PCBs

Polychlorinated Biphenyls (PCBs) Guide

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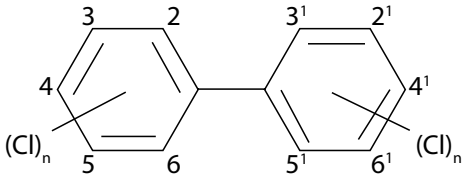


For the PCBs measured in the Metametrix profile, n =2 or 3, so there are 4 or 5 chlorine atoms in various positions of the phenyl rings.

Why Measure PCBs?

Within a span of about 20 years, more than 1.2 billion pounds of polychlorinated biphenyls (PCBs) were produced in the United States. They were used extensively as coolants and lubricants for electrical transformers and in many other industrial uses. The production of PCBs in the United States ceased in 1977 due to build-up in the environment and association with severe health problems. Much of U.S. soil and groundwater were already heavily polluted. PCBs are very resistant to degradation by heat, chemical, or biological attack. PCBs were attractive for industrial applications because they outlasted the equipment in which they were used. However, once introducing that property into the environment, PCBs remained extremely persistent, resisting decomposition for hundreds of years. Thus, the levels of these persistent organic pollutants (POPs) built up more and more with each year of their use. Once POPs are introduced into the environment, they undergo biomagnification as illustrated in Figure 1. PCBs have been found to have potential soil-to-human biomagnification factors of over one million.[1]

