Sources of Exposure

General Populations

- People may be exposed to chlorine if they mix an acid with a solution containing sodium hypochlorite. Examples include mixing toilet bowl cleaners containing hydrochloric, phosphoric, or oxalic acid with bleach. If enough acid is added to lower the pH of the hypochlorite solution to below 4, chlorine gas will be released.
- Individuals may also be exposed to chlorine gas if swimming pool chemicals are accidentally mixed with acids or if too much sodium hypochlorite is added to the water over a short period of time.
- Exposure to chlorine gas also may occur in the vicinity of an accidental spill or industrial mishap such as a chlorine tank spill or rupture.

Occupational Populations

- Workers at facilities that produce, transport, or use chlorine may be exposed to low concentrations of the gas.
- Workers may also be exposed to high chlorine concentrations if an accidental release occurs at a facility.

Toxicokinetics and Normal Human Levels

Toxicokinetics

- Studies in human volunteers found that irrespective of the mode of breathing (nasal or oral) and respiratory flow rate, >95% of inhaled chlorine was absorbed in the upper airways and <5% was delivered to the lower airways.
- No relevant data regarding oral or dermal absorption of aqueous chlorine.
- The distribution, metabolism, and excretion of chlorine is determined by the products of the reactions of hypochlorous acid/hypochlorite and biomolecules in vivo.

Normal Human Levels

- Greater than 95% of the chlorine that is inhaled (over a 1–5 ppm range) reacts in the upper respiratory tract (and eventually joins the chloride pool in the body). Therefore, analysis of human biological materials such as blood, urine, and body tissue for chlorine is not considered relevant.

Biomarkers/Environmental Levels

Biomarkers

- There are no biomarkers that can be used to quantify exposure to chlorine gas or aqueous chlorine.

Environmental Levels

Air

- Levels of chlorine in ambient air are not available. Chlorine levels in air surrounding areas of accidental release from railroad tank cars have exceeded 1,000 ppm.

Sediment and Soil

- Levels of chlorine in sediment and soil are not available. Chlorine is not expected to be found in soil because it reacts and volatilizes quickly.

Water

- Levels of chlorine in water are not available. Because aqueous chlorine is not a predominant species at environmental pH, chlorine is not expected to be detected in the aquatic environment.

Reference

Agency for Toxic Substances and Disease Registry (ATSDR). 2010. Toxicological Profile for Chlorine. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Services.

ToxGuide™ for Chlorine

Cl_2

CAS# 7782-50-5

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U.S. Department of Health and Human Services
Public Health Service
Agency for Toxic Substances and Disease Registry
www.atsdr.cdc.gov

Contact Information:
Division of Toxicology
and Environmental Medicine
Applied Toxicology Branch

1600 Clifton Road NE, F-62
Atlanta, GA 30333
1-800-CDCINFO
1-800-432-4636
http://www.atsdr.cdc.gov/toxprofiles/index.asp

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Chemical and Physical Information

Chlorine is a Gas

- Chlorine is a heavier-than-air, greenish-yellow gas with a pungent, irritating odor. The mean odor threshold for chlorine lies between 0.2 and 0.4 ppm.
- Chlorine is a nonflammable gas; however, it is a very strong oxidizing agent, reacting explosively or forming explosive compounds or mixtures with many common chemicals.
- Chlorine reacts directly with nearly all of the elements to form chlorides.
- When chlorine is released into water, such as during water chlorination, the gas quickly dissolves and forms hypochlorous acid and hypochlorite anion within seconds. Chlorine is stored and transported as a liquid in pressurized containers.
- The major uses of chlorine include the manufacturing of vinyl chloride to make polyvinyl chloride (PVC) plastics, the manufacturing of other organic and inorganic compounds, water treatment and pulp and paper bleaching. Chlorine has been used in the food industry as a bleaching agent for flour.

Routes of Exposure

- Inhalation – Predominant route of exposure for general population and workers.
- Oral – Not a relevant route of exposure.
- Dermal – Minor route of exposure.

Chlorine in the Environment

- Chlorine may be released into the environment through the process of water chlorination and during accidents such as a chlorine gas leak from an industrial facility or a chlorine tank spill or rupture.
- Due to its high reactivity, chlorine gas is unlikely to remain in the environment very long after it is released. Chlorine immediately reacts with both organic and inorganic materials that it comes into contact with.
- Free chlorine in drinking water is defined as the sum of dissolved chlorine gas, hypochlorous acid, and hypochlorite anion.

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

- An MRL of 0.06 ppm has been derived for acute-duration inhalation exposure (≤14 days).
- An MRL of 0.002 ppm has been derived for intermediate-duration inhalation exposure (15–364 days).
- An MRL of 0.00005 ppm has been derived for chronic-duration inhalation exposure (≥1 year).

Oral

- No acute-, intermediate-, or chronic-duration oral MRLs were derived for chlorine.

Health Effects

- The principal targets of toxicity to chlorine gas are the respiratory airways and the eyes.
- The toxicity of chlorine appears to be dependent on the duration of exposure and exposure concentration, and the moisture content of the surface contacted by the gas (e.g., the respiratory epithelium or conjunctivae).
- DHHS, IARC, and EPA have not classified chlorine gas as to its human carcinogenicity.

Children's Health

- There is some suggestive evidence that children may be more sensitive to the respiratory effects of chlorine than adults.