

**Status report: Association of perfluorooctanic acid (C8/PFOA) and  
perfluorooctanesulfonate (PFOS) with lipids among children in the Mid-Ohio Valley**

**The C8 Science Panel (Kyle Steenland, Tony Fletcher, David Savitz)**

**Oct 28, 2009**

This status report summarizes the findings of a statistical analysis of the relationship between PFOA (and PFOS) levels measured in the blood serum of the childhood participants in the C8 Health Project, and cholesterol and other lipids in their serum. A detailed report will be submitted to a peer-reviewed journal for publication.

The work leading to this report, unlike previous status reports to the court that reflect work directed by the Science Panel members, has been led by collaborators at West Virginia University, Stephanie Frisbee, Anoop Shankar, Sarah Knox, and Alan Ducatman. These investigators have access to the same de-identified data set originating from the C8 Health Project as we do. All three Science Panel members are co-authors on the report being submitted to the journal and concur with its findings, which are outlined below.

## Summary

**Background:** Serum perfluorooctanoic acid (PFOA) has been associated with total cholesterol and other lipids in some studies of exposed workers. Here we examine the association of PFOA and a related chemical, perfluorooctanesulfonate (PFOS), with lipids in a large population of children in the mid-Ohio valley. Many in this population have high levels of serum PFOA due to drinking water contaminated from a nearby chemical plant.

**Methods:** The study population consisted of 12,476 community residents under age 18 living at some point in six water districts contaminated by PFOA, who participated in a large health survey in 2005-2006. Participants in the health survey (the C8 Health Project) were required to have lived, worked, or gone to school in one of the contaminated water districts for at least one year. The relationship between PFOA and PFOS with total cholesterol, low density lipoprotein (LDL), high density lipoprotein (HDL), and triglycerides was examined via linear and logistic regression, after adjustment for other variables which affect these lipids.

**Results:** The average level of PFOA in the serum was 69 ng/ml, while the average level of PFOS was 23 ng/ml. The PFOA levels were much higher than the US population average level of about 5 ng/ml, while the PFOS levels were similar to the average level for the US population. In multivariate models adjusting for other factors (age, body mass index, sex, fasting status prior to blood collection), higher PFOA and PFOS were each significantly associated with higher total cholesterol and LDL cholesterol. There were no consistent trends between PFOA and either HDL or triglycerides. Higher PFOS was associated with higher HDL, but showed no trend with triglycerides.

The predicted increase in cholesterol from lowest to highest quintile of PFOA (the lowest 20% to the highest 20% of the population) was 5 mg/dl, for example an increase from 160 to 165 mg/dl cholesterol. The corresponding increase in cholesterol for high vs. low PFOS was 9 mg/dl.

The risk for high cholesterol in children (total cholesterol  $\geq$ 170 mg/dl), and high LDL in children, (LDL  $\geq$ 110 mg/dl) was also studied. There was a modest but statistically significant extra risk of high total cholesterol with increasing PFOA; there was a 20% extra risk for those with the highest 20% of PFOA vs. the lowest 20%. Also, there was a 60% extra risk of high cholesterol for those with the highest 20% of PFOS, vs. those with the lowest 20%. Similar increases in risk were seen for both chemicals for high levels of LDL (the 'bad cholesterol'); a 40% extra risk of high LDL for the highest quintile PFOA vs. the lowest, and a 60% extra risk for the highest quintile of PFOS vs. the lowest. For HDL (the 'good cholesterol') higher levels of PFOS were associated with decreased risk of low HDL ( $<$ 40 mg/dl), i.e., a change in a favorable direction. No trends for high triglycerides were observed for either fluorocarbon.

**Interpretation:** We have seen modest associations between PFOA and PFOS and some lipids in children. Interpretation of these results is made difficult by the cross-sectional design of our study, which prohibits knowing whether an increase in cholesterol (or LDL cholesterol) may have followed or preceded an increase in PFOA or PFOS. The mechanism by which these chemicals might be related to cholesterol in humans is not known. These data alone cannot prove whether the PFOA and PFOS differences in these children caused the observed shift in cholesterol, or whether there is another explanation. For example, another explanation could be that there is some unknown exposure (such as another substance in the blood), which itself correlates both with increased lipids, and with increased retention of PFOA/PFOS in the blood.

The Science Panel is conducting further more definitive studies to try to determine which of these possibilities is more likely. The fact that both PFOA and PFOS were associated with increases in cholesterol may indicate an association with this chemical class (perfluorinated compounds) in general, rather than specifically either PFOA or PFOS. These findings for total cholesterol and LDL cholesterol in children are similar to a previous finding in adults in this same population.