THE HAZARDS TO THE UNBORN CHILD OF METHYLMERCURY IN THE ENVIRONMENT

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October 12, 2004

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Mercury is a chemical element, a heavy metal. Mercury exists in nature in three different forms: (1) metallic mercury – the dense silvery liquid metal that we all know from thermometers and from our high-school chemistry labs; (2) inorganic salts of mercury; and (3) organic mercury compounds, most notably methylmercury and ethylmercury. Each of these forms of mercury has a different distribution in the environment, and each poses different risks to human health.

It is **methylmercury** (chemical symbol, **Me-Hg**) that poses the greatest risk to the unborn child.

Concern has also arisen about **ethylmercury** (chemical symbol, **Et-Hg**), which has been used as a preservative in certain vaccines. Some reports have suggested a link between Et-Hg exposure and autism.

How is Me-Hg formed? Me-Hg arises in nature through the chemical transformation of metallic mercury that has been discharged into the environment. The following is a step-by-step description of the process.

Step 1. Metallic mercury is released to the environment from human and also from natural sources.

Polluting industry is the main source of mercury emission to the environment. Industry accounts for about 70% of the 5500 tons of mercury released around the world each year[i,ii,iii]. Two industries are especially problematic:

- *Coal-burning electrical power plants*. All coal contains some mercury (as well as lead, iron and other elements). When coal-fired power plants are not equipped with filters and stack scrubbers, the mercury in the coal is vaporized, goes up the smokestack and is discharged into the atmosphere in the form of tiny, microscopic droplets. These droplets can travel for long distances in the air. Ultimately, they are washed out of the atmosphere by rain and snow. They go into rivers, and lakes and the oceans.
- *Chloralkali plants*. These are large chemical facilities that produce chlorine gas. They use metallic mercury as a catalyst. If leakage of this liquid mercury occurs, the metal can escape into lakes, rivers and groundwater.

Volcanoes and other natural sources account for the remaining 30% of the mercury released to the environment each year. When a volcano erupts, the traces of mercury that exist naturally in the earth's rocks are vaporized to the atmosphere in the form of tiny droplets. Exactly as in coal-fired power plants, these droplets of mercury are lofted long distances through the atmosphere, and they eventually wash into rivers, lakes and oceans.

Step 2. When metallic mercury that has been discharged to the environment falls into rivers, lakes and the oceans, it settles to the sediments on the bottoms of these waterways. There it is ingested by bacteria and other microorganisms. These creatures have unique enzymes that enable them to add a methyl group to the metallic mercury. This chemical reaction transforms the metallic mercury into methylmercury.[iv] The microorganisms accumulate the methylmercury within their bodies.

How does Me-Hg get from the environment into people? Consumption of fish that has become contaminated by methylmercury is the major route of human exposure to Me-Hg.

Fish become contaminated with Me-Hg because they accumulate high levels of the Me-Hg that is formed by marine microorganisms.

What happens is that the mercury-transforming microorganisms in marine sediments are eaten by plankton. The plankton are then consumed by little fish. The little fish are eaten in turn by larger fish. And those fish are eaten by the very large predatory fish that are at the top of the food chain, such as tuna, shark, king mackerel, swordfish or striped bass. Me-Hg is a persistent pollutant, and the plankton and fish are not able to excrete it. So as the creatures on each level of the food chain eat the creatures below them, they ingest the mercury that has accumulated in those creatures' bodies. Thus each large fish at the top of the food chain contains in its flesh all of the mercury that has accumulated in all of the millions of smaller organisms that stand below it.[v,vi,vii,viii] The result is that methylmercury can accumulate to reach very high concentrations in predatory fish at the top of the food chain.

How does Me-Hg damage the unborn child? Me-Hg is extremely toxic to the brain and nervous system, especially to the rapidly developing brain of the unborn child.

When a pregnant woman eats mercury-contaminated fish, the Me-Hg from the fish enters the mother's blood stream. From the mother's bloodstream, the Me-Hg can move directly across the placenta to enter the body of her unborn child. The placenta poses no barrier to the passage of Me-Hg. Once in the child, the Me-Hg accumulates in the brain, where we know that it can damage neurons (brain cells) to cause brain damage.

