Update on Childhood Environmental Health Issues at Home, School, and Beyond

Jennifer Bevacqua RN MS CPNP-AC CPNP-PC
Pediatric Nurse Practitioner Hospitalist, Randall Children’s Hospital
Clinical Instructor Faculty, OHSU SON
bevacqua@ohsu.edu

Special thanks to: Ardys Dunn PhD PNP

Objectives

1. Recognize the impact of the environment on childhood health
2. Identify anticipatory guidance to provide parents/caregivers to lessen harmful exposures
3. Review the evidence of connection between neurodevelopmental problems, cancer, and other health problems with environmental hazards
4. Participants are competent in addressing environmental hazards, even in the face of uncertainty

Definitions

• Chemical = a substance that has constant composition and characteristic properties.
• Toxin = a poisonous substance, especially one produced by a living organism or endogenous to earth. Examples: lead, venom
• Toxicant = a poisonous, man-made substance/chemical. Examples: many products of industrial waste, pesticides.
Regulation

- **EPA (Environmental Protection Agency)** was established in 1970.
- **TSCA (Toxic Substances Control Act)** was enacted in 1976.
  - 62,000 chemicals “grandfathered” in (only ~200 have been tested)
  - 22,000 chemicals introduced since TSCA
  - Nearly 20% of these chemicals are not public info citing “trade secrets”
  - Instead of requiring proof of safety before entering into marketplace, gov’t must prove actual harm in order to restrict a chemical
- Leading environmental organizations advocate for TSCA reform/modernization. Legislation is in committee (US House of Rep).

http://saferchemicals.org/get-the-facts/what-is-tsha/

The environment is a basic determinant of human health and illness

- Safe water
- Clean air (outdoor, indoor)
- Safe, healthy food, food preservation
- Safe homes and possessions
- Safe hygiene, personal care products
- ... and more

Children are particularly susceptible to environmental threats
Asthma

http://www.atsdr.cdc.gov/csem/csem.asp?csem=18&po=1

The environment & asthma

<table>
<thead>
<tr>
<th>CAUSAL RELATIONSHIP</th>
<th>SUFFICIENT EVIDENCE OF ASSOCIATION</th>
<th>LIMITED EVIDENCE OF ASSOCIATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cat, Cockroach, ETS (environmental tobacco smoke) in preschoolers, House dust mite</td>
<td>Dog, Molds, Rhinovirus, Nitrogen oxide (from emissions from cars, trucks and buses, power plants, and off-road equipment)</td>
<td>Formaldehyde, Fragrances, RSV (Respiratory Syncytial Virus), ETS in school-aged and older children</td>
</tr>
</tbody>
</table>

The environment & asthma, continued

- Dust
- Stuffed animals
- Carpet
- Furry pets
- Rats/mice droppings
- Cockroach droppings
- ETS
- Mold/mildew
- Paints, floor furnishings, crafts, or other items which give off “fumes” or distinct smells
- Wood burning fireplace or stove // Products of combustion
- Miscellaneous: latex, chlorine, ammonia, formaldehyde
The environment & asthma, continued

- Dust
- Stuffed animals
- Carpet
- Furry pets
- Rats/mice droppings
- Cockroach droppings

- ETS: limit as much as possible!
- Mold/mildew
- Paints, floor refurnishings, crafts, or other items which give off "fumes" or distinct smells: limit and/or ventilate well
- Wood burning fireplace or stove: Products of combustion: ventilate well, limit when possible

Some environmental exposures may be protective:
Children who grow up on traditional farms are protected from asthma, hay fever, and allergic sensitization. Asthma, hay fever, atopic dermatitis, allergic sensitization is higher in affluent, Western countries (urbanization) than in developing countries.

