How PCBs Impact Human Health

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Polychlorinated Biphenyls (PCBs)

- Manufactured for electrical system uses - insulators, transformer boxes on power poles
- Non-flammable, do not easily degrade; many uses on consumer goods (rubber, pesticides, paints, inks, weatherproofing)
- Ubiquitous on the planet (air, soil, water)
- Over 3.4 billion pounds released into the environment worldwide
- Major contaminant in the Kalamazoo River Superfund Site

Introduction: Polychlorinated Biphenyls (PCBs)

- Synthetically produced
  - Production banned in 1977
- Ubiquitous environmental contaminants
  - 1.5 billion lbs in USA
  - 230,000 lbs in Kalamazoo River sediments
- Bioaccumulate in food chain
  - resistant to degradation
  - lipophilic
- Affect a variety of health endpoints
  - immune, nervous, endocrine and reproductive systems; skin and liver lesions

Polychlorinated Biphenyls (PCBs)

- Co-planar
  - Most toxic
  - Need to be in co-planar or flat position to bind to receptors
- Non co-planar
  - Responsible for disrupting calcium homeostasis, neurological and neuromuscular function

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Fetal Exposure to PCBs

- Fetus is more sensitive
  - Crosses the placenta
  - Accumulates in breast milk
  - Some studies show
    - Lower birth weight
    - Smaller head
    - Premature birth
    - Lower IQ

“Effects of PCB exposure on Neuropsychological Function in Children”

- PCB adversely affects neurodevelopment
  - Taiwan
  - Michigan
  - New York
  - The Netherlands
  - Germany
  - The Faroe Islands
Yu-Cheng Cohort

- From contaminated rice oil – high concentrations of PCBs
- Yusho or “rice oil disease”
- Acne-form lesions, hyper-pigmentation, ocular swelling
- Headaches, memory loss, numbness, hypoesthesia, neuralgia of limbs

Eating Great Lakes Fish and Impaired Human Development  Sandra and Joseph Jacobson, Wayne State University

- Pregnant mothers who ate 3 meals of Great Lakes fish a month had higher risk for giving birth to children who developed more slowly and showed neurological abnormalities
  - lower birth weight
  - premature birth
  - smaller heads
  - lower IQ
  - visual deficits
  - correlated with levels of PCBs in mothers’ systems
  - similar effects seen in wildlife contaminated with PCBs, DDT, dieldrin, chlordane, and lindane

The Dutch Cohort

- Measured PCBs in maternal and cord blood and in breast milk
- Lower birth weight, slower growth in first three months, neuro-developmental abnormalities
- Breast fed children scored higher than formula fed children

PCBs and Neurological Function

- Additional studies have shown that adults who eat more than 2 meals of Lake Michigan fish/month show memory and learning deficits
- Animal studies show that learning physiology at the cellular level is altered by PCBs

Mechanisms of Endocrine Disruption: Role of the Ah receptor

- Dioxins and some PCB’s bind the Ah receptor, dissociating it from heat shock protein 90 (HSP90) and PS5
- The ligand-Ah complex binds Arnt, the complex enhances transcription
- Tetrachlorodioxin (TCDD), e.g., causes inappropriate transcription that leads to immunosuppression, teratogenesis, carcinogenesis, testicular atrophy, chloracne (hyperplasia, hyperkeratosis)
PCB Contaminated Groundwater at the Allied Site
Kalamazoo Gazette. 4/10/2007

• Readings up to 0.3 ppb have been recorded in groundwater near the landfill
• MDEQ accepts 0.2 ppb as uppermost threshold?
• Is remediation of water underway?

EPA Groundwater and Drinking Water Standards for PCBs
http://www.epa.gov/safewater/contaminants/dw_contamfs/pcbs.html

• EPA Maximum Contaminant Level (MCL) is 0.5 ppb in drinking water
• Short-term: EPA has found PCBs to potentially cause the following health effects when people are exposed to it at levels above the MCL for relatively short periods of time: acne-like eruptions and pigmentation of the skin; hearing and vision problems; spasms.
• Long-term: PCBs has the potential to cause the following effects from a lifetime exposure at levels above the MCL: effects similar to acute poisonings; irritation of nose, throat and gastrointestinal tracts; changes in liver function; cancer.

Questions:

• Will Adding More PCB Contaminated Material to the Allied Site Increase Human Health Risk in Kalamazoo?
• Could groundwater flow change to produce contamination of drinking water wells?
• Will adding new contaminated waste create a permanent waste site in downtown Kalamazoo?
• What effects will that have on the city’s economic development plans to make the river a vibrant centerpiece for downtown development?