MIND, DISRUPTED

How toxic chemicals change how we think and who we are

Perchlorate

What Is Perchlorate?

Perchlorate is a colorless, odorless chemical that readily dissolves in water, which means that it may easily enter groundwater and be taken in by plants through irrigation.[1,2] Since the 1940s, perchlorate compounds have been synthesized and used for their explosive properties in rocket fuel, fireworks, roadside flares, explosive devices, and rocket launchers.[1,3] Other products that contain perchlorate include matches and airbag inflation systems. It is also used in the production of dyes, paints and rubber.[4]

Perchlorate also forms naturally in the atmosphere, where it can lead to trace levels in precipitation.[4] There are natural deposits of perchlorate salt in Western Texas[5] and in Northern Chile.[6] In Chile, deposits known as Chilean saltpeter are mined and used in fertilizer because they are rich in sodium nitrate.[6] These same deposits also contain perchlorate.[6] One study found a concentration of 0.7-2 mg of perchlorate per gram of Chilean sodium nitrate fertilizer.[6]

Perchlorate continues to be used for medicinal purposes to treat thyroid problems. High doses (600-1200 mg per day) of potassium perchlorate was used to treat thyrotoxicosis (or hyperthyroidism) in the 1960s until cases of aplastic anemia associated with this treatment were reported.[7] More recently, perchlorate has been used to treat amiodarone (antiarrhythmic cardiac drug) induced thyroid problems.[7]

How Are We Exposed?

The primary route of exposure to perchlorate is ingestion of contaminated vegetables or dairy products. Because perchlorate dissolves and is distributed readily in surface waters and groundwater, drinking water and food sources may become contaminated by perchlorate.[1] In the United States, there are no standards to limit perchlorate levels in irrigation water, so water used to irrigate crops may contain high levels of perchlorate. Leafy greens such as lettuce and alfalfa have been found to contain perchlorate.[2] Over 90% of the lettuce grown in the United States during the winter months is grown in California's Imperial Valley and is irrigated by perchlorate contaminated water from the Colorado River.[8] Water from the Colorado River has been found to contain 1.5-8 µg/L of perchlorate, but lettuce irrigated by this water may contain much higher concentrations.[8] A U.S. Food and Drug Administration (FDA) "bread basket" survey found levels from below the detectible level to 129 µg/L in lettuce irrigated by Colorado River water.[9]

Milk sampled from 11 states was also found to contain perchlorate, possibly because the dairy cows consumed perchlorate contaminated water and alfalfa.[11] Perchlorate has also been found in oranges and chewing tobacco.[1]

Infants may be exposed to perchlorate both through breast milk and infant formula.[12] In a recent study by the Centers for Disease Control and Prevention (CDC), perchlorate was found in human breast milk as well as in dairy milk, lactose-free milk, and soy infant formula that was reconstituted with perchlorate-free water.[12] Average perchlorate levels found in the samples of lactose containing dairy milk based infant formula were 1.72 µg/L.[12]

Living near military waste dumps and rocket testing areas increases the risk of exposure to perchlorate through contaminated air, dust, and water.[1] Factories that produce fireworks, rocket fuel, rocket launchers, and other products that contain perchlorate may also increase the risk of perchlorate inhalation or ingestion[1] among workers and neighboring community residents.

Exposure to perchlorate may occur before and after fireworks shows.[1] Perchlorate may also be present as a contaminant in bleach and exposure may occur through bleach, certain cleaning products and pool chemicals.[1]

Perchlorate in Our Bodies

Based on the results of a 2007 biomonitoring study, perchlorate exposure is ubiquitous in the United States.[13] Perchlorate was found in 100% of 2,820 urine samples from the 2001–2002 National Health and Nutrition Examination Survey (NHANES).[13] Participants in this study were 6 years and older. Even after adjusting for urinary creatinine levels, children aged 6-11 had higher levels of urinary perchlorate than adolescents or adults. Researchers found that "children had higher median urinary perchlorate levels (5.2 µg/L; 5.79 µg/g creatinine) compared with adults (3.5 µg/L; 3.25 µg/g creatinine)."[13]

Reducing Your Exposure

You can prevent or minimize exposure to perchlorate in the following ways:

- If you are concerned about perchlorate in your home drinking water, you can contact your local water provider, or local and state agencies. The only readily available water treatment process that can remove or reduce perchlorate in drinking water is reverse osmosis.[32] The non-profit organization NSF International has listings of reverse osmosis filters that effectively remove perchlorate and other contaminants from drinking water.[33]
- If you work in a factory where perchlorate, flares, fireworks, or other explosives containing perchlorate are manufactured, you may have perchlorate dust on your clothes and body.[1] Avoid spreading the dust around the house and car by changing clothes at work and taking a shower when you get home.
- Store gunpowder, flares, fireworks and other items that may contain perchlorate away from your house, if possible.[1]
- Do not let children play in the dirt near perchlorate contaminated sites.[1] Abandoned military sites are likely to be contaminated with perchlorate.
- Ensure the clean-up of perchlorate contaminated areas by contacting your regional EPA office and your state and federal representatives.
- Support federal regulation that sets a standard for allowable perchlorate levels that are safe for women of childbearing age, in order to protect the developing fetus.

