fatal) among workers at the BF Goodrich rubber plant in Louisville. They approached the managers of the plant and the UofL Occupational Toxicology group, led by the late Dr. Carlo Tamburro. A health surveillance program was quickly instituted wherein all plant workers received health exams, blood and urine were obtained, and medical and occupational histories were recorded. It was rapidly determined that exposure to large amounts of vinyl chloride was the cause of the hemeangiosarcoma. Workers were quickly removed from exposure and OSHA rapidly promulgated regulations for vinyl chloride. This event is considered a seminal event in occupational toxicology.

Vinyl chloride is mainly used to manufacture the polymer polyvinyl chloride, which is extensively used to make pipes, wire coatings, building materials, and other consumer products. Although production of vinyl chloride in Louisville has decreased over the years, the global production of vinyl chloride exceeds 8 million metric ton/year. Vinyl chloride is classified as a human carcinogen and is ranked fourth on the Centers for Disease Control and Protection's Agency for Toxic Substances and Disease Registry Substance Priority List.

The recent train derailment and vinyl chloride spill in East Palestine, Ohio resulted in involuntary exposure to extremely high levels of vinyl chloride and warrants further studies to examine the chronic health effects of acute vinyl chloride and other structurally related chemicals exposure. The UofL Superfund Research Center (https://louisville.edu/enviromeinstitute/superfund) of the Envirome Institute (https://www.enviromeinstitute.com) and Hepatobiology & Toxicology COBRE (https://louisville.edu/medicine/departments/pharmacology) could serve as core resources for such studies and help in such disaster preparedness, response, and health surveillance.

Selected recent publications on vinyl chloride from UofL:

Wahlang B, Beier JI, Clair HB, Bellis-Jones HJ, Falkner KC, McClain CJ, Cave MC. Toxicant-associated steatohepatitis. Toxicol Pathol., 2013 Feb;41(2):343-60. PMID: 23262638; PMCID: PMC5114851; doi: 10.1177/0192623312468517. Epub 2012 Dec 21.

Zelko IN, Taylor BS, Das TP, Watson WH, Sithu ID, Wahlang B, Malovichko, MV, Cave MC, Srivastava S. Effect of vinyl chloride exposure on cardiometabolic toxicity. Environ Toxicol. 2022 Feb;37(2):245-255. PMID: 34717031; PMCID: PMC8724461; doi: 10.1002/tox.23394. Epub

Wahlang B, Jin J, Beier JI, Hardesty JE, Daly EF, Schnegelberger RD, Falkner KC, Prough RA, Kirpich IA, Cave MC. Mechanisms of Environmental Contributions to Fatty Liver Disease. Curr Environ Health Rep. 2019 Sep;6(3):80-94. PMID: 31134516; PMCID: PMC6698418; doi: 10.1007/s40572-019-00232-w.

Cave M, Falkner KC, Ray M, Joshi-Barve S, Brock G, Khan R, Bon Homme M, McClain CJ. Toxicant-associated steatohepatitis in vinyl chloride workers. Hepatology. 2010 Feb;51(2):474-81. PMID: 19902480; PMCID: PMC4019991; DOI: 10.1002/hep.23321

Wahlang B, Hardesty JE, Head KZ, Jin J, Falkner KC, Prough RA, Cave MC, Beier JI. Hepatic Injury Caused by the Environmental Toxicant Vinyl Chloride is Sex-Dependent in Mice. Toxicol Sci. 2020 Mar 1;174(1):79-91. PMID: 31774537; PMCID: PMC7043220; DOI: 10.1093/toxsci/kfz236

Guardiola JJ, Hardesty JE, Beier JI, Prough RA, McClain CJ, Cave MC. Plasma Metabolomics Analysis of Polyvinyl Chloride Workers Identifies Altered Processes and Candidate Biomarkers for Hepatic Hemangiosarcoma and Its Development. Int J Mol Sci. 2021 May 11;22(10):5093.
PMID: 34065028; PMCID: PMC8150673; DOI: 10.3390/ijms22105093

Anders LC, Yeo H, Baelin BR, Lang AL, Bushau AM, Douglas AN, Cave M, Arteel GE, McClain CJ, Beier JI. Role of dietary fatty acids in liver injury caused by vinyl chloride metabolites in mice. Toxicol Appl Pharmacol. 2016 Nov 15;311:34-41. PMID: 27693805; PMCID: PMC5079761; DOI: 10.1016/j.taap.2016.09.026. Epub 2016 Sep 28.

Guardiola JJ, Beier JI, Falkner KC, Wheeler B, McClain CJ, Cave M. Occupational exposures at a polyvinyl chloride production facility are associated with significant changes to the plasma metabolome. Toxicol Appl Pharmacol. 2016 Dec 15;313:47-56. PMID: 27765658; PMCID: PMC5712227; doi: 10.1016/j.taap.2016.10.001. Epub 2016 Oct 17.