Lead
- Lead is a heavy metal naturally occurring in the earth’s crust
- Major pathway of exposure = ingestion. Minor pathway of exposure = inhalation
- Effects include:
  - Neurodevelopmental cognitive problems (lower IQ, ADHD, learning disabilities, behavioral challenges)
  - Dental, renal, cardiac effects less common
- Effects modulated by:
  - Stage of development
  - Nutritional status (e.g. iron or calcium deficient, lead absorption will be higher)
- Definition of "told" levels have been down-going over the last 30 years. The CDC advises action at ≤10 ug/dl, although evidence now shows developmental and behavioral effects at levels much lower than this. An estimated average of 6 IQ points may be lost due to lead poisoning with BLLs in the range of 1–9.9 ug/dl.
- Oregon children most likely to be exposed from lead-based paint (chips or dust) found in homes built prior to 1978.
- Estimated 1,000-2,000 children in Oregon with elevated blood lead levels

http://public.health.oregon.gov/HealthyEnvironments/HealthyNeighborhoods/LeadPoisoning/Documents/LeadPoisoningInOregon.pdf
Mercury

- Methylmercury (an organic mercury compound) is most toxic and found in the food chain.
- Methylmercury enters the CNS → metabolizes to its inorganic form and cannot exit the CNS
- Like lead, mercury is a developmental neurotoxicant impacting cognition, memory, attention, language, fine motor, visual spatial, and coordination
- An estimate of 75,000 newborns are prenatally exposed annually in the US

Mercury cycle

Mercury sources

Finfish & shellfish with the highest levels of mercury:
- Mackerel king
- Shark
- Sablefish
- Tuna fish
- Predator marine mammals (e.g. seals, whales) pose concern for children in Arctic regions.

Prenatal exposure: reflection of mother’s mercury burden and ongoing exposure (e.g. dental amalgams, occupational hazards).

Infant exposure: Breast milk, teething powders, soaps, organo-mercurial medicines

Childhood exposure: Diet (e.g. rice)

Medical preparations: [traditional medicines, intravenous, pharmaceutical preparations, hypodermic injections, contraceptive gels (e.g. some topical, ointments), dental amalgams, mercury containing paints, broken or compromised thermometers, broken or compromised switches and pressure gauges, broken or compromised fluorescent light bulbs, thermometers, industrial sources (e.g. factories emitting aerosolized waste, paints tracking mercury home on shoes from workplace, school chemistry classes, batteries, electronics, antiques in the home), in the developing world child labor in gold mining camps and waste scavenging]
**Fluorescent light bulb clean up (www.epa.gov)**

**Before Cleanup**
- Have people and pets leave the room.
- Air out the room for 5-10 minutes by opening a window or door to the outdoor environment.
- Shut off the central forced air heating/air-conditioning system, if you have one.
- Collect materials needed to clean up broken bulb:
  - stiff paper or cardboard;
  - sticky tape;
  - damp paper towels or disposable wet wipes (for hard surfaces); and
  - a glass jar with a metal lid or a sealable plastic bag.

**During Cleanup**
- **DO NOT VACUUM.** Vacuuming could spread mercury-containing powder or mercury vapor.
- Be thorough in collecting broken glass and visible powder. Use stiff paper/cardboard, sticky tape, such as duct tape, to pick up any remaining small glass fragments and powder. Place the used tape in the glass jar or plastic bag. Place cleanup materials in a sealable container.

**After Cleanup**
- Promptly place all debris outdoors in a trash container or protected area until materials can be disposed of.
- Next, check with your local government about disposal requirements in your area.
- If practical, continue to air out the room where the bulb was broken and leave the heating/air-conditioning system shut off for several hours.

---

**Radon**
- Colorless, odorless, radioactive gas produced by the decay of naturally occurring uranium in soil, rock, and water
- Enters homes through basement floors, cracks in foundations, drains
- Chronic exposure can lead to lung cancer
- 2nd leading cause of lung cancer in US

**Interventions:**
- Assess all homes with a basement / below ground floor should be tested
- Can buy test from hardware or home improvement store
- If high levels, will need professional mitigation

---

**Molds**

- Natural purpose in the environment is biodegradation of natural materials, providing balance in nature
- Molds have been used to create medicines (penicillins, cyclosporine, etc) and food products (tempeh, cheeses, etc)

Sometimes, when exposed to molds, children have an increased risk of:
- asthma,
- dyspnea,
- wheezing,
- cough,
- respiratory infections,
- allergic rhinitis,
- bronchitis, and eczema.

