Reducing Pesticide Handler Exposures

A Model Research and Practice Initiative in Washington State

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THE CHALLENGE

Farmers and farmworkers alike voice concerns about exposure to OP pesticides, and for good reason. The consequences can be severe. A relatively minor difference in dose can produce symptoms as mild as a headache or become life-threatening. Plus, evidence suggests that some pesticides, such as OPs, may have long-term health effects on adults and children. Research has linked pesticide exposure to increased risk for male infertility, Parkinson's disease, certain types of cancers. A mother's exposure can result in birth defects, lower birth rates and birth weights, and miscarriages.

In particular, pesticide handlers have the greatest potential for exposure because their work brings them in close contact with pesticides.

Safety is the "*work of changing minds. And it is not done overnight*." – Project Participant

In 1992, the US Environmental Protection Agency (EPA) estimated that 10,000 – 20,000 physician-diagnosed pesticide poisonings occur each year among hired farmworkers. The same year, the Worker Protection Standard was revised and expanded in an attempt to reduce these poisonings. However, a recent study in California from 1997 to 2000 found that no worker safety laws were violated in 38% of pesticide poisoning cases, calling into question whether standards are adequately protective. According to a review of pesticide poisonings from 2003-2008 by the Washington State Department of Health, pesticide drift is the leading cause of overexposure for bystanders and agricultural workers in Washington state.

In February 2004, the Washington State Department of Labor & Industries implemented a cholinesterase monitoring rule, which requires agricultural employers to provide a blood test to workers who handle certain pesticides 30 hours or more within a 30 day period. The goal is to identify a worker affected by pesticide exposure—even before symptoms occur—using the worker's own cholinesterase levels as a baseline.

While worker safety laws exist, they may not be adequately protective. The sources of pesticide exposure are varied, and when exposed to similar levels, different people react to the chemical in different ways.

Cholinesterase Monitoring

Cholinesterase is an enzyme in the body that acts as the nervous system's "off switch." Many pesticides act by disrupting the function of this type of enzyme in insects (and in people), so the nervous system works overtime causing neuro-muscular detriment. Workers whose cholinesterase levels are low could become sick if they continue to be exposed. Monitoring workers' cholinesterase levels can provide an early warning of overexposure, so steps can be taken to prevent further harm.

RESPONSE & RESULTS

PNASH investigators seek to understand and reduce pesticide exposures in Washington state's Yakima Valley, one of the most agriculturally productive areas in the country.

To support and evaluate the cholinesterase monitoring rule, PNASH conducted research, trained community-based medical personnel doing the monitoring, improved the laboratory assay's validity and reliability, and interpreted monitoring results.

Identifying risk factors for exposure
PNASH researchers discovered that workers' behavioral practices, such as the availability and use of protective equipment, can dramatically impact their exposure levels. Results of a five-year study led by PNASH identified the following risk factors for pesticide overexposure that lead to cholinesterase inhibition: cleaning spray equipment, mixing/loading pesticides, and not using a locker to store PPE. Protective factors included: wearing a full-face respirator and wearing chemical-resistant footwear. These findings were used in support of workplace-based solutions to reduce exposures.

Pesticide safety training and education tools

➥ Fluorescent Tracers were first used in research to assess pesticide contamination routes and dermal exposures. Now, the Fluorescent Tracer (FT) technique has grown into an effective tool for hands-on pesticide safety training. The dramatic visualization of the FT shows workers where contamination occurs and helps them to evaluate their day-to-day practices and personal protective equipment.

➥ To address risk factors that lead to pesticide exposure, PNASH, in partnership with farmers, educators, and researchers in Washington state, collected 24 solutions and ideas identified on farms and developed a guide called *Practical Solutions for Pesticide Safety*. The effort included 25 farms, 95 participants and hundreds surveyed.

A splash shield designed and constructed by the Expert Working Group – a team of growers, applicators and safety professionals

Cutting-edge studies to measure exposure and genetic risk

➥ The oxime reactivation assay, developed by scientists at PNASH and the Centers for Disease Control (CDC), improved the cholinesterase laboratory test. It helps diagnose acute poisoning with OP pesticides and guide treatment when a person comes into an emergency clinic with pesticide poisoning symptoms. The assay increases accuracy in a diagnosis and detects the specific pesticide that caused the exposure.

