Environmental Fate and Transport Modeling and Retrospective Exposure Estimation for Perfluorooctanoic Acid (PFOA) for Participants in the C8 Health Project

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People who might have been exposed to perfluorooctanoic acid (PFOA) released by the DuPont Washington Works facilities near Parkersburg, West Virginia, were concerned about a possible association between PFOA exposure and their health problems; 69,030 of these individuals participated in a cross-sectional study in 2005-2006 ("The C8 Health Project"). This dissertation sought to estimate historical PFOA exposures and serum concentrations experienced by each of about 45,000 non-occupationally exposed participants in the C8 Health Project who consented to share their residential histories and measured PFOA serum concentrations.

We linked several environmental fate and transport modeling systems to model PFOA concentrations in local air and water based on estimates of historic emission rates from the facility, physicochemical properties of PFOA, and local geologic and meteorologic data beginning in 1951. Annual PFOA exposure rates were estimated for each individual based on predicted calibrated water concentrations and predicted air concentrations from a linked environmental fate and transport model, individual residential histories, and default assumptions from the EPA Exposure Factors Handbook. Individual exposure estimates were coupled with a one-compartment pharmacokinetic model to estimate time-dependent serum concentrations.

Our linked environmental fate and modeling system predicts water concentrations within a factor of 2.1 of the average observed water concentration for each of the six municipal water districts. For all participants (n = 45,276), predicted and observed median serum concentrations in 2005-2006 are 14.2 and 24.3 ppb, respectively (Spearman's rho = 0.67). For participants who provided daily public well water consumption rate and who had the same residence and workplace in one of six municipal water districts for five years before the serum sample (n = 1,074), predicted and observed median serum concentrations in 2005-2006 are 32.2 and 40.7 ppb, respectively (Spearman's rho = 0.82).

Serum PFOA concentrations predicted by linked environmental fate and transport model, and exposure and pharmacokinetic models are well correlated with observed 2005-2006 human serum concentrations for C8 Health Project participants. These individualized retrospective exposure and serum estimates will be used in a variety of epidemiologic studies being conducted in this region.