AAP ENVIRONMENTAL HEALTH ECHO
(EXTENSION FOR COMMUNITY HEALTHCARE OUTCOMES)
Pesticides & Children: Don’t Try This at home

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University of Washington
Pediatrics/Environmental & Occupational Health Sciences
INSECTICIDES
- Pyrethroids
- Organophosphates
- Carbamates
- Organochlorine
- Manganese compounds

FUNGICIDES
- Thiocarbamates
- Dithiocarbamates
- Cupric salts
- Tiabendazoles
- Triazoles
- Dicarboximides
- Dinitrophenoles
- Organotin compounds
- Miscellaneous

FUMIGANTS
- Aluminium and zinc phosphide
- Methyl bromide
- Ethylene dibromide

HERBICIDES
- Bipyridyls
- Chlorophenoxy
- Glyphosate
- Acetanilides
- Triazines

RODENTICIDES
- Warfarines
- Indanodiones

Complexity:
- > 1.2 billion pounds of active ingredient
- > 20,700 products
- ~ 1000 active ingredients
- ~ 4000 “inerts”
Multiple sources & pathways of exposure

- Residential Use – indoor/outdoor
- School/Daycare – indoor/outdoor
- Agricultural Use
- Dietary
- Rx – lice/scabies
- Parks/neighborhood

Figure 1 Prevalence of using pesticides: responses in the first-year telephone interviews (N = 477) and web surveys (N = 182). Note: Four of the telephone survey participants did not complete the pesticide section of the interview in the first year but only in a subsequent year. Percentage of behind-the-neck treatment on pets was calculated among pet owners.

Wu X et al. Env Health 2013
### Table 3: Prevalence of common active ingredients, classified by type of pesticide and chemical class, inventoried in the 246 control households that stored at least one pesticide product, NCCLS (2001–2006).

