Presentation entitled “Children’s Exposure to Pesticides: Studies from Washington State” by Dr. Richard Fenske

Children's Exposure to Pesticides

Studies from Washington State

Richard Fenske
University of Washington
School of Public Health and Community Medicine

Contributors and Support

- Cynthia Curl
- Kai Elgethun
- Kit Galvin
- Vince Hebert
- John Kissel
- Chengsheng Lu
- Jaya Ramaprasad
- Jeff Shirai
- Rene Showlund-Irish
- Ming Tsai
- Sarah Weppner
- Michael Yost
- NIOSH Agricultural Centers Program
- EPA STAR Grant Program
- EPA/NIEHS Center for Child Health Risks Research
- Dept of Environmental and Occupational Health Sciences

Guiding Principles of the UW Research Program on Children's Pesticide Exposure

- ✓ Identify high risk populations
- ✓ Evaluate exposure to a common class of chemicals
- ✓ Measure multiple exposure pathways
- ✓ Identify opportunities for intervention

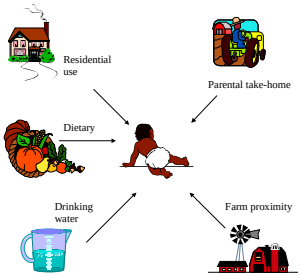
Pesticide Exposure Assessment

- **Biological Monitoring Approaches**
  - Pesticide metabolites in urine
  - Pesticides in body fluids (blood, saliva)
  - Biomarkers of effect (e.g., cholinesterase)
- **Environmental Exposure Assessment**
  - Measure environmental concentrations
  - Characterize time-location and personal activities
  - Exposure and dose modeling

Washington Orchards

Orchard Pests

Agricultural Workplace/Playground



Study Sites

Seattle Wenatchee Yakima Valley

Pesticide Use in Washington State Apples

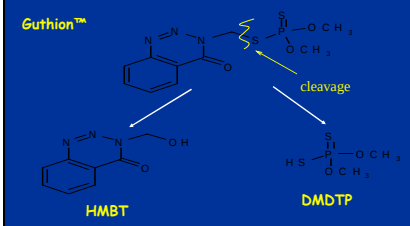
Captan
Azinphosmethyl
Phosmet
Chlorpyrifos
Diazinon
Malathion
Methyl Parathion

Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.

Fungicide Insecticide

Dimethyl metabolites

Guthion™



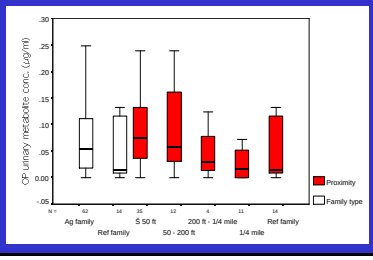
Biological Monitoring Study 1995

- ✓ Children 0-6 years of age
- ✓ 91 children of agricultural workers
- ✓ 18 reference children
- ✓ 2 spot urine samples per child during spraying season

Study Group Definitions

- **Agricultural Families**
  - One or more household member engaged in pesticide application or field work
- **Reference Families**
  - No household members engaged in agricultural work
  - Residence >400 m (1/4 mile) from treated farmland

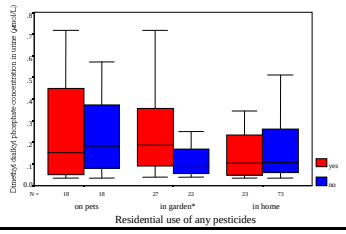
Dimethyl Metabolites (µg/mL)
Family Status and Proximity



Seattle Metropolitan Area Study 1998

- Study population: 50 children from each of two communities
- Urine sample collection: fall and spring
- Questionnaire data: residential environment, parental occupation, income level, and pesticide use patterns

Residential OP Use
Dimethyl DAP Metabolites



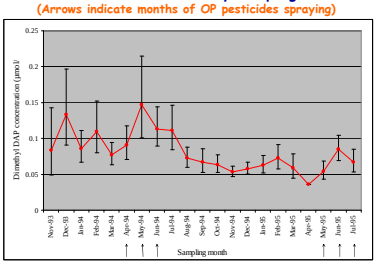
Longitudinal Biomonitoring Study in an Agricultural Community

Koch et al. Environ Health Perspect 110:829-33, 2002

- Agricultural community in E. Washington state
- OP pesticide exposure monitored in 44 preschool children for one year
- Spot urine samples collected on a bi-weekly basis
- Pesticide spray patterns documented by cooperative extension
- Para-occupational and proximity factors not significant predictors

