Environmental Impacts on Reproductive Health: Pesticide Exposure

Association of Reproductive Health Professionals

www.arhp.org
Expert Medical Advisory Committee

- Kathleen Hill Besinque, PharmD, MSEd, FCSHP
- Maureen Paul, MD, MPH
- Barbara Sattler, RN, DrPH, FAAN
- Ted Schettler, MD, MPH
- Michael Thomas, MD (co-chair)
- Tracey Woodruff, PhD, MPH (co-chair)
- Sandy Worthington, MSN, WHNP-BC, CNM
Learning Objectives

At the conclusion of this course, clinicians should be able to:

• Discuss how pesticide exposure can affect reproductive health
• Identify critical windows of susceptibility when exposures can affect reproduction and reproductive outcomes

more…
Learning Objectives (continued)

• Counsel patients about risks and steps they can take to reduce risks
• Refer patients for additional information about pesticide exposure and reproductive health risks
Pesticides Defined

Chemicals used against unwanted organisms:
- Insects
- Rodents
- Plants
- Fungi

Pesticide Use Is Widespread in United States

More than 1.2 billion pounds used annually

Household Use Is Common

75% of US households use at least 1 pesticide product indoors.

May be used to:
• Eliminate insects and rodents
• Care for lawn and garden
• Prevent fleas and ticks

Lesson Learned: DDT

A well-known harmful pesticide

1874: DDT developed

1939: Insecticidal properties discovered

1940s: Used in WWII typhus epidemic

1945: Available as agricultural insecticide

1962: Silent Spring published

1972: Banned in US

more…
“The most alarming of all man’s assaults upon the environment is the contamination of air, earth, rivers, and sea with dangerous and even lethal materials.”

Rachel Carson
Silent Spring
## Types of Pesticides

### Examples:

<table>
<thead>
<tr>
<th>Type of Pesticide</th>
<th>Target Organisms</th>
<th>Chemical Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insecticide</td>
<td>Aphids, fleas, beetles</td>
<td>Organophosphates, pyrethroids</td>
</tr>
<tr>
<td>Rodenticide</td>
<td>Mice, rats</td>
<td>Coumarins</td>
</tr>
<tr>
<td>Herbicide</td>
<td>Invasive grasses</td>
<td>Acetyl-coenzyme A carboxylase inhibitors</td>
</tr>
</tbody>
</table>

EPA. 2008.
Sources of Pesticide Exposure

- Residues on food
- Tap water
- Community applications
- Occupational exposure

more…

EPA. 2008.
NPIC. 2008.
Sources of Pesticide Exposure (continued)

Household uses:
- Insecticides
- Rodent traps
- Weed killers
- Pet flea products

more…

EPA. 2008.
NPIC. 2008.
Sources of Pesticide Exposure (continued)

Personal uses:
• Contaminated dust in the home
• Insect repellents
• Some herbal medications
• Pets tracking in chemicals from outdoors
Pesticides Contain Active and Inert Ingredients

more...

PANNA. 2008.
Inert Ingredients: Examples of Effects

Some inert ingredients have been found to:

- Decrease heart rate and blood pressure
- Reduce mitochondrial activity
- Be toxic to human placenta cell cultures

Data come primarily from animal studies

Routes of Exposure

1. Inhalation
2. Ingestion
3. Skin contact
4. In utero exposure (fetus)

Klaassen C. In: Casarett & Doull’s Toxicology: The Basic Science of Poisons. 7th ed. 2007.
Exposure-Effect Continuum

Source
- e.g., air, water, food, soil

Intake
- Breathing, eating/drinking, skin contact, biologic uptake (exposure)

Target Organ Contact
- e.g., testis, ovary, transplacental transport

Biologic Change/ Clinical Effect

CDC. 2009.
“Every chemical class of pesticides has at least one agent capable of affecting a reproductive or developmental endpoint in laboratory animals or people.”

Frazier LM. J Agromedicine. 2007
“…every child conceived today in the Northern hemisphere is exposed to pesticides from conception throughout gestation and lactation regardless of where it is born.”