<table>
<thead>
<tr>
<th>Pesticide type</th>
<th>Chemical class</th>
<th>Common active ingredients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insecticide (46%)/miticide (44%)</td>
<td>Pyrethroid (37%)</td>
<td>Permethrin (14%); p-trans allethrin (12%); imiprothrin (9%); Cypermethrin, beta (9%); tralomethrin (9%); tetramethrin (7%)</td>
</tr>
<tr>
<td>Organophosphorus (24%)</td>
<td></td>
<td>Dieldrin (12%); chlorpyrifos (8%); acephate (8%); disulfoton (3%); malathion (2%); phosmet (1%)</td>
</tr>
<tr>
<td>Unclassified (23%)</td>
<td></td>
<td>Piperonyl butoxide (20%); triforine (7%); pyriproxyfen (2%)</td>
</tr>
<tr>
<td>Botanical (21%)</td>
<td></td>
<td>Pyrethrins (19%); rotenone (1%); neem oil (1%)</td>
</tr>
<tr>
<td>Dicarboximide (10%)</td>
<td></td>
<td>N-octyl bicycloheptene dicarboximide (10%)</td>
</tr>
<tr>
<td>Herbicide terrestrial (24%)</td>
<td>Phosphonoglycine (14%)</td>
<td>Glyphosate, isopropylamine salt (14%)</td>
</tr>
<tr>
<td>Chlorophenoxy acid or ester (13%)</td>
<td></td>
<td>2,4-D, dimethylamine salt (11%); 2,4-dichlorophenoxyacetic acid (6%); MCPP, dimethylamine salt (5%)</td>
</tr>
<tr>
<td>Benzoic acid (9%)</td>
<td></td>
<td>Dicamba, dimethylamine salt (8%); dicamba (2%)</td>
</tr>
<tr>
<td>2,6-Dinitroaniline (4%)</td>
<td></td>
<td>Pendimethalin (2%); trifuralin (1%); oryzalin (1%)</td>
</tr>
<tr>
<td>Anyloxyphenoxy propionic acid (2%)</td>
<td></td>
<td>Fluazifop-p-butyl (2%)</td>
</tr>
<tr>
<td>Fungicide (15%)</td>
<td>Unclassified (8%)</td>
<td>Triforine (8%)</td>
</tr>
<tr>
<td>Organophosphorus (7%)</td>
<td></td>
<td>Acephate (7%); permethrin (1%)</td>
</tr>
<tr>
<td>Pyrethroid (8%)</td>
<td></td>
<td>Resmethrin (5%); permethrin (1%)</td>
</tr>
<tr>
<td>Inorganic copper (2%)</td>
<td></td>
<td>Copper sulfate (basic) (2%); copper ammonium complex (1%)</td>
</tr>
<tr>
<td>Substituted benzene (2%)</td>
<td></td>
<td>Chlorothalonil (2%)</td>
</tr>
<tr>
<td>Organin, heavy metal (2%)</td>
<td></td>
<td>Fenbutatin-oxide (2%)</td>
</tr>
<tr>
<td>Molluscicide and tadpole shrimp (13%)</td>
<td>Aldehyde (9%)</td>
<td>Metaldehyde (9%)</td>
</tr>
<tr>
<td>Inorganic (3%)</td>
<td></td>
<td>Iron phosphate (3%); Carbaryl (3%)</td>
</tr>
<tr>
<td>N-Methyl carbamate (3%)</td>
<td></td>
<td>Carbaryl (3%)</td>
</tr>
<tr>
<td>Repellent or feeding depressant (11%)</td>
<td>Unclassified (10%)</td>
<td>DEET (9%); piperonyl butoxide (2%); dipropyl isocinchomeranate (1%)</td>
</tr>
<tr>
<td>Botanical (2%)</td>
<td></td>
<td>Pyrethrins (2%); p-menthan-3,8-diol (0.4%)</td>
</tr>
<tr>
<td>Dicarboximide (2%)</td>
<td></td>
<td>N-octyl bicycloheptene dicarboximide (2%)</td>
</tr>
<tr>
<td>Pyrethroid (2%)</td>
<td></td>
<td>Permethrin (1%); p-trans allethrin (0.4%); phenothrin (0.4%)</td>
</tr>
<tr>
<td>Rodenticide (0.4%)</td>
<td>1,3-Indandione (0.4%)</td>
<td>Diphacinone (0.4%)</td>
</tr>
</tbody>
</table>

*This list is not comprehensive because it contains only the most common pesticide types, chemical classes, and active ingredients. As listed in the U.S. EPA Pesticide Product Information System database. As listed in the PAN Pesticide database; detailed information on active ingredients can be found using this database (PAN 2011). Insecticides and miticides contained the same active ingredients and chemical classes and were therefore combined.

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**Figure 1.** A comparison of detection frequencies of selected insecticides from the AHHS and child care centers (Tulve et al 2006).

**Guha N et al EHP 2013.**

**Stout EM et al. Env Sci Tech 2009,**
Pesticide concentrations are higher in the child breathing zone after indoor pesticide application.

Children ingest more soil and dust (mg/day)
### Dietary exposures

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Apple (g/kg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1</td>
<td>5.0</td>
</tr>
<tr>
<td>3-5</td>
<td>3.8</td>
</tr>
<tr>
<td>Adolescent/Adult</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Adapted from Selevan 2000, US EPA 2011
Dietary intervention reduces exposure

The agricultural workplace creates unique sources/pathways.
# Age & Biomarker Concentrations (Pyrethroids)

## Urinary 3-Phenoxybenzoic acid (creatinine corrected) (1999 - 2010)

Metabolite of Cypermethrin, Deltamethrin, and Permethrin

Geometric mean and selected percentiles of urine concentrations (in μg/g of creatinine) for the U.S. population from the National Health and Nutrition Examination Survey.