Geometric Means (µmol/L) and 95% C.I. for dimethyl Metabolite Concentrations by Sampling Month

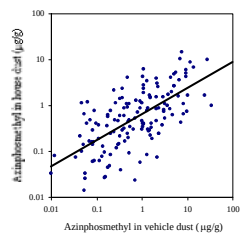
(Arrows indicate months of OP pesticides spraying)



Yakima Valley Study of Take Home Pesticide Exposure 1999

- ✓ Children 0-6 years of age
- ✓ 211 children of agricultural workers
- ✓ Vehicle and house dust samples for each agricultural worker
- ✓ Composite urine sample from each child after peak spray season

Azinphosmethyl in House and Vehicle Dust of Agricultural Workers

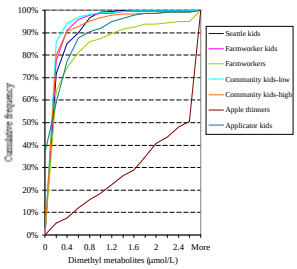


Comparison of WA State Studies

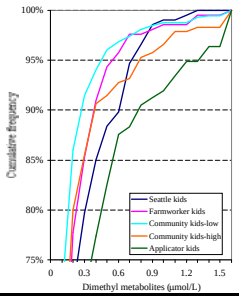
Study Populations

- ✓ Apple thinners
- ✓ Farm workers
- ✓ Farm applicator kids
- ✓ Farm worker kids
- ✓ Kids in an agricultural community
- ✓ Kids in the Seattle metropolitan area

Cumulative frequency distribution of OP pesticide metabolites



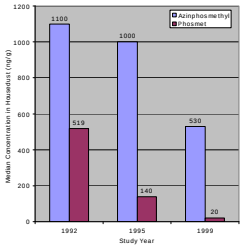
Cumulative frequency distribution- 75th Percentile



Composite Dimethyl Dialkylphosphate Concentrations (nmol/L) for Seattle, Yakima Valley and NHANES-III Children

Population	N	Percentiles 50th	90th
Seattle kids	110	117	453
Farmworker kids	211	87	378
NHANES (6-11 yrs)	471	91	460

Pesticides in House Dust in Agricultural Workers' Homes, 1992-1999



Conclusions

- ✓ Agricultural workers are more highly exposed than children, regardless of risk factors
- ✓ Elevated exposures of children in agricultural communities are associated with agricultural spraying
- ✓ Most children of farm workers and children in agricultural communities have exposures similar to urban children for much of the year
- ✓ Additional studies should focus on identification of highly exposed sub-populations
- ✓ Timing of sampling is critical for exposure studies

Dietary Exposure to OP Pesticides

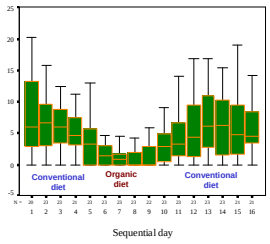
Curl et al. Environ Health Perspect 111:377-82 (2003)

- Recruitment from two Seattle grocery stores
- 39 Pre-school children (2-5 yrs old)
- 3-day diet log kept by parents
- 24 hour urine sample
- Children classified by consumption of organic or conventional produce
- Residential pesticide use minimal

Dialkylphosphate Concentrations in Children's Urine Samples

	Median (μmol/L) Dimethyl	Diethyl
Conventional	0.17	0.02
Organic	0.03	0.02

TCPY Concentrations in the Urine of 22 Children Before, During, and After Organic Diet Intervention



Lu et al. 2005 Environ Health Perspect on-line

Saliva Biomonitoring

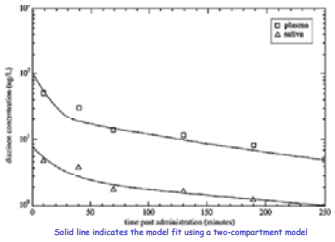
A Novel Pesticide Exposure Assessment Approach

Chensheng (Alex) Lu, Ph.D.
Assistant Professor
Emory University

Feasibility Studies in Animals

- ✓ Intracellular passive diffusion determines appearance of pesticides in saliva
  - Lipid solubility
  - Degree of ionization (pKa)
  - Molecular weight
  - Protein binding
- ✓ Rodent selected as model animal
- ✓ Pesticide administration through i.v. injection, skin or gavage (oral) ingestion
- ✓ Simultaneous arterial blood and saliva collection

Observed and predicted saliva and plasma concentration-time profiles for diazinon in rats after I.V. bolus injection of 1 mg/kg diazinon



Solid line indicates the model fit using a two-compartment model

Conclusions from Animal Studies

- ✓ Both atrazine and diazinon excreted into saliva,
- ✓ Salivary excretion of atrazine and diazinon unaffected by the dose, route of administration or salivary flow rate,
- ✓ Significant correlation of atrazine and diazinon concentration in saliva and plasma samples
- ✓ Findings suggest that salivary concentrations can be used to predict plasma levels for both pesticides.

