CEHC FACT SHEETS: Mercury

What is mercury?
Mercury is a chemical element, a heavy metal. Mercury exists in nature in three different forms: metallic (elemental) mercury – the dense silvery liquid metal we all know from thermometers and our high school chemistry labs; inorganic salts of mercury; and organic mercury compounds, most notably methylmercury and ethylmercury. Each form of mercury is found in different environmental locations and each poses different risks to human health.

- **Metallic Mercury:** Metallic mercury is the most recognizable form of mercury. Often known as “quicksilver”, it is distinguished by its silver-liquid consistency. Metallic mercury is used in thermometers and mercury switches for a wide variety of industrial and commercial purposes, as well as in many batteries. For example, those popular children’s sneakers that light up as they walk contain mercury switches.

- **Inorganic Mercury:** Inorganic mercury, which takes the form of a white solid, is occasionally used in Chinese, Spanish, and homeopathic medicines for stomach disorders, and may be present in skin lightening creams. In the past, inorganic mercury was used in the US as a treatment for worms and as a teething powder. Most uses of inorganic mercury in the US have been stopped.

- **Organic Mercury:** There are two major forms of organic mercury – methylmercury and ethylmercury. While ethylmercury and methylmercury are both forms of organic mercury (meaning they have carbon-based structures), both have very different properties. The difference between the two is like the difference between ethyl alcohol (found in alcoholic beverages) and methyl alcohol, a highly toxic form of alcohol, which causes blindness and death.

Methylmercury is formed when elemental mercury is released into the environment through either industrial processes or natural occurrences such as volcanoes. Once this mercury is discharged into the environment it finds its way into rivers, lakes and oceans where it eventually settles to the sediments on the bottoms of these waterways. There it is ingested by bacteria and other microorganisms that contain unique enzymes that enable them to add a methyl group to the metallic mercury to form methylmercury. Since methylmercury is a persistent pollutant, as creatures on each level of the food chain eat the creatures below them, they ingest the mercury that has accumulated in those creatures’ bodies. The result is that methylmercury can accumulate to reach very high concentrations in predatory fish at the top of the food chain. **This also means that fish and shellfish which are towards the bottom of the aquatic food-chain have lower concentrations of mercury in their flesh and are safer to eat. For a list of which popular fish and shellfish are high and low in mercury, please see table 1 in “Ways to avoid mercury exposure”**.
Ethylmercury is a second quite different form of organic mercury. It has been used in thimerosal, a preservative used in certain killed virus vaccines administered to children, in the Rh vaccine to pregnant women to prevent Rh incompatibility, and in other biological agents and medications.

**How does mercury exposure occur?**
Exposure to the different forms of mercury (organic, metallic, inorganic) comes from different unique sources and via different routes.

- **Metallic Mercury:** Metallic (elemental) mercury exposure occurs through inhalation of mercury vapors. Metallic mercury is readily vaporized at room temperature and then is easily absorbed through the lung. Once absorbed through the lung, it moves to the circulatory system which can distribute this toxin throughout the body. Any time mercury-containing items are damaged or improperly discarded, there is a potential for exposure to the vapors released by the metallic mercury they contain creating a health hazard.

- **Inorganic Mercury:** Inorganic mercury salts once were used as a teething powder and as a treatment for worms, but their use has almost been completely abandoned in light of studies displaying their detrimental health effects. Exposure to inorganic mercury is therefore very rare.

- **Organic Mercury:** Consumption of fish that has been contaminated with methylmercury is the major route of human exposure to methylmercury. Methylmercury is a persistent pollutant and plankton and fish are not able to excrete it or break it down. As described previously, methylmercury becomes concentrated in large, predatory fish. When humans consume these fish, they in turn also consume the high concentrations of methylmercury in their fatty tissues.

The other form of organic mercury is ethylmercury. The only significant source of ethylmercury exposure is through its presence in thimerosal, a preservative and antiseptic used in some vaccines and drug therapies. While the toxicity of low-levels of ethylmercury is still under debate, the American Academy of Pediatrics, along with the American Academy of Family Physicians, the Advisory Committee of Immunization Practices, and the US Public Health Service issued a joint recommendation that thimerosal be removed from vaccines as quickly as possible as a precautionary measure. Thimerosal was voluntarily removed from most vaccines in a joint decision of the major vaccine manufacturers in 1999.