**Why?**
- Hygiene hypothesis?
- Biodiversity hypothesis?
Molds: management of health effects

- #1 Control moisture! Remove contaminated carpets, ceiling tiles, drywall; clean bathrooms. May use dehumidifier. Use detergent & water solution.
  - Bleach is not recommended for routine clean-up of mold (EPA, 2010) as it can cause adverse respiratory effects, does not remove dead spores (which are allergens) and does not address the key of moisture control.

- Control symptoms (allergy, asthma, etc)

- NOTE: “Black mold” (Stachybotrys chartarum [Stachybotrys atra]) has no special risks and does not require special precautions differing from molds in general (http://www.cdc.gov/mold/stach.htm#Q1)

ETS (Environmental Tobacco Smoke)
The single largest preventable cause of death and disease in the U.S.

Effects:
- Quality of life and costs
- Prematurity, prenatal mortality. Higher rates of miscarriage
- Abnormal fetal growth and development
- Increased risk of cleft lip and palate
- Decreased IQ in offspring
- Increased risk of SIDS
- Respiratory problems, increased resp infections
- Premature coronary artery disease
- Neurobehavioral problems
- Middle ear problems
- Childhood cancer
- Gastroenteritis
- Impaired immune system function
- Epigenetic effects (change in genetic expression)

First hand smoke = direct

Second hand smoke = exposed to smoke of others

Third hand smoke = smoke contamination which remains after the cigarette has been extinguished (found on clothes, people, furniture, etc)
Atypical or novel ways to smoke

Hookah
- Battery powered vaporizer
- Contains nicotine liquid and other ingredients
- Middle and high-school student use doubled from 2011 to 2012
- Often flavored

E-cigarettes

Snus

ETS exposure management

- Prevention (public health-based)
- All children should be informed of the dangers of smoking
- Tobacco cessation programs
- Tobacco cessation counseling
  - Ask if parents smoke
  - Advise smokers to quit
  - Assess willingness to quit
  - Assist in quit attempt (offer plan, education, replacement therapy, referral to program)
  - Arrange follow-up

If all else fails, limit exposure as much as possible: smoke outside the home; use a ‘smoking jacket’ which stays outside; ensure adequate ventilation and never smoke in car. Remember to consider daycare/childcare exposures.

Particulate matter (PM)

- PM is air pollution consisting of extremely small particles and liquid droplets.
- Often PM is a by-product of industrial production, gasoline and diesel engines (e.g. school buses), wood-burning stoves, and natural phenomena (e.g. volcanic activity, forest fires, etc)
- Coarse PM can be filtered by nasal mucosa, or removed by coughing or sneezing
- Fine PM can be inhaled and carried deep into lungs
- Ultrafine PM can penetrate into cells

In 2012, EPA updated its nat’l air quality standards to limit PM. The EPA estimates that this action will save the US $4-9 billion annually by decreasing mortality rates and decreasing incidence of asthma, heart attacks, and strokes.
Air Quality Index (AQI)

- EPA calculates the AQI for five major air pollutants regulated by the Clean Air Act:
  - ground-level ozone,
  - particle pollution (also known as particulate matter),
  - carbon monoxide,
  - sulfur dioxide, and
  - nitrogen dioxide

- Value of 0-500, with higher numbers meaning more pollution

Asbestos

- Group of incombustible fibrous magnesium silicate minerals used most often in construction materials
- Most types banned under TSCA era regulation
- Causes lung disease (via chronic exposure)
- In buildings currently containing asbestos, it is only a hazard if disrupted through deterioration or renovation (causing fibers to become airborne)

Carbon Monoxide (CO)

- Colorless, odorless, tasteless toxic gas that is a product of incomplete combustion of carbon-based fuels
- Sources: motor vehicle exhaust, motorboats, kerosens/propane space heaters, leaking chimneys, furnaces, woodstoves/fireplaces, charcoal/propane grills, gas appliances, gasoline-powered generators or equipment, tobacco smoke

<table>
<thead>
<tr>
<th>Acute effects</th>
<th>Delayed effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Nonspecific flu-like symptoms progressing to confusion, coma and death from prolonged or intense exposure</td>
<td>- Memory, attention, executive function impairment; cognitive, personality changes, parkinsonism, dementia</td>
</tr>
<tr>
<td>- Fetuses, infants, pregnant, elderly, chronically ill are extra vulnerable</td>
<td></td>
</tr>
</tbody>
</table>
Pesticides