Preliminary Survey of Atrazine Exposure Among Herbicide Applicators

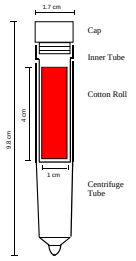
in collaboration with the
National Institute for Occupational Safety and Health
Denovan et al., Environ Health Perpsect 73:457-462

- ✓ Evaluate sampling protocol for saliva collection in the field
- ✓ Measure atrazine concentrations in saliva for a cohort of herbicide applicators

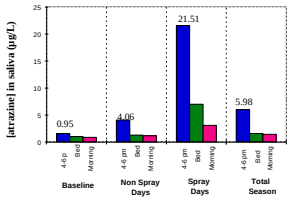
Study Design

- ✓ Baseline (3 months prior to application)
- ✓ 15 applicators
- ✓ Sampled every fourth day; 103 events
- ✓ Sampling schedule included post-shift, before bed, and next morning samples
- ✓ Urine, hand wash, skin patches collected by NIOSH

Salivette™



Profiles of median salivary concentrations of atrazine for custom herbicide applicators



Conclusions from Field Study

- ✓ Saliva sampling is practical in the field
- ✓ Saliva captures the trends of atrazine exposure and elimination in the body
- ✓ Urine data confirmed the exposure even without atrazine spraying in the field
- ✓ Lack of plasma samples to confirm the validity of saliva biomonitoring

On-going Saliva Biomonitoring Studies

- ✓ Human exposure studies
  - Children's dietary study, Seattle
  - Farm worker family study, Nicaragua
  - Human controlled-exposure study (UC Davis)
- ✓ Explore other pesticides
  - Chlorpyrifos
  - Permethrin

Acknowledgments

- ✓ US EPA STAR Grant R828606
  2001 - 2004
- ✓ US EPA STAR Grant R829364
  2002 - 2006
- ✓ Dr. Dana Barr, CDC Laboratory
  National Center for Environmental Health

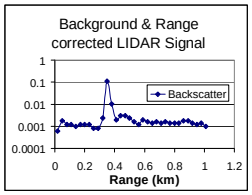
Environmental Monitoring Studies

Orchard Airblast Spraying

Pesticide Spray Drift Characterization with LIDAR

Michael Yost
Professor
Dept of Environmental and
Occupational Health Sciences
University of Washington

LIDAR testing, Wenatchee Region



- Prototype LIDAR has a limited range
- Extending range to 2-4 km requires bigger laser
- Shifting to UV provides stronger signal

Pesticide Spray Drift and Children's Exposure

Kai Elgethun
Doctoral Candidate
Dept of Environmental and
Occupational Health Sciences
University of Washington

Spray Drift Studies

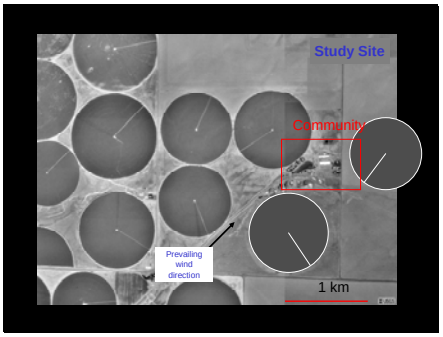
- **Spray Drift Modeling Studies**
  - Human exposure not measured directly
- **Spray Drift Incident Studies**
  - Exposure estimated after-the-fact
- **Washington Aerial Spray Drift Study**
  - Measure and model spray event
  - Measure community and residential air and surface levels
  - Measure and model children's activities and exposures

Application Site

- **Central Washington State**
  - Dry summer climate
  - Flat topography
- **Aerial Applications on Potatoes**
  - 1-2 times per season every third season
  - Aerial applications -- fixed wing aircraft

Methamidophos

- Highly toxic organophosphorus insecticide (Toxicity I)
- Monitor-4™ 40% emulsifiable concentrate formulation
- 283 hectares treated @ 1.1 kg a.i. per hectare (1 lb/acre)