Colborn T. Environ Health Perspect. 2006
Studying Pesticide Exposure Has Inherent Problems

Limitations impeding research:
• Human trials precluded by ethical considerations
• Difficulties in assessing impacts
• Difficulties in measuring outcomes
Environmental Exposures and Critical Windows of Susceptibility

Identified Reproductive Endpoints in Animal and/or Human Studies

<table>
<thead>
<tr>
<th>Female</th>
<th>Male</th>
</tr>
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<tbody>
<tr>
<td><strong>Effects on:</strong></td>
<td><strong>Effects on:</strong></td>
</tr>
<tr>
<td>▪ Oocyte &amp; follicle development &amp; function</td>
<td>▪ Sertoli cell differentiation</td>
</tr>
<tr>
<td>▪ Ovary formation, cell organization</td>
<td>▪ Spermatogonia formation, sperm count</td>
</tr>
<tr>
<td>▪ Uterine development</td>
<td>▪ Testis, prostate, penis development</td>
</tr>
<tr>
<td>▪ Corpus luteum development &amp; function</td>
<td>▪ Increased risk of testicular germ cell cancer</td>
</tr>
<tr>
<td>▪ Pubertal development</td>
<td>▪ Low serum testosterone levels</td>
</tr>
<tr>
<td>▪ Menstrual &amp; ovarian function</td>
<td></td>
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</tbody>
</table>

**Increased risk of:**

<table>
<thead>
<tr>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Cervical/vaginal cancer</td>
<td></td>
</tr>
<tr>
<td>▪ Infertility</td>
<td></td>
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<tr>
<td>▪ Miscarriage</td>
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</table>

Reproduction-Related Effects: Women

Pesticide exposure

Mechanisms of action

Effects on fertility

Spontaneous abortion
Stillbirth
Premature birth
Low birth weight/small for gestational age
Developmental defects
Reproductive system effects

Reproduction-Related Effects: Men

- Testicular damage:
  - Azoospermia, oligospermia
  - Damage to germinal epithelium
  - Genetic alterations in sperm
  - Reduced fertility

- Altered hormone function

Pesticide: DBCP

- Soil fumigant used in US agriculture
- Banned in 1979

Linked to male reproductive effects:
- Decreased sperm counts (humans)
- Altered sex ratio (humans)
- Infertility (humans)
- Testicular effects (humans)

ATSDR. 1995.
Pesticide: Organophosphates

Findings on reproductive effects are inconsistent/inconclusive

- Insecticides in the 1930s
- Lawn and garden sprays in U.S.
- Nerve agents in WWII
- Disrupts cholinergic nervous system

Dyro FM. 2006.
Pesticide: Pyrethroids

Some animal studies show reduced male and female fertility

- Synthetic versions of pyrethrins
- Control mosquitoes and other insects
- 1,000 developed; < dozen used in U.S

ATSDR. 2003.
Endocrine-Disrupting Chemicals (EDCs)

- Include pesticides, industrial chemicals and byproducts, ingredients in manufacture of plastics
  - Interfere with hormonal function
  - Effects observed from animal studies and epidemiological observations
Delayed Effects of Exposure

Critical windows of susceptibility:
- Preconception
- Prenatal
- Postnatal (lactation)

- Childhood and adult cancer
- Delayed development
- Childhood asthma and allergies
- Infections
- Postnatal growth effects

# Preconception and Prenatal Exposures: Examples

<table>
<thead>
<tr>
<th>Pesticide</th>
<th>Potential Reproductive Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organophosphates</td>
<td>Neurological development</td>
</tr>
<tr>
<td>Ethylene oxide</td>
<td>Spontaneous abortion</td>
</tr>
<tr>
<td>DBCP</td>
<td>Reduced male fertility</td>
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</tbody>
</table>

“So What Do I Do?”

• Science regarding environmental exposures and reproductive health is:
  ▪ Primarily based on animal studies
  ▪ Warrants guidance to limit/avoid exposure
• Approach patients on case-by-case basis
• Exposure is unavoidable, but specific changes can make a difference

Expert Medical Advisory Committee on Environmental Impacts on Reproductive Health. 2009.
Focus on Windows of Susceptibility

- For male and female adolescents
- For male and female patients who experience unintended pregnancy
- For women and men during pregnancy planning
- For pregnant women
- For male and female patients with newborns and children

Expert Medical Advisory Committee on Environmental Impacts on Reproductive Health. 2009.
The Environmental Health History