Researchers also developed a process for tandem mass spectrometry (HPLC/MS/MS) of protein adducts in the blood of exposed workers. The HPLC/MS/MS method can detect exposures to OP pesticides at low levels more reliably than using the original cholinesterase activity assay.

➥ Personal susceptibility to the harmful effects of certain pesticides may lie in our genetics. Paraoxonase 1 (PON1) is an enzyme in our bodies that plays an important role in breaking down certain OP pesticides into less toxic forms. Research suggests that PON1 levels and how efficiently the enzyme can detoxify reagents may be based on an individual's genotype, the genetic identity of an individual—somewhat like an architect's blueprint for a house.

PNASH researchers compared levels of PON1 and PON1 genotypes to the results of the cholinesterase monitoring of pesticide handlers. The scientists found there were differences in the level of serum cholinesterase inhibition by PON1 genotype, suggesting that some pesticide handlers were better able to metabolize OP pesticides than others, and also that people with high PON1 activity had less cholinesterase inhibition than those with low PON1 activity.

Health care provider education

Protecting workers from the negative effects of pesticides is truly in the hands of frontline primary care providers. Currently, half of US states require that physicians report occupational pesticide-related illness and injury and other states can voluntarily participate in national surveillance through the Centers for Disease Control. PNASH has educated physicians, mid-level practitioners, and *promotores* (community health workers) on recognizing and treating illness from pesticide exposure by developing guidelines, training and outreach materials.

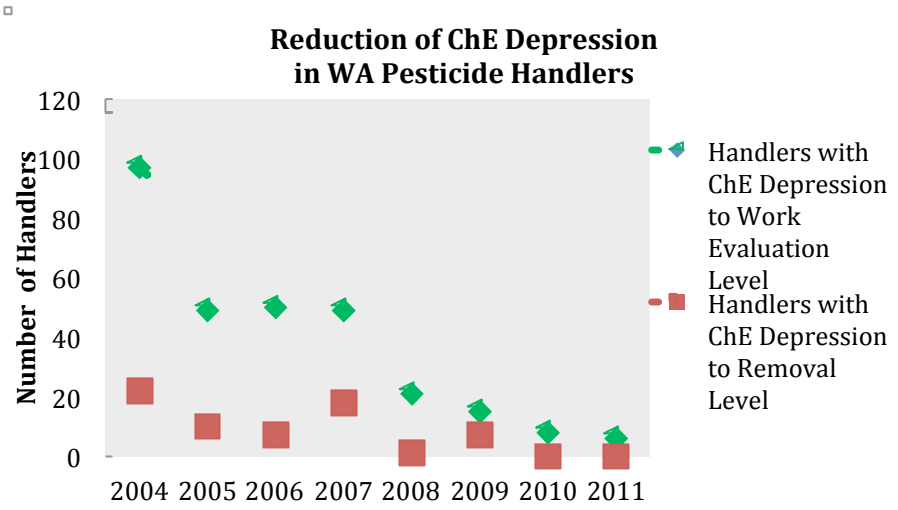
Interagency partnerships

In the last five years, Washington state has become a model for how multiple players contribute to improving pesticide safety. There is a strong network of farmworker and community clinics and exceptional pesticide education programs, including hands-on training for pesticide handlers and supervisors. In addition, a working group of staff from PNASH and the Washington State Departments of Health, Agriculture, and Labor & Industries reviewed surveillance and compliance data and research to better understand the problem of pesticide poisoning in the Northwest region. The group explored how and why they are being exposed and what can be done to reduce overexposures.

IMPACT

PNASH's multidisciplinary, collaborative approach to addressing the problems of pesticide poisoning has helped demonstrably reduce the risks of pesticide exposure faced by agricultural workers in the Northwest.

➥ Data from the state-wide cholinesterase monitoring program shows a marked decline in pesticide applicator exposures since the program began in 2004. The program's early cases mobilized PNASH, multiple agencies, nonprofits and the industry to address exposures. The current low rate of cases is evidence for the success of education efforts, a reduction in the use of azinphosmethyl (due to EPA phase out of this pesticide), and employers' limiting handler exposures.