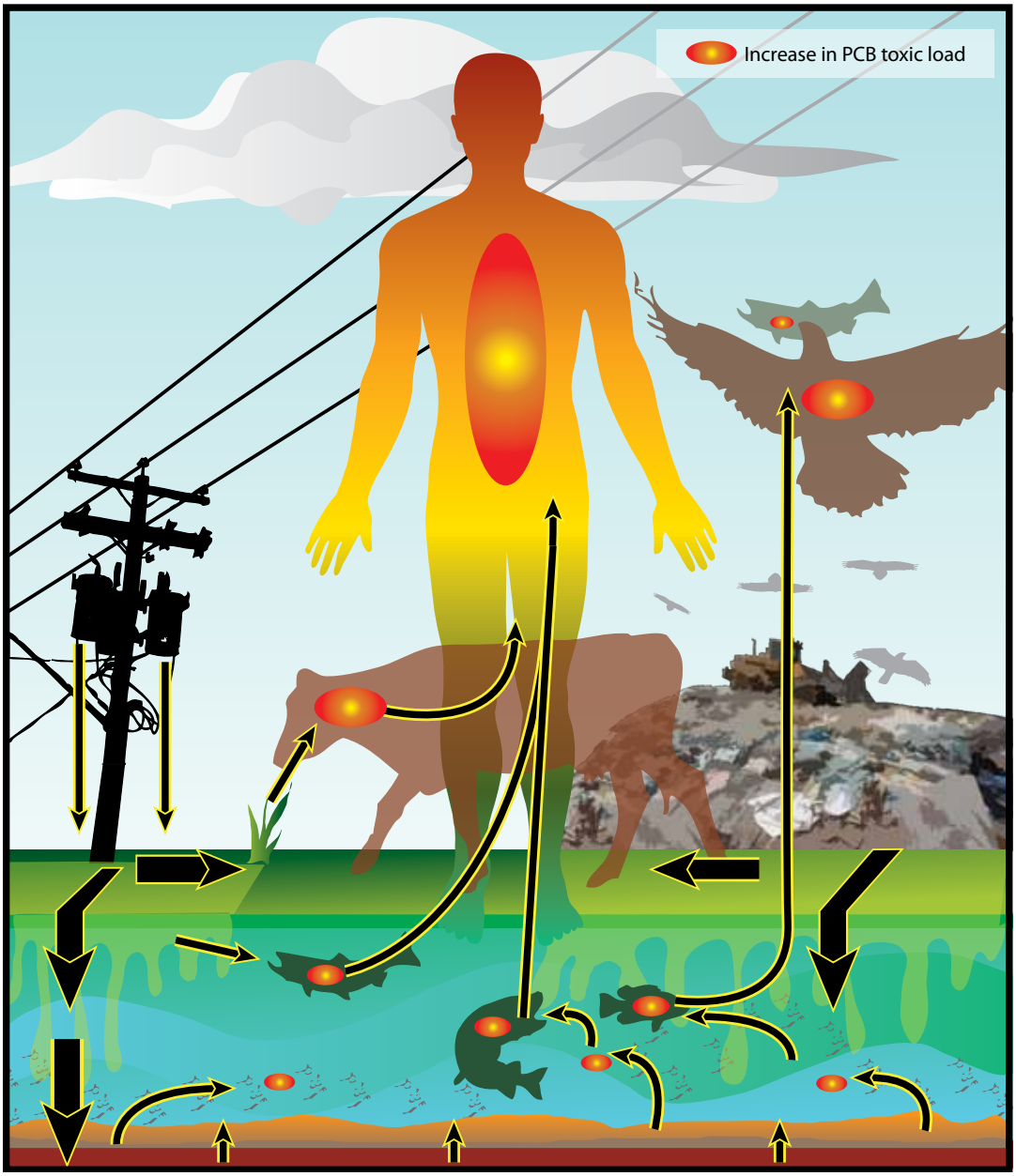


Figure 1. **Bioaccumulation and biomagnification of toxins that are slowly eliminated from exposed life forms.**

Over 200 different PCBs were made before 1977, and some consumer products may still contain PCBs including old fluorescent lighting fixtures, electrical devices or appliances containing PCB capacitors, electrical transformers, as well as old microscope oil and

Table 1								
PCB	CDC 50th		CDC 75th		CDC 90th		CDC 95th	
	ppb	ng/g lipid	ppb	ng/g lipid	ppb	ng/g lipid	ppb	ng/g lipid
Dioxin-like PCBs								
# 118	0.032	5.19	0.066	10.4	0.143	21.8	0.216	31.3
# 126	89.8*	14.7*	159*	24.8*	308*	46.7*	475*	68.7*
# 156	0.021	3.29	0.048	7.0	0.075	11.4	0.103	15.3
# 169	<LOD	<LOD	133*	19.5*	203*	31.0*	269*	40.6*
Non-Dioxin-like PCBs								
# 74	0.027	4.36	0.058	8.72	0.104	15.8	0.153	22.3
# 138	0.095	15.1	0.206	30.5	0.359	55.4	0.477	75.3
# 153	0.135	20.8	0.283	43.3	0.477	71.8	0.624	97.1
# 180	0.114	18.0	0.246	37.1	0.409	63.7	0.534	81.5
#194	<LOD	<LOD	.070	11.1	.123	18.1	.162	23.7

Table 1. **Percentile cutoff values found in the Fourth National Report on Human Exposure to Environmental Chemicals conducted by the U.S. CDC reported in 2009.** LOD stands for Limit of Detection. *measured in parts per quadrillion (ppq), and picogram per gram (pg/g) lipid.

hydraulic fluids. In an Environmental Working Group study with volunteers that lead healthy lives and do not work with chemicals, the subjects contained an average of 91 compounds – most of which did not exist 75 years ago. Bill Moyers, a well-know journalist and news commentator, participated in the study. Of the 48 different PCBs tested, 31 were present in his blood.[2] The CDC is also measuring PCB levels in the NHANES trial and to date has been looking for 15 different PCBs.[3] Of those fifteen, ten are found fairly often. Of those ten, six have known health effects published in the medical literature. These six PCBs, all frequently found in people and with documented health effects, are the ones measured in the Metametrix PCBs Profile.