<table>
<thead>
<tr>
<th>Survey years</th>
<th>Geometric mean (95% conf. interval)</th>
<th>50th Percentile (95% conf. interval)</th>
<th>75th Percentile (95% conf. interval)</th>
<th>90th Percentile (95% conf. interval)</th>
<th>95th Percentile (95% conf. interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>99-00</td>
<td>.261 (.224-.304)</td>
<td>.246 (.203-.280)</td>
<td>.550 (.459-.629)</td>
<td>1.40 (1.13-1.73)</td>
<td>3.19 (2.16-4.55)</td>
</tr>
<tr>
<td>01-02</td>
<td>.324 (.284-.371)</td>
<td>.290 (.247-.336)</td>
<td>.600 (.512-.743)</td>
<td>1.54 (1.26-1.91)</td>
<td>3.35 (2.50-4.92)</td>
</tr>
<tr>
<td>07-08</td>
<td>.426 (.374-.485)</td>
<td>.384 (.333-.450)</td>
<td>1.02 (.886-1.19)</td>
<td>3.08 (2.31-4.04)</td>
<td>5.83 (4.52-7.51)</td>
</tr>
<tr>
<td>09-10</td>
<td>.438 (.409-.469)</td>
<td>.384 (.342-.432)</td>
<td>1.01 (.898-1.13)</td>
<td>2.88 (2.50-3.19)</td>
<td>5.44 (4.52-6.38)</td>
</tr>
<tr>
<td><strong>Age group</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>6-11 years</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>99-00</td>
<td>.450 (.299-.677)</td>
<td>.371 (.241-.592)</td>
<td>1.13 (.733-1.62)</td>
<td>3.97 (1.75-8.07)</td>
<td>9.91 (2.43-64.0)</td>
</tr>
<tr>
<td>01-02</td>
<td>.423 (.335-.534)</td>
<td>.383 (.296-.500)</td>
<td>.864 (.594-1.35)</td>
<td>2.21 (1.61-2.95)</td>
<td>3.32 (2.64-5.40)</td>
</tr>
<tr>
<td>07-08</td>
<td>.511 (.431-.605)</td>
<td>.448 (.363-.545)</td>
<td>1.20 (.886-1.83)</td>
<td>3.81 (2.13-7.27)</td>
<td>9.86 (3.81-15.7)</td>
</tr>
<tr>
<td>09-10</td>
<td>.744 (.537-1.03)</td>
<td>.667 (.503-.838)</td>
<td>1.87 (1.30-2.60)</td>
<td>4.73 (2.88-9.57)</td>
<td>10.2 (4.48-51.9)</td>
</tr>
<tr>
<td><strong>12-19 years</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>99-00</td>
<td>.227 (.178-.290)</td>
<td>.205 (.156-.269)</td>
<td>.486 (.379-.732)</td>
<td>1.37 (1.03-1.62)</td>
<td>2.52 (1.41-4.44)</td>
</tr>
<tr>
<td>01-02</td>
<td>.274 (.229-.328)</td>
<td>.236 (.189-.313)</td>
<td>.539 (.424-.730)</td>
<td>1.11 (.864-1.63)</td>
<td>2.35 (1.36-6.19)</td>
</tr>
<tr>
<td>07-08</td>
<td>.316 (.280-.343)</td>
<td>.281 (.191-.425)</td>
<td>.869 (.523-1.29)</td>
<td>3.13 (1.47-4.37)</td>
<td>5.41 (3.36-9.20)</td>
</tr>
<tr>
<td>09-10</td>
<td>.347 (.302-.399)</td>
<td>.301 (.256-.397)</td>
<td>.733 (.575-903)</td>
<td>1.53 (1.33-2.46)</td>
<td>2.64 (1.76-3.75)</td>
</tr>
<tr>
<td><strong>20-59 years</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>99-00</td>
<td>.246 (.216-.278)</td>
<td>.239 (.200-.272)</td>
<td>.505 (.405-.590)</td>
<td>1.11 (.861-1.49)</td>
<td>2.53 (1.73-4.09)</td>
</tr>
<tr>
<td>01-02</td>
<td>.311 (.271-.357)</td>
<td>.282 (.245-.328)</td>
<td>.552 (.444-673)</td>
<td>1.44 (1.02-1.91)</td>
<td>3.22 (1.91-4.92)</td>
</tr>
<tr>
<td>07-08</td>
<td>.443 (.384-.510)</td>
<td>.401 (.353-.472)</td>
<td>1.01 (.867-1.16)</td>
<td>2.95 (2.22-4.04)</td>
<td>6.29 (4.18-8.05)</td>
</tr>
<tr>
<td>09-10</td>
<td><strong>.419 (.389-.451)</strong></td>
<td><strong>.365 (.326-.421)</strong></td>
<td><strong>.993 (.826-1.10)</strong></td>
<td><strong>2.93 (2.35-3.62)</strong></td>
<td><strong>4.72 (4.17-6.15)</strong></td>
</tr>
</tbody>
</table>
Case Report