**Because autism so frequently develops in children at the same time in their lives that they are receiving multiple immunizations, concern has risen that the use of thimerosal (which contains ethylmercury) might have contributed to the causation of some cases of autism. To date, none of the studies that have examined the 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.**

**How does mercury affect human health?**
The health effects of mercury depend on which form (metallic, organic or inorganic) of mercury the individual is exposed to.
• **Metallic Mercury**: If metallic mercury vapors are inhaled, they are easily absorbed through the lung into the circulatory system. Chronic exposure to low levels of mercury vapor have been associated with tremors, irritability, impulsiveness, drowsiness, impaired memory, and sleep disturbances. At high levels, exposure to metallic mercury vapors can result in respiratory distress. Continued high levels of exposure can lead to respiratory failure and pulmonary tissue death. Metallic mercury tends to eventually accumulate in the kidneys and can result in nephritic syndrome.

• **Inorganic Mercury**: Exposure to inorganic mercury salts, such as those once used as a treatment for worms, can result in a condition known as acrodynia. Also known as “pink disease”, acrodynia causes reddening of the palms and soles of the feet. Although a rarity in modern society, cases of acrodynia is occasionally reported. Ingestion of inorganic mercury can also result in gastrointestinal ulcers, perforations, and hemorrhages and eventually circulatory collapse.

• **Organic Mercury**: Methylmercury is extremely toxic to the brain and nervous system, especially in the bodies of rapidly developing infants. When a mercury molecule is attached to an organic molecule, its physical and toxic properties are radically changed. Organic mercury molecules are much more soluble in fatty tissues. Because of this, they cross membranes and enter cells more readily.

Due to its chemical properties, methylmercury that has been consumed with fish is easily absorbed into the circulatory system where it is able to access the brain and nervous system. When a pregnant woman eats mercury-contaminated fish, the methylmercury that gets into her blood-stream can also move directly across the placenta to enter the body of her developing infant. The placenta poses no barrier to the passage of methylmercury. Once in the child, methylmercury accumulates in the brain where it can damage neurons (brain cells) to cause brain damage.

The toxicity of methylmercury to the developing brain was first recognized in the 1950s in Minamata, a small fishing village in Japan. In Minamata, pregnant women traditionally consumed large quantities of fish from local waters. Unfortunately, those waters had become contaminated with very concentrations of methylmercury, and so the fish that the women ate were highly contaminated as well. The result was that at least thirty babies were born in Minamata with severe brain damage. The source of the mercury was a chemical plant that had discharged metallic mercury into Minamata Bay and the metallic mercury was subsequently transformed into methylmercury. Permanent loss of intelligence, blindness, and disruption of behavioral and motor function were noted in the children exposed in the womb. The mothers showed no symptoms, or at most suffered only mild effects.

As the situation in Minamata tragically teaches, infants are uniquely vulnerable to methylmercury. This is in large part due to their rapidly developing brains. Making methylmercury even more dangerous to infants is the fact that the blood-brain barrier, which insulates the brain from toxins in the bloodstream, is not fully developed until the first year of life. Once deposited in the brain and nervous system, methylmercury poisoning can lead to blindness, deafness, disruption of behavioral and motor functions, seizures, and mental retardation. In 2002, the US National Academy of Sciences published a report titled *Toxicological Effects of Methylmercury*. This authoritative analysis concluded that there is strong evidence for the neurotoxicity of methylmercury to the developing brain, even at low levels of exposure.
The health effects of ethylmercury, the second major form of organic mercury, have been studied to a much lesser degree than those of methylmercury. At very high levels, thimerosal-containing products, the main source of human exposure to ethylmercury have been shown to be toxic, causing acrodynia, chronic mercury toxicity, renal failure, and neuropathy. Because autism so frequently develops in children at the same time in their lives as they are receiving multiple immunizations, concern has risen that the use of thimerosal (which contains ethylmercury) might have contributed to the causation of some cases of autism. To date, none of the studies that have examined the 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.

