Sources of Exposure

Toxicokinetics and Normal Human Levels

Biomarkers/Environmental Levels

General Populations

- Human exposure to perchlorate is expected to occur through the ingestion of contaminated water, as it has been found in drinking water supplies, tap water samples, and groundwater.
- Perchlorate has also been found in food, including cow's milk and human breast milk.
- Chewing tobacco could be a source of exposure because perchlorate has been detected in several brands of chewing tobacco.
- Children may undergo dermal exposure if they crawl over perchlorate-contaminated soil. Children may also be exposed if they touch contaminated soil with their hands and then place their hands in their mouth. Children are more likely to be exposed by this route then are adults.

Occupational Populations

- Occupational exposure to perchlorates may occur through the inhalation of and dermal contact with the dusts formed during its manufacture and use.
- Deposition of perchlorate dust into the mouth is also possible.

Toxicokinetics

- Perchlorate appears to be readily absorbed by the digestive system after oral exposure and enters the bloodstream within a few hours of ingestion.
- Perchlorate is rapidly taken up into the thyroid gland by an active transport mechanism.
- Perchlorate does not appear to be modified in the body, either by degradation or covalent binding.
- Perchlorate is rapidly eliminated from the body in the urine with half-times of approximately 8-12 hours in humans.

Normal Human Levels

Urine

- Perchlorate has been detected in human urine, but representative levels across the nation are not available.

Biomarkers

- Urine is a convenient testing medium for perchlorate, but it might be detectable for only a few days after exposure because it leaves the body so rapidly.
- Levels of iodide in serum or urine, and levels of T3, T4, and TSH in serum, can all be considered biomarkers of effect for perchlorate. It should be noted that none of these biomarkers is specific to perchlorate.

Environmental Levels

Water

- Perchlorate was monitored in public water systems across the United States. Perchlorate was detected above the detection limit of 4 part per billion (ppb): in 5.4% surface water systems that served >10,000 people with a mean (range) concentration of 15.6 (4.0-420) ppb; in 2.1% surface water systems that served <10,000 people with a mean (range) concentration of 6.4 (4.1-17) ppb; in 7.2% groundwater systems that served >10,000 people with a mean (range) concentration of 11.3 (4.0-200) ppb; and in 1% groundwater systems that served <10,000 people with a mean (range) concentration of 7.8 (4.3-20) ppb. Perchlorate was detected in drinking water wells in California at levels from 4 to 260 ppb and in tap water in Nevada at 4-15 ppb.

Other

- Perchlorate has been detected in food and cow's milk but representative levels across the nation are not yet available.

ToxGuide™ for Perchlorate and Perchlorate Salts ClO_4

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Chemical and Physical Information

Perchlorates are colorless salts

- Five perchlorates are manufactured in large amounts; magnesium perchlorate, potassium perchlorate, ammonium perchlorate, sodium perchlorate, and lithium perchlorate.
- When perchlorates dissolve they dissociate into the perchlorate anion.
- Perchlorates can be very reactive chemicals, producing large amounts of heat capable of exploding.
- Perchlorates are used mainly in rocket motors, fireworks, and explosives.
- Ammonium perchlorate is produced in very large amounts because it is used in rockets. 90% of perchlorates that are produced are used for defense and aerospace activities.
- Other uses of perchlorates include flares, gunpowder, temporary adhesives, electrolysis baths, batteries, drying agents, etching agents, and oxygen generating systems. They are also used for making other chemicals.
- Currently, perchlorate is used to prevent technetium uptake during medical imaging and as part of a treatment to counter the thyroid effects of the drug amiodarone.
- Perchlorates also occur naturally, for example, in the saltpeter deposits in Chile, South America. Chilean saltpeter is used to make fertilizer which has been used on tobacco products in the U.S. in the past. It is no longer imported.

Routes of Exposure

- Ingestion (drinking contaminated water, eating contaminated food including milk).
- Inhalation (breathing dusts or suspended particles).
- Dermal (contact with contaminated soil).

Perchlorate in the Environment

- Perchlorate has been found in water and food, including cow's milk.
- Perchlorate entered the environment where rockets were made, tested, and dissembled.
- Factories that make or use perchlorates may also release them.
- Perchlorate may enter the environment from fireworks, explosives, flares, and similar products.
- Perchlorate also occurs naturally in the environment.
- Perchlorate released to the environment is deposited in soil or water (rivers, streams, lakes, and ponds) and can leach into groundwater from soil.
- Perchlorate can be taken up by vegetation and animals, as it has been found in lettuce and cow's milk.
- Perchlorate will persist in water and soil for a very long time, that is, many years.

Relevance to Public Health (Health Effects)

Health effects are determined by the dose (how much), the duration (how long), and the route of exposure.

Minimal Risk Levels (MRLs)

Inhalation

- No MRLs for inhalation exposure have been derived for perchlorate since adequate data were not available by this route of exposure.

Oral

- ATSDR adopted the National Academy of Sciences chronic reference dose (RfD) of 0.0007 mg/kg/day for the draft chronic oral MRL. The MRL does provide protection for children and the developing fetus.

Health Effects

- The main target organ for perchlorate toxicity in humans is the thyroid gland.
- Perchlorate inhibits the thyroid's uptake of iodine. Iodine is required as a building block for the synthesis of thyroid hormone.
- Perchlorate's inhibition of iodide uptake by the thyroid must be great enough to cause hypothyroidism. The prevalence of hypothyroidism is about 5% in the general population of the United States.
- Thyroid hormones regulate certain body functions after they are released into the blood. These include metabolism, growth and neurological development in children. Exposure of people to excessive amounts of perchlorate for a long time may lower the thyroid activity, leading to a condition called hypothyroidism.
- Because thyroid hormones play a critical role in the neurological development of the fetus, there is concern that hypothyroidism (maternal and fetal) during pregnancy could result in neurodevelopmental effects.

Children's Health

- Children and developing fetuses may be more likely to be affected by perchlorate than adults because thyroid hormones are essential for normal growth and development.

Reference

Agency for Toxic Substances and Disease Registry (ATSDR). 2005. Toxicological Profile for Perchlorates (Draft for Public Comment). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Services.