Perchlorate has also been measured in breast milk. A study of 36 human breast milk samples from 18 states found perchlorate in every sample.[11] A range of 1.3-411 µg/L of perchlorate was detected in the breast milk of Boston area mothers who participated in a 2007 CDC study.[14] Another study found perchlorate levels in breast milk up to 92 µg/L.[11] Based on average milk intake,[15] infants of more highly exposed mothers in both of these studies may exceed the EPA reference dose for perchlorate of 0.7 µg per kilogram of body weight per day.[11]

What Does Exposure to Perchlorate Mean for Our Health?

The presence of environmental chemicals in the human body does not necessarily imply that they are causing adverse health effects; however, environmental chemical exposures can and do affect human health. It is important to note that both the dosage and the timing of exposure have significant effects on any potential health outcome.

The following information is intended to inform the reader about the current state of knowledge on the health effects of perchlorate, including both human and animals studies.

Due to its effects on the thyroid gland, perchlorate affects many body systems. Infants and neonates are especially vulnerable to the effects of perchlorate.

Thyroid Disruption and Neurodevelopmental Disorders

Perchlorate has been shown to interfere with the absorption of iodine by the thyroid gland.[16] As a result, the thyroid gland produces less T_4 hormone, which can result in hypothyroidism if exposure continues.[16] Thyroid hormones are important in regulating growth and metabolism.[17] In fetuses and young babies, perchlorate exposure is a particular concern because the chemical may interfere with neural development.[18] In adults, hypothyroidism can lead to dry skin, depression, weight gain, fatigue, and sensitivity to cold.[19]

A 2006 CDC study of 2,299 men and women over the age of 12 found a relationship between increased levels of perchlorate in urine and changes in thyroid hormone levels.[20] Women with urinary iodine less than 100 µg/L were more likely to have decreased levels of the thyroid hormone T_4 when exposed to perchlorate.

Administration of perchlorate to humans at doses of 7 and 500 µg/kg/day (significantly higher than the EPA reference dose) caused changes in iodine uptake, but changes in thyroid hormones only occurred at 500 µg/kg/day.[16]

Thyroid hormones are critical for normal growth and development in fetuses, infants, and small children.[21] Low maternal thyroid hormone levels have been associated with neurodevelopmental delays and decreased IQ scores.[22] Even after thyroid hormone treatment, some children continue to experience cognitive impairment.[23]

Infants are vulnerable to perchlorate exposure due to its effects on the thyroid and the developing brain. In a 2003 animal study, maternal perchlorate exposure was associated with a reduction of iodine in breast milk and a reduction in neonatal thyroid hormone levels.[24]

Regulations for Perchlorate

In 2005, the EPA adopted a reference dose of 0.7 µg/kg/day, which translated into a Drinking Water Equivalent Level (DWEL) of 24.5 µg/L. However, this is an incomplete standard that assumes all exposure comes from water. In 2008, the EPA issued a preliminary determination for perchlorate in the Federal Register which stated that national drinking water regulations would

not be a "meaningful opportunity for health risk reduction."[25]

Over 32,000 public comments were generated[26] in response to this determination, including a letter from the EPA Children's Health Protection Advisory Committee which stated, "This decision does not recognize the science which supports the exquisite sensitivity of the developing brain to even small drops in thyroid hormone levels and the fact that neonates have much diminished stores of thyroid hormone relative to adults."[27]

The Safe Drinking Water for Healthy Communities Act (HB 3206) was introduced in July 2009 to amend the Safe Drinking Water Act by requiring national regulation of perchlorate in drinking water.[28]

A few state level policies have been implemented to protect public health. Massachusetts was the first state to regulate perchlorate in drinking water, setting the standard of 2 µg/L.[29] Parties responsible for perchlorate contamination are required to contact Massachusetts Department of Environmental Protection (MassDEP) to conduct an environmental assessment and cleanup of contaminated sites. Perchlorate is also a regulated drinking water contaminant in California where the maximum allowable level is 6 µg/L.[30] In New Jersey, the maximum allowable level of perchlorate in drinkingwater is 5 µg/L.[31]

Endnotes

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ACAT Alaska Community Action on Toxics

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Fact sheets on toxic chemicals for the *Mind, Disrupted* Biomonitoring Project provided by the Alaska Community Action on Toxics (www.akaction.net) and Commonweal (www.commonweal.org). For more information, please visit the *Mind, Disrupted* website at www.minddisrupted.org, or contact Pam Miller at pkmiller@akaction.net or Sharyle Patton at spatton@igc.org.