➥ Isolation and identification of protein adducts for OP pesticides at low levels to develop an assay more reliable than using the existing cholinesterase activity assays.

➥ Identification of genetic susceptibility (PON1 status) in farmworkers exposed to organophosphate (OP) pesticides. This is the first time that a study of a working population has demonstrated the validity of the assumptions behind PON1's effect on pesticide overexposure susceptibility.

➥ Research to Practice delivery on the long-term effects of pesticide exposure on human health. This educational program was delivered to over 800 pesticide applicators thoughout the Northwest.

➥ Development and distribution of targeted pesticide safety educational materials and tools for educators, growers and health care providers (See Products).

➥ The Fluorescent Tracer (FT) training was an early PNASH product and has now been employed in safety and integrated pest management programs throughout the United States and in other countries (Cambodia, Vietnam, Ecuador, Guyana). The Washington State Department of Agriculture's hands-on training program uses FT, training approximately 200 pesticide handlers each year. There is monthly demand for this PNASH training program, with regular FT Kit purchases and online viewing of the video and website.

The impact of the FT tool is immediate and striking. Observed one pesticide safety professional: "*This is one of the most powerful training tools that I have encountered, because the message is clear and it is shocking.*"

➥ Washington state is recognized as a model for pesticide safety, with PNASH investigators and partners serving and leading national and international initiatives, including: The NIOSH National Personal Protective Laboratory; US EPA work on human exposure study ethics, agent orange, and medical education surveillance; Fogarty International Scholar Training in SE Asia, International Society for Exposure Sciences.

This body of work responds to the National Academies of Sciences recommendations: Improve Stakeholder Engagement and Partnership; Implement Integrative and Interdisciplinary Approaches; Enhance Awareness of National Policy.

PRODUCTS

Practical Solutions for Pesticide Safety ➥ http://depts.washington.edu/pnash/practical_solutions
The Practical Solutions for Pesticide Safety guide is a collection of 24 solutions and ideas identified on farms and developed in partnership with farmers, educators and researchers in Washington state. **(**English/Spanish)

Fluorescent Tracer Training - Hands on Learning for Pesticides
Website ➥ http://depts.washington.edu/pnash/fluorescent_tracer
Video ➥ http://www.youtube.com/user/PNASHCenter
Pesticide safety trainers find the fluorescent tracer (FT) to be a powerful tool for mimicking pesticide contamination and helping workers self-evaluate their practices and protective equipment. Available are the FT kit, manual and video. **(**English/Spanish)

Pesticide Worker Education Packet ➥
http://depts.washington.edu/pnash/pesticides_health
Originally packaged and delivered to Northwest Promotes, this packet is available online with make-your-own instructions.

Organophosphate Pesticides & Child Health: A Primer for Health Care Providers
➥ http://depts.washington.edu/opchild/index.html

This course presents the current scientific evidence regarding health risks for children exposed to organophosphate pesticides.

Pesticide Health Effects Medical Education Database ➥ http://www.pesticidemededucation.com
This online toolbox provides instructors and students with case-based trainings covering modern day environmental health hazards, exposure scenarios, signs and symptoms, and directives for treatment.

Cholinesterase Test Kit
We have shown the Test-mate™ kit to be an effective, cost-efficient test that can provide rapid results for workers – important if they are shown to have a ChE depression.

RESEARCH PUBLICATIONS

Hofmann JN, Keifer MC, De Roos AJ, Fenske RA, Furlong CE, van Belle G, Checkoway H. Occupational determinants of serum cholinesterase inhibition among organophosphate-exposed agricultural pesticide handlers in Washington State. Occup Environ Med. 2010 Jun;67(6):375-86.

Hofmann JN, Keifer MC, Furlong CE, De Roos AJ, Farin FM, Fenske RA, van Belle G, Checkoway H. Serum cholinesterase inhibition in relation to paraoxonase-1(PON1) status among organophosphate-exposed agricultural pesticide handlers. Environ Health Perspect 2009;117(9):1402—1408.

Keifer M, Gasperini F, Robson M. Pesticides and Other Chemicals: Minimizing worker exposures. Journal of Agromedicine, 2010: 15:264-274.