The toxicity of methylmercury to the developing brain of the unborn child was first recognized in the 1950s in Minamata, a fishing village in Japan. In Minamata, consumption of fish with very high concentrations of methylmercury by pregnant women resulted in at least thirty cases of severe brain damage.[ix] Metallic mercury had been discharged into Minamata Bay by a chemical plant, and the marine microorganisms in the bay transformed the metallic mercury into Me-Hg. Permanent loss of intelligence, blindness, and disruption of behavioral and motor function were noted in the children exposed in the womb. By contrast, their mothers showed no symptoms, or at most suffered only mild effects.

This difference in symptoms between the mothers of Minamata and their children illustrates how exquisitely sensitive is the brain of the unborn child to Me-Hg.

A similar episode occurred in Iraq in 1972, when the improper use of a methylmercury fungicide led to poisoning in thousands of people.[x] Infants exposed to Me-Hg in the womb appeared normal at birth, but subsequently developed blindness, deafness, seizures and mental retardation.[xi,xii]

The unique vulnerability of the unborn child to methylmercury results from the ability of Me-Hg to cross the placenta and concentrate in the developing brain.[xiii] Moreover, the blood-brain barrier, that in the adult insulates the brain from toxins in the bloodstream, is not fully developed until the first year of life. Thus methylmercury can cross this incomplete barrier to damage developing brain tissue.[xiv]

Low-level exposure to Me-Hg and brain injury to the unborn child. The Minamata and Iraq episodes involved high-level exposures to Me-Hg. More recently, painstaking medical research has shown that lower level exposures of the unborn child to Me-Hg can also cause brain injury.

Three large-scale, prospective epidemiologic studies have examined children who experienced methylmercury exposures in the womb at concentrations relevant to current exposure levels in the U.S.:

- The first of these studies, undertaken in New Zealand, found a three-point loss in the Wechsler full-scale IQ among children born to women with maternal hair mercury concentrations above 6 µg/g.[xv,xvi] Fish consumption was the principal source of the mothers' exposure.
- A second study in the Seychelles Islands in the Indian Ocean found an adverse association between maternal hair mercury concentration during pregnancy and children's performance on a grooved pegboard test. The grooved pegboard test is a measure of eye-hand coordination in children.[xvii]
- A third study in the Faroe Islands, a component of Denmark inhabited by a Scandinavian population in the North Atlantic, has followed a population of children for fourteen years. These children were exposed to Me-Hg while in their mothers' wombs. The Faroes researchers found significant associations between prenatal mercury exposure and decreased performance on a wide range of tests that assess memory, attention, language and visual-spatial perception.[xviii]

A 2000 assessment of these three studies by the US National Academy of Sciences resulted in the report, *Toxicological Effects of Methylmercury*. This authoritative analysis concluded that there is strong evidence for the neurotoxicity of methylmercury to the unborn child, even at low levels of exposure.[xix]

Ethylmercury and children's health. Et-Hg, another form of organic mercury, different from Me-Hg, has been used in the form of thimerosal as a preservative for certain killed virus vaccines administered to children, in the Rh vaccine administered to pregnant women to prevent Rh incompatibility, and in other biological agents and medications.

Rates of autism have been rising in American children over the past decade. Autism is a terrible and tragic disease that commonly makes its appearance at the age of 1-3 years in children who previously appeared to be completely healthy.

Because autism so frequently develops in children at the same time in their lives as they are receiving multiple immunizations, concern has arisen that the use of thimerosal in vaccines may have contributed to the causation of some cases of autism. This concern has prompted a series of careful studies to examine the possibility of a causative role.

To date, none of the studies that have looked into the possibility of a link between thimerosal and autism has found evidence for an association. These studies have been very well conducted, and the conclusions appear honest and credible.

Nonetheless, as a precautionary measure, the American Academy of Pediatrics, along with the American Academy of Family Physicians, the Advisory Committee on Immunization Practices, and the US Public Health Service issued a joint recommendation that thimerosal be removed from vaccines as quickly as possible. As a result, thimerosal was voluntarily removed from vaccines in a joint decision of the major vaccine manufacturers in 1999. The only thimerosal-containing vaccine still used in children is the influenza vaccine. Manufacturers are in the process of developing and producing thimerosal-free versions of the flu vaccine.

How can You Reduce Your Exposure and your Unborn Child's Exposure to Mercury?