United States population distribution values (50th, 75th, 90th, and 95th percentile cutoffs) for the PCBs that the CDC measured in the 2009 Fourth National Report on Human Exposure to Environmental Chemicals are shown in Table 1. Their levels include both parts per billion (ppb) in the serum and lipid-adjusted values. The values highlighted in yellow were chosen for measurement in this panel. While PCB numbers 74, 170, 187, and 194 are also found with some regularity, Metametrix does not measure them due to lack of evidence regarding health effects.

Dioxin-like Polychlorinated Biphenyls

- PCB 118 (2,3',4,4',5-Pentachlorobiphenyl)
- PCB 126 (3,3',4,4',5-Pentachlorobiphenyl)
- PCB 156 (2,3,3',4,4',5-Hexachlorobiphenyl)
- PCB 169 (3,3',4,4',5,5'-Hexachlorobiphenyl)

Non-dioxin-like Polychlorinated Biphenyls

- PCB 74 (2,4,4',5-Tetrachlorobiphenyl)
- PCB 138 (2,2',3,4,4',5'-Hexachlorobiphenyl)
- PCB 153 (2,2',4,4',5,5'-Hexachlorobiphenyl)
- PCB 180 (2,2',3,4,4',5,5'-Heptachlorobiphenyl)

The benefit of seeing both "ppb" and "ng/g lipid" values

The levels reported in parts per billion (ppb) are reflective of the amount of toxin present in the serum, mostly found in the lipoprotein and albumin fractions.[4] This level most likely reflects the recirculation of toxins from the adipose tissue due to diurnal lipolysis cycles. Loss of adipose tissue due to stress, rigorous exercise, or weight loss causes increased serum levels from the release of stored PCBs. Current exposures from air and food can also be detected in the serum.

All fat-soluble toxins, including PCBs, are carried in the lipid fraction of the serum, mostly in low-density lipoprotein particles (LDL). Since levels of PCBs change in direct proportion to blood lipid levels, improper test interpretations can result from examining only the concentrations in blood. Measurement of cholesterol and

triglycerides in the blood serum from the same specimen used to perform the PCB testing allows calculation of total lipid level. The PCB concentrations can then be expressed as nano gram per gram (ng/g) lipid. This method of correction has been shown to generate results that reflect adipose tissue levels of organotoxin compounds.[5]
PCBs stored in adipose tissue are a result of bio-accumulation over the lifespan. When lipolysis occurs (with fasting, exercise, stress, weight loss, and saunas) a portion of these toxins accompany the cholesterols and triglycerides that are released from the body's fat stores. By measuring the amount of lipids present in the blood and adjusting the amount of toxins to that lipid level, one is able to get a very accurate idea of just how much of those toxins are in storage. Effective cleansing or detoxification protocols will eventually produce low levels of PCBs, representing lower overall burden of these persistent and accumulating toxins.

A recent exposure may be detected as high ppb in serum, but low or undetectable ng/g lipid levels. This combination indicates that the PCBs in blood have not had time to redistribute to the adipose tissue, a process that occurs over several weeks.