• Substances used to kill (-cide), repel, or control unwanted pests (insects, rodents, weeds, fungi, algae, microorganisms, prions, etc)

• ~20,000 pesticide products marketed in the US, >1,000 active ingredients registered as pesticides

• Herbicides are most common category of pesticides used… followed by insecticides then fungicides

• Exposed in various ways (e.g. drinks & food consumed; outdoor play; school playgrounds; tracked indoors on shoes; and more)

Advantages of Pesticides

• Larger crop yields (increasing supply and lowering prices)
• Decrease infectious diseases (e.g. west nile virus, lyme disease, rabies, anthrax, staph, etc)
• Decrease asthma/allergies (e.g. cockroaches)
• Protect buildings from damage due to termites
• Sanitize drinking water

Pesticides, cont.

Causal links are difficult to establish given the infinite combinations of ingredients and varied (subacute, acute, chronic) effects possible. Known associations include:

• Polyneuropathy, CNS dysfunction (including neurodevelopmental problems such as ADHD, psychomotor delays, possibly autism)
• Endocrine disruption (precocious puberty, thyroid dysfunction, hypospadias, etc)
• Cancer. In particular, childhood leukemia and Wilm’s tumor associated with maternal exposure to pesticides. Brain tumors linked to common home/garden pesticides
• Pulmonary fibrosis
• Asthma; respiratory problems
Acute organophosphate ingestion

Toxidrome

- Muscarinic effects
  - Salivation
  - Lacrimation
  - Urination
  - Diarrhea
  - GI upset
  - Emesis
- Nicotinic effects
  - Fasiculations, weakness, tachycardia
- CNS effects
  - Confusion, ataxia, tremors, seizures, anxiety. Late onset neuropathy.

Reporting

Healthcare provider must report
- a reported pesticide exposure resulting in one ocular symptom,
- one dermal symptom,
- or two general/systemic symptoms (cough, vomiting, etc.)
... to the Oregon Health Authority’s Pesticide Exposure Safety & Tracking Program.

Anticipatory guidance on pesticides

- Utilize Integrated Pest Management (combines physical, cultural, biologic, and other means of pest control with minimal use of pesticides)
- Avoid (or minimize) occupational exposure to pesticides
- Wash fruits & vegetables prior to eating
- Choose local foods when able (usually require less pesticides and preservatives if not traveling far)
- Choose in season foods (more likely to be local)
- Choose organic when possible
- Regulation of pesticides should be improved to provide all children with safe foods, not simply the families that can ‘afford it’.

... linked to Environmental Justice
Insect Repellent

- N,N-diethyl-3-methyl-benzamide or N,N-diethyl-meta-toluamide (commonly known as DEET) is the active ingredient in many insect repellent products. Benefits: decrease lyme disease, encephalitis
- Commercial products for skin application contain from 4% to 99.9% DEET
- Concentrations >30% provide no increase in protection
- EPA review in 2014 found no harm from DEET, even to children, when applied as directed (*AAP advises against use of sunscreen + DEET because if product reapplied often, like sunscreen often is, the patient may receive too much DEET). However, the endocrine effects have not yet been reviewed (due late 2014)
- Do not apply on hands, near eyes, or near mouth in children
- Do not spray directly on face (may rub on with parent hands)

Alternatives to DEET
- Picaridin (equally effective as DEET)
- Oil of lemon eucalyptus (almost as effective as DEET)
- Citronella is not as effective as DEET, and therefore are not recommended when concern exists about arthropodborne disease

Endocrine disruptors: BPA

Used in production of polycarbonate plastics (rigid plastics) and epoxy resins (adhesives used as coatings). Exposure is ubiquitous in US population.