Home Use of a Pyrethroid-Containing Pesticide and Facial Paresthesia in a Toddler: A Case Report

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Even in setting of “lower toxicity pesticide”, used per label instructions, symptomatic pesticide-related illness can occur.

Identification in clinical practice requires INDEX OF SUSPICION – Environmental History

PEHSUs (along with Poison Centers) are available for guidance on suspect exposures.

State & National Biomonitoring infrastructure - valuable resource

Mandated Pesticide Reporting & Programs are highly - valuable resource

Alternative pest control methods are available
Safer approaches to Pest Control: Integrated Pest Management

Preventing pest problems
1. keeping pests out
   and
2. getting rid of their food, water and shelter

Managing pest problems
1. using non-chemical approaches
2. using least-toxic pesticides when necessary and
3. reducing the use of harmful pesticide

IPM Resources
UC IPM online
EPA Controlling pests
Magnitude of the Problem?

No national surveillance, no “rates”

Poison Center Data

<table>
<thead>
<tr>
<th>Reports 2006-2010</th>
<th>( \leq 5 \text{ years} )</th>
<th>6-19 years</th>
<th>( \geq 20 \text{ years} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insecticides</td>
<td>69,696</td>
<td>29,509</td>
<td>107,635</td>
</tr>
<tr>
<td>Rodenticides</td>
<td>60,209</td>
<td>2,633</td>
<td>6,929</td>
</tr>
<tr>
<td>Misc.pesticide</td>
<td>20,161</td>
<td>835</td>
<td>2,387</td>
</tr>
<tr>
<td>Herbicide</td>
<td>11,592</td>
<td>3,225</td>
<td>18,715</td>
</tr>
<tr>
<td>Fungicide</td>
<td>1,199</td>
<td>433</td>
<td>3,044</td>
</tr>
<tr>
<td>Fumigant</td>
<td>215</td>
<td>196</td>
<td>950</td>
</tr>
</tbody>
</table>

Acute Poisoning

Underreporting

80% of children with organophosphate poisoning were transferred with the wrong diagnosis....

Lack of training

12% of Pediatric Residencies include Pesticides

70% of clinicians treating children at farmworker clinics had no training re: pesticides & children

Chronic low dose effects

Mechanisms ≠ acute toxicity mechanisms

Epidemiological associations with major chronic morbidities of childhood:

Neurocognitive/neurobehavioral deficit and disorder (reduced IQ, inattention/ADHD, Autism, Learning disability)
Pediatric cancer (Leukemia, brain)
Birth outcomes (premature birth, fetal growth, congenital anomalies)

Other – asthma, diabetes

Animal models + well designed cohort studies demonstrate insecticide (OP) exposures that are being experienced by U.S. children/pregnant women may have adverse neurodevelopmental consequences.

More limited data on pyrethroids raise similar concerns.