<table>
<thead>
<tr>
<th>HOW?</th>
<th>Incorporate into reproductive health history</th>
</tr>
</thead>
<tbody>
<tr>
<td>WHY?</td>
<td>Identify and reduce or eliminate potentially harmful exposures</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WHEN?</th>
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<tbody>
<tr>
<td>Vulnerable Stages:</td>
</tr>
<tr>
<td>- Early childhood</td>
</tr>
<tr>
<td>- Puberty</td>
</tr>
<tr>
<td>- Adolescence</td>
</tr>
<tr>
<td>- Preconception planning (men &amp; women)</td>
</tr>
<tr>
<td>- Pregnancy</td>
</tr>
</tbody>
</table>

Guide patients in making decisions

Expert Medical Advisory Committee on Environmental Impacts on Reproductive Health. 2009.
One Tool for Conducting an Environmental History: CH₂OPS

Community  Home/Hobbies  Occupation/School

Personal  Socioeconomic

Adapted from Schettler T. 2009.
Adapted from Schettler T. 2009; Expert Medical Advisory Committee on Environmental Impacts on Reproductive Health. 2009.
Community: Guidance for Patients

Learn about/inform patients about community organizations & resources, such as:

• Dry cleaners that avoid toxic solvents
• Salons products without toluene, phthalates, other toxic chemicals
• Grocery stores that carry organic products

Resource Tip:

• Download the What We Can Do: Community Efforts to Protect Our Health Tool Kit from the Women’s Health and the Environment Web site

CH$_2$OPS: Home/Hobbies

- Pesticides
- Adhesives
- Furniture products
- Cleaners
- Detergents
- Gardening products (e.g., pesticides, plant food)

Adapted from Schettler T. 2009; Expert Medical Advisory Committee on Environmental Impacts on Reproductive Health. 2009.
CH$_2$OPS: Home/Hobbies (continued)

Exposure to:
- Carbon monoxide
- Metals
- Solvents

Fishing:
- Be aware of fish advisories for mercury
Home: Guidance for Patients

- Check for lead paint and pipes; manage dust
- Avoid vinyl products, such as shower curtain liners
- Avoid certain types of plastics for food:
  - No. 3: Polyvinyl chloride (PVC)
  - No. 6: Styrene (Styrofoam)
  - No. 7: Polycarbonate (bisphenol A [BPA])
- Where possible, avoid food stored in plastic containers or plastic wrap

Adapted from Schettler T. 2009; Expert Medical Advisory Committee on Environmental Impacts on Reproductive Health. 2009; Centers for Disease Control and Prevention. 2009.
Home: Guidance for Patients (continued)

- Use glass, ceramic, or food-safe metal containers
- Avoid using pesticides in homes, lawns, gardens, or on pets
- Wash fruits & vegetables; buy organic

Resource Tips:
Extensive resources are available to eliminate the use of pesticides or to use less toxic products. Some examples include:
- Visit www.beyondpesticides.org
- Visit the Pesticide Action Network (PAN): www.pesticideinfo.org
- Download the Shopper’s Guide to Pesticides wallet card from the Environmental Working Group

Adapted from Schettler T. 2009; Expert Medical Advisory Committee on Environmental Impacts on Reproductive Health. 2009.
• Read labels on cleaning products
• Avoid using ammonia or chlorine,
• Use inexpensive, nontoxic products such as vinegar and baking soda

Resource Tip:
• Find non-toxic cleaning recipes on the Women’s Voices for the Earth Web site or www.care2.com

Adapted from Schettler T. 2009; Expert Medical Advisory Committee on Environmental Impacts on Reproductive Health. 2009.
Limit fish with high levels of mercury

Resource Tips:
- Learn about on-local fish advisories from the EPA
- Download a regional fish seafood-watch pocket guide from Seafood WATCH

Hobbies: Guidance for Patients

- Understand mercury present in recreationally caught fish
- Use glue and solvents in well-ventilated spaces
- Garden with organic products

Adapted from Schettler T. 2009; Expert Medical Advisory Committee on Environmental Impacts on Reproductive Health. 2009.
CH$_2$OPS: Occupation/School

- Chemicals
- Radiation
- Biological agents
- Pesticides in schools

Adapted from Schettler T. 2009; Expert Medical Advisory Committee on Environmental Impacts on Reproductive Health. 2009.
Occupation: Guidance for Patients

- Use protective gear with toxic substances or radiation
- For chemicals, wash exposed skin; change work clothes; clean clothes separately.
- Understand chemicals used at work
- Take extra care if pregnant (planning pregnancy)

