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THE GRITTY-NITTY ON PORTLAND HARBOR'S PCB PROBLEM

Why was the Portland Harbor designated as a Superfund site in 2000? If you said untreated poo or some other equivalent yuck, you're wrong. Said dubious distinction was bestowed in large part because of persistent and elevated concentrations of polychlorinated biphenyl ethers (PCBs) in the resident fish.

Why should clinicians care? People who eat fish with elevated PCBs, become exposed themselves. And PCBs have been associated with increased risk of liver toxicity, neurologic deficits, certain cancers, immunosuppression and other medical problems. This *CD Summary* provides a primer on the basics of PCBs for health care providers and offers resources for more information.

WHAT ARE PCBs?

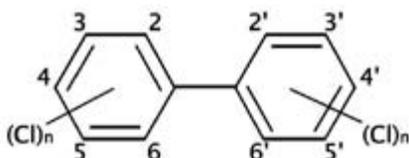
PCBs comprise a class of man-made chemicals used for a myriad of industrial purposes in their heyday (Box 1).

Box 1. Historic Uses of PCBs

- Transformers and capacitors
- Other electrical equipment
- Oil used in motors and hydraulic systems
- Fluorescent light ballasts
- Cable insulation
- Thermal insulation material including fiberglass, felt, foam, and cork
- Adhesives and tapes
- Oil-based paint
- Caulking
- Plastics
- Carbonless copy paper

PCBs (Figure) have two connected phenyl rings with varying numbers of arrayed chlorine atoms. Each of the 209 permutations is called a congener.

Figure. PCB chemical structure



Cumulatively, the U.S. manufactured an estimated of 1.5 billion pounds of PCBs. PCBs were industrially useful in part for their chemical stability. Now, 34 years after their use was banned in the U.S., that same indestructibility makes them nearly impossible to purge.

HEALTH EFFECTS

Information on the health effects of PCBs comes from a variety of sources, including: occupational data of people exposed to PCBs in the workplace; two incidents in Japan and Taiwan where people were exposed to PCB-contaminated rice oil; studies of people exposed to contaminated fish (the concern with the Portland Harbor Superfund site); and experimental studies of primates and rodents exposed to PCBs. The potential health effects of PCBs are outlined below.¹

Hepatotoxicity: Most of the data on liver toxicity comes from animal, rather than human, studies. Findings include: microsomal enzyme induction, liver enlargement, increased serum liver enzymes and lipids, fatty necrosis, and tumors.

Endocrine Effects: Although direct evidence linking PCB exposures to thyroid morbidity in humans is lacking, experimental studies on animals have demonstrated that exposure to PCBs *in utero* and during early development can deplete thyroid hormones, which in turn can lead to neurodevelopmental deficits associated with hypothyroidism.

Neurologic Effects: Data on the adverse neurologic effects of PCBs come from both human and animal studies. These neurologic deficits include: abnormal reflexes, and alterations in memory, learning, and IQ. In addition, PCB exposure in infancy has been associated with deficits in executive functioning, such as impulse control, anticipation and organization, and risk of developmental conditions like attention deficit and hyperactivity disorder (ADHD) and autism.

Immunosuppression: Data from the studies in Asia of consumption of PCB-contaminated rice oil suggest PCB exposure decreases immune function, as evidenced by alterations in serum antibody levels and increased infectious diseases, such as acute otitis media.

Cancers: Studies in animals provide conclusive evidence that PCBs cause cancers of the liver. In addition, studies in workers exposed to PCBs provide suggestive evidence that PCBs increase the risk of cancers of the liver, biliary tract, and malignant melanoma.

Other: While the human data are limited, animal studies indicate that PCB exposure may have negative impact on reproduction, including: menstrual disturbances, effects on sperm production, decreased embryo implantation rate, and fetal death associated with abnormal placental vasculature. In addition, children born to women with occupational exposures to PCBs had decreased birth weight and decreased gestational age with increasing exposures to PCBs.

CURRENT PCB EXPOSURE

Historically, Portland Harbor has been the site of varied industrial uses (Box 2). Until the late 1960s, it was standard practice for industry to discharge waste products directly into the river. Thus, many of the fish, particularly bottom-feeders, in Portland Harbor (lower Willamette) have

Box 2. Historical Industrial Usage of Portland Harbor

- Ship building, dismantling, and repair
- Wood processing and treatment
- Chemical manufacture (including a large pesticide manufacturer that produced DDT)
- Metal recycling, production, and fabrication
- Manufactured gas products
- Electricity production and distribution
- Bulk fuel distribution, storage, and asphalt
- Steel mills, smelters, and foundries
- Commodities and maritime shipping
- Rail yards



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become contaminated. Contamination of fish today is a result of pollution and practices that ended long ago.