- During pregnancy and lactation, strictly limit your intake of those species of fish that are known to be high in methyl mercury. Specifically, you should avoid King Mackerel, Tile Fish, Shark and Swordfish entirely.

- If you are hoping to become pregnant, limit your intake of those same fish in the 3 to 6 months before you conceive. That time interval will give your body time to get rid of any mercury that you may previously have consumed.

- Eat up to 12 ounces (2 average meals) a week of a variety of fish and shellfish that are lower in mercury. These fish will provide you and your baby with the omega-3 fatty acids that are abundant in fish and that are so beneficial to the development of your baby's brain and cardiovascular system.

- Five of the most commonly eaten fish that are low in mercury are shrimp, canned light tuna, salmon, pollock, and catfish.

- Another commonly eaten fish, albacore ("white") tuna has more mercury than canned light tuna. So, when choosing which fish to eat, you may eat up to 6 ounces (one average meal) of albacore tuna per week. Below is a chart that presents groupings of low-mercury containing fish as well as fish that contain moderate and high amounts of fish.
- Check local advisories about the safety of fish caught by family and friends in your local lakes, rivers, and coastal areas. If no advice is available, eat up to 6 ounces (one average meal) per week of fish you catch from local waters, but don't consume any other fish during that week.

- Carefully handle and dispose of products that contain mercury, like thermometers, thermostats and fluorescent light bulbs.

- If mercury has been spilled in your home, contact your local health department about its clean-up. Stay out of the room where the spill happened, especially if you are pregnant.

- And lastly, consider becoming involved in groups that are seeking to educate the American public about environmental hazards to the unborn child and to limit discharges of mercury into the environment:

1. Some groups are working with hospitals and doctors' offices to reduce use of mercury in medical instruments; very effective, mercury-free medical instruments are now widely available at comparable cost.
2. Some groups are working to reduce mercury emissions from coal-fired electrical power plants.

REFERENCES

Mercury Levels in Commercial Fish and Shellfish

Adapted from EPA/FDA, 2004:http:// www.cfsan.fda.gov/~frf/sea-mehg.html

SPECIES	MEAN MERCURY LEVEL (parts per million [ppm])
Lower Mean Mercury Levels (None detected [ND] to 0.29 ppm)	
Bass (saltwater; includes sea bass/striped bass/rockfish)	0.27
Catfish	0.05
Clams[a]	ND
Cod[b]	0.11
Crab (blue, king, and snow)	0.06
Crawfish	0.03
Flatfish (includes flounder and sole)	0.05
Haddock	0.03
Halibut	0.26
Herring[c]	0.04
Lobster (spiny)	0.09
Mackerel (Atlantic)	0.05
Mackerel chub (Pacific)	0.09
Mackerel, Spanish (South Atlantic)	0.18
Monkfish[b]	0.18
Oysters	ND
Perch (freshwater)	0.14
Pollock	0.06
Salmon (fresh/frozen)[c]	0.01
Sardines[c]	0.02
Scallops	0.05
Shad (American)	0.07
Shrimp	ND
Skate	0.14
Snapper[b]	0.19
Squid	0.07
Tilapia	0.01
Trout (freshwater)	0.03
Tuna (canned chunk light)	0.12
Weakfish (sea trout)	0.25
Moderate Mean Mercury Levels (0.3 to 0.59 ppm)	
Bluefish[c]	0.31
Grouper[b]	0.55
Lobster (Northern/American)	0.31
Mackerel, Spanish (Gulf of Mexico)	0.45
Marlin	0.49
Orange roughy[b]	0.54
Tuna (canned, white albacore)	0.35
Tuna (fresh/frozen)	0.38
Highest Mean Mercury Levels (≥ 0.6 ppm): Avoid Eating	
Mackerel-King (Atlantic & Gulf of Mexico)	0.73
Shark[b]	0.99
Swordfish[b]	0.97
Tilefish (Gulf of Mexico)[b]	1.45

a) FDA testing has been extremely limited (<10 samples tested) and may not reflect actual contamination levels. b) Some species have been overfished in recent years, and thus may not be good choices for those concerned about fisheries sustainability. Visit http:// www.mbayaq.org for more information. c) These fatty fish may be low in mercury but high in PCBs or other persistent organic pollutants.

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