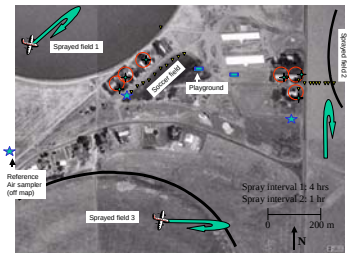


Study Site and Population

- **Agricultural Community**
  - Surrounded by potato, corn, wheat fields
  - Single-family residences, recreational facilities
- **Children**
  - Parents are farmworkers
  - Live in community year-round
  - Ages 3-11
  - 4 male, 4 female

Informed consent/assent obtained from all parents and children

Recruitment Poster

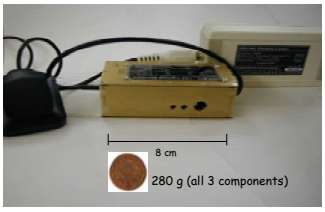


Sampler locations and airplane flightpath

Sampling Procedures

- **Deposition Samples**
  - Silica gel chromatography plates
- **Surface Wipes**
  - Playground equipment
  - Toys and apples
  - Indoor surfaces
- **Children's Hands**
  - Isopropanol wipes
- **Children's Activities**
  - Global positioning system - personal activity loggers
- **Air Samples, Housedust, Urine samples**

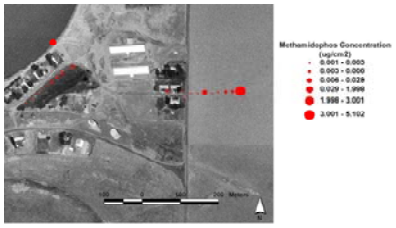
GPS Personal Acquisition Logger (GPS-PAL) (Entertech)



GPS-PALS Unit

Clothing does not block reception

Methamidaphos Deposition



Methamidaphos Deposition
Morning Spray

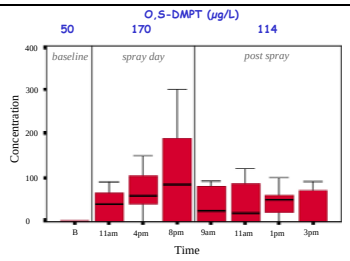
Sampler Location	Loading (ng/cm^2)
North field boundary	2,131
East field boundary	5,653
Soccer field (median)	2.9
East housing (median)	2.4

Methamidaphos on Playground Equipment (ng/cm2)

Sample Source	Morning	Afternoon
Monkey bars - 1	2.09	2.00
Monkey bars - 2	0.57	1.04
Tire swing	0.36	0.98
Baby swing	2.96	5.10

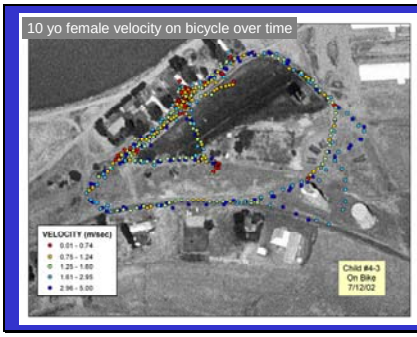
Methamidaphos on Toys, Apples, and Indoor Surfaces (ng/cm2)

Sample Source	Baseline	Post-Spray
Toy - Side yard	nd	0.19
Toy - Back yard	nd	0.37
Toy - Playground	nd	0.14
Apples	nd	nd
Indoor surfaces	nd	nd



Child Hand Wipe Levels over Time (ng/sample)

One hour outdoor path of 10 yr old female path using GPS PALS technology



Key Findings

- **Well controlled aerial application**
  - Levels at field boundary 1,000X greater than off-target
- **Low levels on surfaces in community**
  - Low ng/cm^2 on play equipment and outdoor toys
  - No detectable residues on indoor surfaces
- **Children contact with residues**
  - O,S-DMPT metabolite associated with hand wipe levels and time spent outdoors
- **Child activities an important component of exposure analysis**
  - 8-fold difference between high and low child exposures

Work in Progress

- Develop dispersion models for vapors and particles
- Estimate dermal contact via deposition modeling and children's activities
- Estimate respiratory exposure via air modeling and children's activities
- Mass balance analysis of aggregate exposure and biological monitoring
- Risk analysis and communication to agricultural community

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Towards a Sustainable Agricultural Workplace