Many pediatric cancer studies suggestive but limited exposure characterization.

Need for more robust studies and characterization of associations of pesticides with birth outcomes, endocrine disruption, asthma.

Roberts 2012, Wagner Schuman 2015, Viel 2017
Glyphosate is the most commonly used herbicide in the world.

Figure 1. Estimated volume of agricultural glyphosate use in the US from 1992 to 2014. (Source: USGS, 2017.)
Glyphosate: Pediatric health concerns?

• Toxicological studies demonstrate potential for oxidative stress, hepatotoxic and/or endocrine disrupting effects at doses far below RfD

• Several studies have also suggested that *in utero* exposures to glyphosate and its formulations can have reproductive effects and can adversely impact developing fetuses

• A study in Minnesota’s Red River Valley found that children with ADHD were 3.6-times more likely to have been born to glyphosate-exposed pesticide applicators
Concerning exposures occur but are preventable

Acute illness/toxicity in children will present to pediatric care providers
  Requires an “Index of suspicion” and Environmental Hx taking

Subclinical, cumulative low dose exposures are increasing linked with important pediatric morbidities, particularly neurocognition and neurobehavioral development

Pediatricians are a trusted/influential voice on safe practices, prevention behaviors and policies
Anticipatory Guidance for Patients

- **Reduce Pesticide exposure**
- **In /Around the Home**
  - Use low toxicity or non toxic pest control approaches for home/garden pest problems.
- **Reduce Take Home from Work Exposure**
  - If work with pesticides, takes steps to reduce “take home” exposure
- **Reduce Exposure From Food**
  - Purchase organic when possible, but not at the expense of a diet rich in a variety of fresh fruits and vegetables.
  - Wash and scrub produce with water (cleansers not necessary), throw away the outer leaves of leafy vegetables.
EWG's 2017 Dirty 12™

1. Strawberries
2. Spinach
3. Nectarines
4. Apples
5. Peaches
6. Pears
7. Cherries
8. Grapes
9. Celery
10. Tomatoes
11. Sweet Bell Peppers
12. Potatoes

EWG's 2017 Clean 15™

1. Sweet Corn
2. Avocados
3. Pineapples
4. Cabbage
5. Onions
6. Sweet Peas
7. Papayas
8. Asparagus
9. Mangoes
10. Eggplant
11. Honeydew
12. Kiwi
13. Cantaloupe
14. Cauliflower
15. Grapefruit

http://www.ewg.org/foodnews/guide/
Resources

Talk to a human
Acute poisoning concerns/acute management – the Poison Center
Chronic health concerns/other - PEHSU

Web Based Resources


eLearning modules (pehsu.net)
Pesticides and Child Health: Exposure Recognition and Prevention
Pesticides Residues in the Indoor Environment

Books

IPM Resources
UC IPM online
EPA Controlling pests
Thank you

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1-877-KID-CHEM
206-221-8671
http://deohs.washington.edu/pehsu/
Disclaimer and acknowledgements

This material is supported by the American College of Medical Toxicology (ACMT) and funded (in part) by the cooperative agreement FAIN: U61TS000238-04 from the Agency for Toxic Substances and Disease Registry (ATSDR).

Acknowledgement: The U.S. Environmental Protection Agency (EPA) supports the PEHSU by providing partial funding to ATSDR under Inter-Agency Agreement number DW-75-9587701-4. Neither EPA nor ATSDR endorse the purchase of any commercial products or services mentioned in PEHSU publications.
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Case Conferences
Journal Clubs
Grand Rounds
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Online Courses
Evidence-based online courses on a variety of children's environmental health topics.
Interactive and Self-Paced
CE Available

Resource Catalog
Fact sheets, journal publications, reports, and other resources for parents, community members, patients and healthcare professionals
Topics included:
Air Quality, Pesticides, Natural Disasters, BPA, Mold, Lead, Mercury

www.pehsu.net/nationalclassroom.html