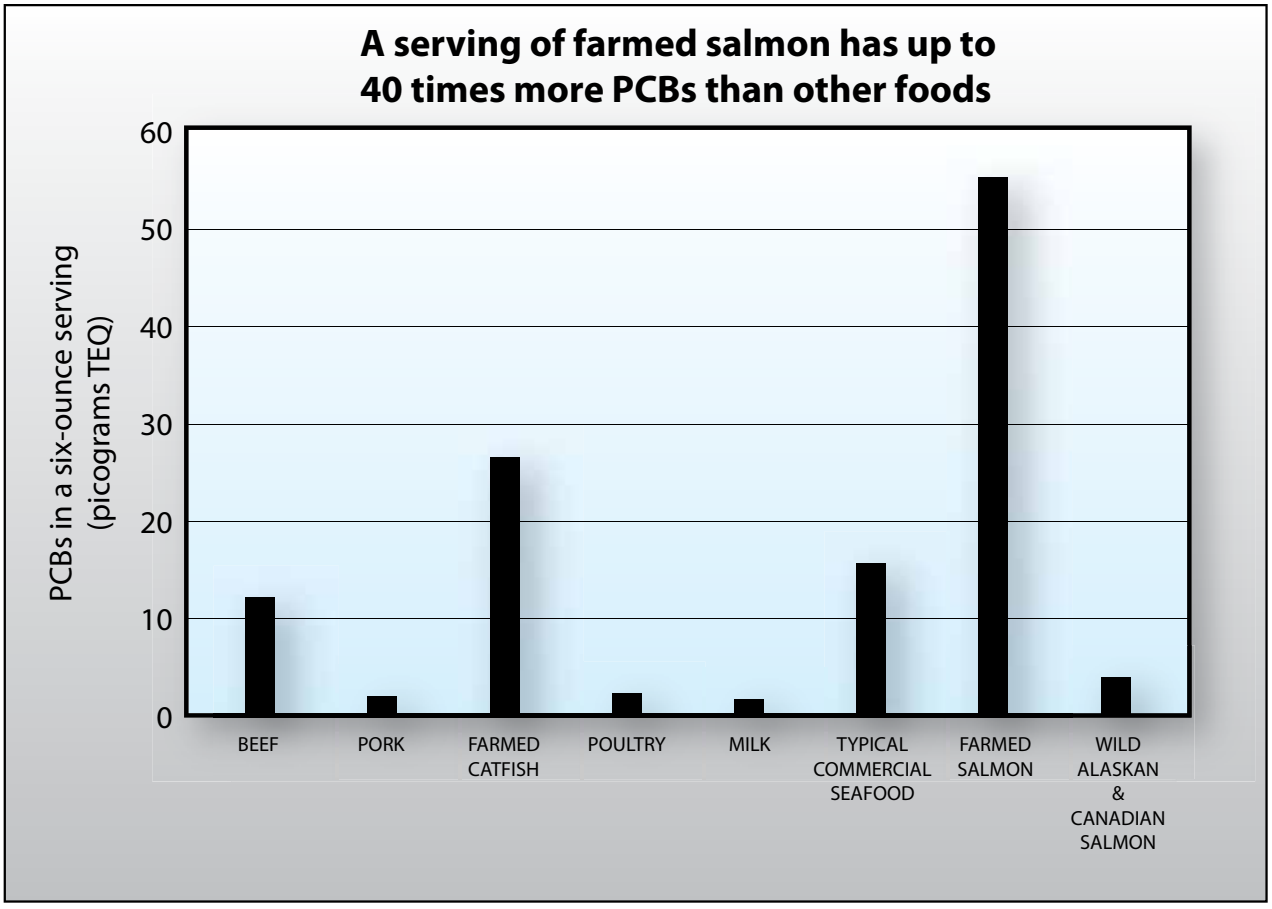
What to expect

PCBs are a class of chemicals that have been found in virtually everyone tested across the planet. The question is not if one has PCBs, but how many are present and are the PCBs adversely affecting that person's health and vitality. Metametrix is using the CDC's values found in the Fourth National Report on Human Exposure to Environmental Chemicals to give the clinician a frame of reference when deciding if a patient has higher levels than what is found in the general population.

What are the adverse effects of polychlorinated biphenyls in humans?