Resource Tip:
- Learn more from the CDC report, “The Effects of Workplace Hazards on Female Reproductive Health”

Adapted from Schettler T. 2009; Expert Medical Advisory Committee on Environmental Impacts on Reproductive Health. 2009.
Occupation (Schools): Guidance for Patients

Advise patients:

• Practice non-pesticide insect management; inform parents if pesticides used
• Use fresh fruit & vegetables; avoid junk foods in cafeterias
• Avoid pressure-treated woods (arsenic) in playground equipment

Resource Tips:
• Visit the Healthy Schools Network Web site and EPA’s Healthy School Environments Web site to learn more about creating a healthier school environment

Adapted from Schettler T. 2009; Expert Medical Advisory Committee on Environmental Impacts on Reproductive Health. 2009.
CH₂OPS: Personal

- Dietary history
- Alcohol use
- Tobacco use
- Prescription & non-prescription medications
- Substance abuse
- Insect repellants
- Cosmetics; personal care products

Adapted from Schettler T. 2009; Expert Medical Advisory Committee on Environmental Impacts on Reproductive Health. 2009.
Advise patients:

- Use fewer, simpler products
- Don’t trust: “dermatologist-tested,” “natural,” “organic”
- Avoid tobacco use; exposure to 2nd-hand smoke
- Use alcohol in moderation
- Learn about skin products that are safe for children

Resource Tips:

- Check the safety of your personal care products at the Skin Deep Cosmetic Safety Database and the Campaign for Safe Cosmetics
- Download the Safety Guide to Children's Personal Care Products from the Environmental Working Group
- Visit www.HealthyToys.org to find toy rankings and a safer toy shopping list

Adapted from Schettler T. 2009; Expert Medical Advisory Committee on Environmental Impacts on Reproductive Health. 2009.
CH₂OPS: Socioeconomic

- Living in higher levels of air pollution
- Exposure to lead, asbestos
- Limited access to nutritious food
- Vulnerability to other factors

Adapted from Schettler T. 2009; Expert Medical Advisory Committee on Environmental Impacts on Reproductive Health. 2009.
Socioeconomic: Guidance for Patients

Advice for patients:
• Know tenant & citizen rights
• Work with community organizations, government agencies to ensure risk awareness & knowledge

Resource Tip:
• Visit the Alliance for Healthy Homes Web site for tools and tips on reducing environmental hazards in homes and communities

Adapted from Schettler T. 2009; Expert Medical Advisory Committee on Environmental Impacts on Reproductive Health. 2009.
An Important Take-Home Message

Identifying and reducing exposures to potentially harmful toxicants now, when couples plan (or not) a pregnancy, increase the likelihood of a successful outcome.

Expert Medical Advisory Committee on Environmental Impacts on Reproductive Health. 2009.
ARHP Resources

Learn more at the ARHP Web site:

• Click on Environmental and Reproductive Health topic area

• www.arhp.org/topics/enviro-repro-health
  --Fact Sheet: Environmental and Reproductive Health Resources for Health Care Providers
  --Patient handout: Health Matters: The Connection Between Your Health and the Environment
Pesticide Resources

• Fact sheets from CDC’s National Agricultural Safety Database (www.cdc.gov/nasd)
• National Pesticide Information Center (npic.orst.edu)
• EPA’s Pesticides Information Web site (includes information for children) (www.epa.gov/pesticides)
• Pesticide Action Network (PAN) database (www.pesticideinfo.org)
Resources for Clinicians

• Critical Windows of Development ([www.endocrinedisruption.com](http://www.endocrinedisruption.com)): Online tool from The Endocrine Disruption Exchange (TEDX)
• ReproTox ([www.reprotox.org](http://www.reprotox.org)): Summaries on the effects of >5,000 agents and exposures on pregnancy, reproduction, and development

more…
Resources for Clinicians (continued)

- American College of Occupational and Environmental Medicine (www.acoem.org)
- Collaborative on Health and Environment (CHE) database (http://database.healthandenvironment.org/)
- EnviRN (www.envirn.umd.edu)
- Local environmental health specialists
- Occupational and environmental health departments in universities
Summary

- Evidence is increasing of effects of pesticide exposure on reproductive health
- Precautionary approach should emphasize prevention
- Environmental health history and patient guidance should be incorporated into health care for all patients