Once PCBs enter the environment, they adhere to soil particles and flow along with the particles, accumulating in the sediment of rivers, streams, and other bodies of water. PCBs are lipophilic, and chemicals that love fat hate water. Accordingly, PCB concentrations in water itself are very low and may be undetectable, even in waterways whose sediment is heavily contaminated like Portland Harbor.

Public health advisories* related to Portland Harbor are not about water contact (*yes, it's safe and some would even say fun to swim in the Willamette*), but rather about eating the fish. Remember the food chain. Microbes, fungi and little insects eat sediment, bigger bugs eat them, little fish eat the bugs and bigger fish eat the little fish. Ultimately, the concentrations of PCBs in Portland Harbor fish are millions of times higher than in the water itself.

By eating fish, and other fatty animal meats, PCBs accumulate in human fatty tissue over our lifetimes. Most of us have measurable levels. Average, lipid-adjusted human serum concentrations are available for the U.S. population but not for Oregon (Table 1);¹ there are no accepted "safe" cumulative human levels of PCBs.

* Oregon Health Authority Portland Harbor Superfund Site. See <http://public.health.oregon.gov/HealthyEnvironments/TrackingAssessment/EnvironmentalHealthAssessment/Pages/phsite.aspx>

Table 1. Serum concentration of PCB-153 in the general population, U.S., 2003–2004

Age group (years)	Geometric mean (ng/g lipid)
12–19	19.8
≥20	23.7

PCBs, MOTHERS AND BABIES

PCBs cross the placenta and are found in breast milk. From conception to weaning, infants are exposed to a portion of their mothers' lifetime accumulation of PCBs. Nevertheless, we hasten to say that breast milk confers a mountain of benefit. Breastfeeding remains the best option whenever possible.² The goal is to reduce women's exposure to PCBs, so that their babies can enjoy the maximum benefit of breastfeeding.

TO EAT FISH OR NOT?

Fish are a good source of protein, and there is convincing evidence that eating a diet that includes fish contributes to good cardiovascular health. And, women who eat diets with lots of fish tend to have children with better health outcomes than women who don't.³ But, you can eat fish *and* be PCB-smart about it. "Resident fish," such as small mouth bass, carp and catfish, that live their entire lives in PCB-contaminated water tend to accumulate more PCBs than migratory fish that are only passing through, such as salmon and steelhead (Table 2).⁴ These migratory fish are healthy choices for women who are looking for healthy omega-3 fatty acids for their developing and nursing babies.

Table 2. Portland Harbor average tissue concentrations

Species	Tissue concentration (ppm)*
Small mouth bass	0.2
Carp	2.5
Catfish	0.4

*For all species listed, consumption of 4 8-oz portions per month would far exceed "safe" average daily consumption of 0.05 ppm for the general population and 0.002 ppm for females aged ≤45 years.

FOR MORE INFORMATION

- Oregon Health Authority information on PCBs: <https://public.health.oregon.gov/healthyenvironments/EnvironmentalExposures/ToxicSubstances/Pages/pcbs.aspx>
- Oregon Health Authority Fish Consumption Advisories: <http://public.health.oregon.gov/HealthyEnvironments/Recreation/Pages/fishconsumption.aspx>
- Portland Harbor Fish Advisory: www.portlandoregon.gov/bes/article/174599
- Portland Harbor Community Advisory Group: <http://portlandharborcag.info>
- EPA Draft Remedial Investigation Report: www.epa.gov/region10/pdf/ph/sitewide/remedial_investigation_draft_final_main_text_8-29-2011.pdf

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1. Agency for Toxic Substances and Disease Registry. Toxicological profile for polychlorinated biphenyls (PCBs). U.S. Department of Health and Human Services Public Health Services 2000. See www.atsdr.cdc.gov/toxprofiles/tp17.pdf
2. Rogan WJ, Blanton PJ, Portier CJ, & Stallard E. Should the presence of carcinogens in breast milk discourage breast feeding? *Regul Toxicol Pharmacol* 1991; 13: 228–40.
3. Genius SJ. To sea or not to sea: Benefits and risks of gestational fish consumption. *Reprod Toxicol* 2008; 26: 81–5.
4. Lower Willamette Group (Kennedy/Jenks). Draft Final Harbor Investigation Report Appendix F, Baseline human health assessment, final draft. May 2011. Tables -12, 3-14, 3-16 (Available upon request from U.S. Environmental Protection Agency, Region 10)