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## VINYL CHLORIDE

$H_2C=CClH$ OSHA Std. 1 ppm

**Synonyms:** Chlorethene; chlorethylene; ethylene monochloride; monochloroethene; monochloroethylene

**Physical Form:** A colorless gas, but usually handled as a liquid under pressure

**Uses:** Production of vinyl chloride resins; production of methyl chloroform; component of propellant mixtures

**Exposure:** Inhalation

**Toxicology:** Vinyl chloride exposure has been associated with an increased incidence of malignant tumors, acroosteolysis, Raynaud's syndrome, scleroderma, thrombocytopenia, circulatory disturbances, and impaired liver function; very high concentrations cause central nervous system depression.

Humans exposed to 20,000 ppm for five minutes experienced dizziness, light-headedness, nausea and dulling of vision and auditory cues.[1] No clinical changes nor abnormal neurologic responses were found in 13 volunteers exposed 7.5 hours to 500 ppm, although exposure to TWA levels of 300 ppm for a working lifetime caused impairment in liver function tests, but there was no overt clinical disease.[2]

Twenty-five cases of acroosteolysis (degeneration of terminal phalanges) have been reported in vinyl chloride workers; Raynaud's phenomenon was the first manifestation noted by a majority of subjects, suggesting that the vascular lesion antecedes the bone changes in most cases.[3,4] Radiologic findings in patients with acroosteolysis included lytic lesions in the distal phalanges of the hands, in the styloid processes of the ulna and radius, and in the sacroiliac joints.[4] Of 20 autoclave cleaners with exposure to vinyl chloride, 16 had thrombocytopenia, seven had splenomegaly, six had hepatomegaly, 14 had fibrosis of the liver capsule, and four had signs of acroosteolysis.[5]

In four facilities engaged in the polymerization of vinyl chloride for at least 15 years, a study of workers exposed for at least five years revealed a significant number of excess deaths due to malignant neoplasms (35 deaths observed, 23.5 expected).[6] The excesses were found for four organ systems: CNS (three observed, 0.9 expected), respiratory system (12 observed, 7.7 expected), hepatic system (seven observed, 0.6 expected), and lymphatic and hematopoietic systems (four observed, 2.5 expected).[6]

Over 30 cases of angiosarcoma of the liver have been reported among vinyl chloride polymerization workers in the United States and nine other nations.[7–9] Because this tumor is extremely rare, the occurrence of these cases under similar occupational conditions strongly suggests a causal relationship to some phase of vinyl chloride production. Clinical features of seven patients with the carcinoma varied from no signs or symptoms to weakness, pleuritic pain, abdominal pain, weight loss, gastrointestinal bleeding, and hepatosplenomegaly; liver function abnormalities were present in all subjects but without a consistent pattern. In addition to the malignant tumors, four cases of nonmalignant hepatic disease characterized by portal fibrosis and portal hypertension have been attributed to vinyl chloride exposure.

In animal experiments vinyl chloride has been shown to be oncogenic: zymbal gland carcinomas, nephroblastomas, and angiosarcomas were the prevailing tumors in rats; results ranged from a 16 per cent tumor incidence at an exposure level of 250 ppm to a 39 per cent incidence at 10,000 ppm; in mice, liver angiosarcomas, pulmonary adenomas, and mammary carcinomas were observed after exposures ranging from 50 to 10,000 ppm.[10] The development of some tumors was more dependent on duration of exposure rather than on concentration of vinyl chloride.

When vinyl chloride was used as an anesthetic agent in dogs, muscular incoordination, sensitization of the myocardium, and serious cardiac arrhythmias were observed.[11] Mice exposed to 80,000 to 120,000 ppm were anesthetized, while 250,000 to 300,000 ppm was lethal in ten minutes. Guinea pigs were killed in a short time at 200,000 to 400,000 ppm; pulmonary edema and hyperemia of the liver and kidneys were observed.

Contact of the skin or eyes with the liquefied gas can produce freezing and frostbite.[12]

**Diagnosis:** Signs and symptoms include weakness, pleuritic pain, abdominal pain, anorexia, weight loss, gastrointestinal bleeding; hepatomegaly, splenomegaly; Raynaud's syndrome, lesions in the distal phalanges of the hands; central nervous system depression.

***Differential Diagnosis:*** Differentiate from the following other causes of liver dysfunction: intrahepatic, such as viral hepatitis, liver abscess, or alcoholic liver disease; extrahepatic obstruction, such as pancreatic tumors, gallstones, and carcinoma of the bile duct; increased bilirubin load from red cell defects or hemolytic anemia.

Angiosarcoma of the liver is seldom recognized until fairly late in its course, within months of death. Precursor physiologic alterations, which might be reversible, have not been identified.

***Special Tests:*** Liver function tests and liver biopsy should be performed.

**Medical Control:** The following medical procedures must be made available to each employee who is exposed to vinyl chloride in excess of the action level without regard to the use of respirators: A complete history and physical examination including examination of the liver, spleen, kidneys, skin, connective tissues, and the pulmonary system.[9] The medical history shall include the following topics: alcohol intake, history of hepatitis, history of blood transfusions, history of hospitalizations, work history, and past exposure to potential hepatotoxic agents, including drugs and chemicals. Liver function tests — a serum specimen shall be obtained and determinations made of: total bilirubin; alkaline phosphatase; serum glutamic oxalacetic transaminase (SGOT); serum glutamic pyruvic transaminase (SGPT); and gamma glutamyl transpeptidase. The above medical examinations are to be repeated every six months for each employee who has been employed in vinyl chloride or polyvinyl chloride manufacturing for ten years or longer and annually for all other employees. When tests in this section show abnormalities, the tests should be repeated as soon as practicable, preferably within three to four weeks. If tests remain abnormal, consideration should be given to withdrawal of the employee from contact with vinyl chloride, while a more comprehensive examination is made. The following additional tests may be useful: urinalysis—a determination of urine albumin and a test for the presence of blood or exfoliated abnormal cells in the urine; FVC and FEV (1 sec.); 14″ × 17″ chest roentgenogram; additional serum tests: lactic acid dehydrogenase, lactic acid dehydrogenase isoenzyme, protein determination, and protein electrophoresis; hepatitis B antigen, and liver scanning for a more comprehensive examination on repeated abnormal serum tests.

### Reference

*Principal*

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