

ORGANOPHOSPHATE PESTICIDES & CHILD HEALTH:

A Primer for Health Care Providers



CHRONIC HEALTH IMPLICATIONS

The long-term consequences of acute organophosphate (OP) poisoning are better understood for adults than children. Memory and attention deficits, as well as increased depression, anxiety and irritability are reported following adult OP poisoning¹⁵. Because the nervous system is still developing in childhood, children are believed to be at increased risk for long-term sequelae following both acute and chronic organophosphate exposure.

At a follow-up appointment one month later, José and Rosa report that Isabella has been well. However, they are still worried that there may be some longstanding damage done to their daughter. They have heard from other workers that pesticides can have effects that develop later, like attention deficit and hyperactivity disorder (ADHD) and cancer.

What are the sequelae of acute organophosphate poisoning?

What is the evidence for chronic health effects in children exposed to pesticides?

CHRONIC SEQUELAE OF ACUTE POISONING

Several studies describe long term neurological sequelae in adults who have experienced acute organophosphate poisoning. As such, there is reason to suspect that childhood OP poisoning can result in long-term health consequences. To date, there is minimal epidemiologic data in children to support or refute such a claim.

A recently published study¹⁶ investigated whether acute OP poisoning in early childhood is associated with behavior and learning deficits later in life. The study found small, but statistically significant, motor impairments in 9-10 year old school children who had been poisoned by OP pesticides at the age of 2 years. This study is one of the first to investigate the sequelae that follows the disruption of the cholinergic system in early life. Given the cognitive and behavioral impairments seen in adult studies following acute

OP poisoning^{15, 17} the potential for memory, learning, and attention deficits in children needs further exploration.

You contact your local [Pediatric Environmental Health Specialty Unit \(PEHSU\)](#) and they help you review the scientific evidence regarding the association between OP poisoning and long-term sequelae in children. You determine that neurological sequelae are possible but not certain, and discern that the likelihood of other health sequelae (such as cancer) is much less certain. You discuss this information with José and Rosa and make a plan to closely follow Isabella's neurodevelopmental progress during her well-baby visits. You also refer Isabella to your local birth-to-three program for an evaluation. In addition, you plan to address other potential threats to Isabella's neurodevelopment by screening her for lead poisoning and anemia. Finally, you discuss things that José and Rosa can do to promote Isabella's healthy growth and brain development, such as ensuring good nutrition and reading to Isabella.

MECHANISMS OF CHRONIC TOXICITY

We have already discussed how childhood behavior and physiology results in elevated exposure to pesticides in children. Due to the fact that their organ system are still developing and growing, the mechanism of chronic organophosphate toxicity has similarities and differences to that experienced by adults. Understanding the similarities and differences clarifies why chronic OP exposure may result in a wider range of illness or developmental deficits in children as compared to adults.

Chronic exposure to organophosphates during development causes toxicity via 3 distinct pathways. First, chronic over-stimulation at cholinergic nerve terminals results in neuronal damage in a mechanism similar to that seen in acute OP toxicity. Distinct from this mechanism, organophosphates disrupt developmental signaling and patterning via cholinergic-dependent and cholinergic-independent mechanisms.

As these data evolve, evidence of childhood susceptibility to OP pesticides has driven the review of [regulatory measures that establish "safe" levels of organophosphate exposure](#). As a result of such regulatory reviews, home use of several OP pesticides, including chlorpyrifos and diazinon, has been phased-out⁵.

ADVERSE EFFECTS OF CHRONIC EXPOSURE

A few days after your follow-up appointment with Rosa, José & Isabella, you receive a nervous phone call from Rosa. She wonders if her child will be harmed by mere virtue of the fact that her husband works on a farm and they live near the fields. Can the lower-level exposure of day-to-day life cause permanent harm?

Chronic OP toxicity is characterized by:

- Subtle, often sub-clinical symptoms (compared to acute toxicity)
- Variable time lag between exposure and illness (often not immediate)

Because of these characteristics, connecting illness to chronic pesticide exposure is difficult. Organophosphates are known to act on the nervous system, thus the research to date has largely focused on determining if chronic OP exposures cause neurodevelopmental effects.

Both toxicological evidence (mostly from rodent models) and evidence from observational epidemiological studies support the idea that chronic organophosphate exposure can produce neurodevelopmental deficits.

Recent studies in U.S. populations have linked higher levels of chronic exposure to organophosphate insecticides *in utero* with reduced birth weight, head circumference, and gestational length in infants. In addition, there is emerging evidence of adverse neurodevelopmental effects in more highly exposed infants. These studies have been conducted in both agricultural and inner-city environments, suggesting that both rural and urban settings have potentially dangerous pesticide exposure opportunities. Pediatric asthma, cancer, and birth defects are also a focus of concern, but the data linking such outcomes with exposure are limited (either inadequate or lacking).

Despite our incomplete understanding, the suggestive harm that chronic OP exposure poses to child development merits recommendations to parents to reduce pre- and postnatal exposure to pesticides, particularly OP's.

You acknowledge Rosa's concerns and provide some anticipatory guidance about how to reduce ongoing, potentially problematic pesticide exposures to their baby. You focus on providing ideas that empower the family to lower the para-occupational and spray drift pathways of exposure.