Effects:
- Endocrinopathies (associated with DM, obesity, precocious puberty, breast/uterine cancer, prostate abnormalities; potentially transgenerational effects)
- Neurodevelopmental abnormalities
Decreasing BPA exposure

- Breastfeed > bottlefeed
- If using bottles, use BPA-free bottles
- Do not use scratched plastic for food storage
- Do not put boiling water in plastic; do not heat foods/liquids in plastic
- Reduce use of canned foods
- Use glass, porcelain, stainless steel instead of plastics
- Avoid #7 for food storage

Endocrine disruptor: PCBs (Polychlorinated biphenyls)

- Synthetic organic chemicals created in 1920s, used in industrial manufacturing until they were banned in 1970s
- Used in coolants, lubricants for transformers, capacitators, etc … made wood and plastics nonflammable … preserved rubber … made stucco weatherproof
- Can be liquid, solid, or vapor. No smell or taste.
- Considered Persistent Organic Pollutants (POPs) because they do not readily degrade in the environment
- Have been found in polar bears high above the Arctic Circle

PCBs: Health Effects

Difficult to evaluate given many different combinations of ingredients.

Known associations include:
- Rashes
- Upper airway irritation
- GI discomforts
- Endocrine mimicry
- Liver injury
Endocrine disruptor: Phthalates

- Colorless liquid industrial compounds used in the production of soft plastics, AKA ‘plasticizers’
- Leaches from plastic into environment
- Sources: cosmetics, plastic toys, toothbrushes, food packaging, vinyl shower curtains, car seats, medical tubing, etc
- Exposure is ubiquitous in US population

Phthalates

- Most research based on animal studies
- High level maternal exposure associated with low birth weight of offspring
- Endocrinopathies: decreased sperm counts, growth abnormalities, skeletal deformities

Decrease exposure by:
- Avoiding plastic food containers (#3), plastic toys, plastic wrap (shrink wrap) and PVC.
- Avoid cosmetics (though ingredients and labels often misleading)

Sunscreen to recommend?

www.ewg.org

- Burt’s Bees
- Nature’s Gate
- California Baby
- Alba Botanical
- … And more
VOCs (Volatile Organic Compounds)

- Variety of chemicals, emitted as gases from solids or liquids
- Some sources include: paints and lacquers, paint strippers, cleaning supplies, pesticides, building materials and furnishings, copiers and printers, correction fluids and carbonless copy paper, graphics and craft materials including glues and adhesives, permanent markers, and photographic solutions
- Includes acetone, formaldehyde, gasoline
- Indoor concentrations higher than outdoor, in general

VOCs: Health Effects

- Eye, nose, throat irritation, epistaxis
- Dyspnea
- Headaches, coordination abnormalities, fatigue, dizziness, vision abnormalities
- Nausea
- Liver injury
- Renal injury
- Dermatological findings
- Some VOCs are known carcinogens (e.g. benzene)

Exposure reduction

- Use household products according to manufacturer's directions
- Ventilate areas well when VOCs in use
- Buy VOCs in small quantities (to avoid having to store remaining)
- Keep away from children & pets
- Never mix household cleaning products unless directed on label
- If dry-cleaned materials have a strong chemical odor (from perchloroethylene), do not accept them until they have been properly dried. Consider finding safer dry cleaner.
On the Horizon: Fracking

- Hydraulic fracturing (‘fracking’) is a well simulation technique in which underground rock is fractured by a hydraulically pressurized liquid so that natural gas, petroleum, and brine will flow more freely.
- Controversial:
  - Economic benefits vs environmental impact (contamination of ground water & air, triggering of earthquakes, noise pollution, etc)
- [https://www.youtube.com/watch?v=4LBJ5XWQRV8](https://www.youtube.com/watch?v=4LBJ5XWQRV8)

Case Studies

Q: I have heard that peanut butter may cause cancer. Is this true?

A: Peanuts are often contaminated with molds producing aflatoxins (known carcinogens). The FDA allows low levels of aflatoxins in nuts, seeds, legumes, calling them ‘unavoidable contaminants’. If levels found to be over a set action level, the peanut butter would be recalled.

Case Studies

Q: Should I have my well water tested? How often?

A: Test when there is a new baby, damage to the well, or living in an area where there is known well water nitrate contamination.

Otherwise, annual testing (late spring recommended) for nitrates and coliform bacteria.


• Occupational Safety & Health Administration (OSHA): Asbestos. Available at: https://www.osha.gov/SLTC/asbestos/standards.html, accessed on 7/21/14.