Immune system effects

- PCBs (both dioxin-like and non-dioxin-like) induce apoptosis of monocytes[6] and thymocytes.[7]
- PCBs cause white cells to have diminished mitogen response, decreased phagocytosis and diminished numbers of CD8+ cells.[8]
- Dioxin-like PCBs can cause thymic atrophy and immnosuppression.[9]
- Dietary PCB exposure can lead to increased rates of certain cancers (especially liver and lung).[10]



Neurologic effects

- Neonatal exposure of mice to PCBs results in persistent aberrations in spontaneous behavior that worsens as they age.[11] PCB exposure also adversely affected learning and memory function when they became adult mice.
- In utero exposure to PCBs affected intellectual functioning in children[12], such as increased cognitive defects, poorer gross motor function, and decreased visual recognition memory.[13] They also have lower IQ levels and have increased rates of hyperactivity, both of these problems persist after birth.[14-16]
- Adults consuming PCB-contaminated fish had increased problems with memory and learning.[17]
- Persons exposed to PCB gas had chronic neurological problems including slower reaction time (for both simple and choice reactions), faster sway speeds, diminished color discrimination and visual performances, and constricted visual fields. They also had diminished scores on digit symbols, vocabulary, verbal recall, and embedded memory.[18]

Endocrine effects

- PCBs adversely affect thyroid levels, including elevated anti-thyroid antibodies.[19-21]
- As PCB serum levels increase, the thyroid hormones triiodothyronine (T_3) and thyroxine (T_4) decrease.[22]
- Women exposed to PCBs report higher incidence of stillbirth, miscarriage, more abnormal menstrual bleeding, and greater incidence of endometriosis than non-exposed women.[23,24]
- PCBs and other chlorinated compounds lead to increased risk for type 2 diabetes.[25]

Adverse Health Effects of specific PCBs

- The sum of PCBs 118, 138, 153, and 180 was used to demonstrate negative immune effects in children.[26]
- PCB 153 was significantly associated with diabetes risk.[27, 28]
- The sum of PCBs 28, 52, 101, 118, 138, 153, and 180 was associated with low T_4 and elevated Gamma Glutamyl Transpeptidase (GGT).[29]
- PCB 118 mimics T_3 action.[30]
- PCBs 153 and 126 can negatively affect the nervous system and thyroid gland.[31]
- PCB 126 is associated with estrogenic[32] and adrenal effects[33] and is immunotoxic.[34]

Exposure sources

The greatest sources of PCBs exposure come from eating contaminated food.[35] The estimated dietary intake of PCBs for an average adult was 0.027 ug/kg/day in 1978 and had declined to <0.001 ug/kg/day by 1991.[36] The highest content of PCBs in one dietary study was found in dairy products (especially butter), meat, and fish. Atlantic farmed salmon is the greatest exposure source among fish, as well as fish caught and consumed from the Great Lakes.[37]

Inhalation of indoor air in buildings with old electrical fixtures is another route of PCB exposure.

Numerous studies from around the globe have consistently documented PCBs in breast milk samples, exposing infants who are breast fed daily.

Action Steps

1. Identify exposure sources and remove them. DO NOT eat Atlantic (farmed) salmon; substitute with wild caught Alaskan salmon. Substitute commercial varieties of butter and margarine with organic butter.
2. Enhance the clearance of persistent toxins from the body with cleansing protocols. Sauna therapy and colonic irrigations have been used to reduce the presence of PCBs and chlorinated pesticides.[38]
3. Increase the normal bowel excretion of the fat-soluble toxins. Daily use of rice bran fiber (RBF) has been documented in several studies in Japan to increase the clearance of PCBs.[39-41] Chlorophyll and all chlorophyll containing foods are also tremendous at increasing the excretion of these fat-soluble persistent toxins in the feces.[42-44] Increasing these foods in the diet, or with supplementation on a daily basis, will slowly increase the excretion of these compounds from the body. In addition to the chlorophyll containing agents, polyphenols found highest in white and green teas have been shown to increase the excretion of fat-soluble toxins.[45]
4. Supplement with high amounts of a combination nutrient and botanical antioxidant to protect the tissues and cells that are under assault from the toxic compounds.

5. Assess detoxification ability with organic acid analysis, amino acid analysis, and genetic predisposition testing. These tests can aid in designing appropriate detoxification protocols for patients.

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