A Closer Look at Chlorpyrifos and Brain Scans

Recent publicity about reported brain anomalies and exposures to the insecticide chlorpyrifos has created some confusion among readers about the potential for the product to cause prenatal effects. These findings have attracted attention because they run contrary to the weight of the scientific evidence. Although some news accounts have treated these new findings as definitive, a closer look shows that these accounts have been greatly overstated.

Epidemiological studies look for statistical associations between health outcomes and various social, biological or environmental factors in hope of gaining insights for further research. But associations themselves cannot demonstrate cause and effect. The apparent link may be a chance event or there may be a third factor underlying both (as when a dog barks just before the doorbell rings but both outcomes are occasioned by someone at the door).

Cause and effect can only be determined by the deeper understanding of associations offered by a weight-of-the-evidence evaluation incorporating all relevant data. In this case, both limitations in study design and also the weight of the evidence from decades of high-quality research calls the findings of these recently published chlorpyrifos brain scan studies strongly into question.

What the Researchers Did

Since the early 2000s, researchers at Columbia University have been using epidemiological methods to study a group of New York inner-city children born between 1998 - 2003 in an effort to link adverse growth and developmental effects with different environmental exposures. This research has produced a number of published studies addressing exposures to chlorpyrifos and additional publications linking adverse health outcomes to exposures to other chemicals as well.

In the study that has recently generated news media attention, the authors compared brain scans of 40 children divided into two groups representing “high” vs. “low” chlorpyrifos exposure. [1] While none of the brain scans showed clinical evidence of adverse effects, the authors noted some differences between the groups, and theorized how the differences might be an indication of developmental problems and how chlorpyrifos might be a cause of them.

What the Columbia University Research Does and Doesn’t Mean

None of the associations with chlorpyrifos exposure reported in the total body of publications of Columbia University researchers – including their most recent publication on chlorpyrifos and brain scans – show cause and effect. Limitations of this research are outlined in the following points.

1. The recent publication evaluating prenatal chlorpyrifos exposures and brain scans in childhood is the first of its kind. It has not been replicated by independent study, as recommended by the scientific method.

[1] Rauh et al. (2012) Brain Anomalies in Children Exposed Prenatally to a Common Organophosphate Pesticide. Proc. Nat. Acad. Sci. early edition.
www.pnas.org/cgi/doi/10.1073/pnas.1203396109

2. Based on extensive, high-quality animal research, all of the exposures reported for these children would have been thousands of times too low to cause any biological effect. (Most of the reported exposures were, in fact, too low to be measured accurately with current analytical methods.)

3. Developmental effects have not been noted with chlorpyrifos in animals at exposures comparable to those reported for these children. (The animal studies cited by the authors to support their findings used doses more than 100,000 times greater than exposures estimated for these children. Additionally, the studies involved injection of chlorpyrifos subcutaneously, mixed in a neurotoxic solvent, which is not characteristic of anticipated real world exposures.)

4. The authors classified the chlorpyrifos exposure based on a single blood sample taken at birth. But this provided no information about chlorpyrifos exposures at relevant prenatal developmental periods.

5. The children were residing in economically stressed neighborhoods, and many confounding variables known to influence brain development (genetics, nutrition, home environment, maternal education, etc.) were controlled for by the authors only imperfectly or not at all.

6. Despite repeated requests, the authors have consistently declined to release the raw data on which their conclusions are based. This limits the ability of other researchers to evaluate their findings and hampers EPA's use of them for regulatory assessments.

Specific to the recently published MRI scan comparisons of these two groups of children:

7. While brain development is dynamic, these MRI scans provide only a single snap-shot in time, offering no information about growth patterns before or after that point. Especially since the average age of the two groups of children differed by more than half a year, the reported differences may merely reflect age-related stages in normal brain development.

8. Although certain elements of brain morphology are highly heritable, the authors provide no comparisons of child vs. parental brain scans, which might have identified genetic components to the reported differences. Nor is it clear that the authors controlled for the effects of maternal IQ and education.

9. The authors do not indicate whether the children were evaluated for psychiatric disorders known to influence brain morphology (e.g., autism). Also, some of the children reportedly had ADHD, yet no information is provided about whether medications were used that could influence brain development. Relevant to ADHD as well, the results of brain scans can be influenced by movement within the scanner, yet the authors do not indicate how they controlled for this potential variable.

How This Research is Being Evaluated

Other researchers have attempted to place findings reported in publications by Columbia University authors in context with other research, including hundreds of laboratory studies with chlorpyrifos. Previous evaluations have concluded that serious limitations "*make it very difficult to infer a causal relationship between chlorpyrifos and adverse neurodevelopment effects based on this study."*[2] Likewise, a recently completed evaluation considering the findings of these researchers concluded that "*the epidemiology data are not sufficiently robust to support the hypothesis that chlorpyrifos is a causal factor for neurodevelopmental effects….the few positive associations observed in epidemiology studies would be attributed to alternative explanations*." [3]

EPA is currently conducting a regularly scheduled regulatory reassessment of chlorpyrifos, including careful evaluations of the latest human health research. EPA has said that it will evaluate this total body of research using a weight of the evidence approach considering all relevant animal and human studies, including studies by Columbia University researchers.

Dow AgroSciences welcomes data-driven, highly transparent regulatory evaluations of its products. We remain confident in the extensive science supporting the continued use of chlorpyrifos, which is currently authorized for application in about 100 nations based on detailed evaluations by regulatory authorities in the U.S., Canada, the United Kingdom, Japan, Australia, New Zealand and elsewhere. No pest control product has been more thoroughly evaluated.

Further information about chlorpyrifos may be found at www.chlorpyrifos.com.

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[2] Eaton et al. (2008) Review of the Toxicology of Chlorpyrifos with an Emphasis on Human Exposure and Neurodevelopment. Crit. Rev. Toxicol. Vol. 38, No. S2, pages 1–125
http://informahealthcare.com/doi/pdf/10.1080/10408440802272158

[3] Prueitt et al. (2011) Hypothesis-Based Weight-of-Evidence Evaluation of the Neurodevelopmental Effects of Chlorpyrifos. Crit. Rev. Toxicol. Vol. 41, No. 10, pages 822-903.
http://informahealthcare.com/doi/pdf/10.3109/10408444.2011.616877