**How is mercury poisoning diagnosed?**
Diagnosis of mercury poisoning is usually made through a medical history and physical examination. **Urine mercury levels are used to assess the levels of metallic and inorganic mercury, while blood mercury levels are used to assess organic mercury levels.** For metallic mercury and inorganic mercury, urine tests can verify mercury levels – results greater than 10-20 μg/L are considered elevated. For organic mercury, blood mercury levels higher than 1.5 μg/L indicate excessive mercury exposure.

**Is there a treatment for exposure to mercury?**
The most important and most effective treatment is to identify and remove the mercury source. For inorganic mercury, there are chelating agents that eliminate mercury, but they have not proved to successfully eliminate or significantly relieve the symptoms of high mercury levels. There is no FDA approved treatment for high organic mercury levels; see your pediatrician for follow-up examinations.

**Ways to avoid mercury exposure.**
Since each source of mercury exposure has a unique source, there are different steps that should be taken to avoid each type of mercury exposure.

- **Metallic Mercury:** In the case of a metallic mercury spill in your house or immediate environment do not try to clean it up yourself. In its liquid state, mercury poses little risk to you or your children. If heated or disturbed, however, mercury is readily vaporized in which case it becomes a serious hazard. Contact your local health department who will have personnel trained to handle mercury spills. Avoid the room where the spill happened until the clean-up has been executed.

  Carefully handle and dispose of products that contain mercury such as batteries, thermometers, thermostats and fluorescent light bulbs. For proper disposal procedures of mercury-containing items, contact your local Department of Health or Department of Waste Management.

- **Inorganic Mercury:** Inorganic mercury exposure is extremely rare as most uses of inorganic mercury salts have been abandoned. Avoid any homeopathic remedies that contain mercury.

- **Organic Mercury:** Infants and children are the most vulnerable population to the effects of mercury poisoning. Therefore, during pregnancy and lactation, mothers should strictly limit their intake of those species of fish that are known to be high in methylmercury. Avoid Chilean Sea Bass, Grouper, King or Spanish Mackerel, Marlin, Orange Roughy, Shark, Swordfish, Tile Fish, and Tuna (fresh, such as that used in sushi) entirely during this period.
Since fish are an important source of protein and omega-3 fatty acids, don’t cut fish completely out of your diet. Instead, stick to those known to be low in methylmercury. These tend to be smaller fish, found on the lower end of aquatic food chains. Some commonly eaten fish that are low in mercury include Shrimp, Canned Light Tuna, Salmon, Pollock, Tilapia and Catfish. See table 1 for the mercury levels typically found in a number of popular seafood choices.

Table 1: Fish and Shellfish by Average Mercury Levels

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<tr>
<th>Mercury Level</th>
<th>Fish and Shellfish</th>
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<tbody>
<tr>
<td>Very Low</td>
<td>Anchovies, Clams, Crawfish/Crayfish, Hake, Herring, Oysters, Pollock, Salmon, Sardines, Shrimp, Tilapia, Whiting</td>
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<tr>
<td>Low</td>
<td>Butterfish, Catfish, Cod, Crab, Croaker (Atlantic), Flounder, Haddock, Jacksmelt, Mackerel (North Atlantic), Mullet, Mussels, Perch (Ocean or White), Scallops, Shad (American), Sole, Squid/Calamari, Trout (Freshwater), Tuna (Canned Light), Whitefish</td>
</tr>
<tr>
<td>High</td>
<td>Bass (Black, Saltwater, Striped), Bluefish, Eel, Halibut, Lobster, Monkfish, Sablefish, Scorpionfish, Sheepshead, Skate, Snapper, Tuna (Albacore or Canned White), Weakfish/Sea Trout</td>
</tr>
<tr>
<td>Very High</td>
<td>Chilean Sea Bass, Grouper, Mackerel (King or Spanish), Marlin, Orange Roughy, Shark, Swordfish, Tilefish, Tuna (Fresh, Steaks, Sushi)</td>
</tr>
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</table>

The only significant source of ethylmercury exposure is through thimerosal, the previously mentioned preservative and antiseptic used in some vaccines and drug therapies. Most current vaccines on the market do not contain thimerosal and those that do usually have an alternative, thimerosal-free version.

References:


Landrigan PJ, Needleman HL, Landrigan M. Raising Healthy Children in a Toxic World. Emmaus, PA; 2001

