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TRICHLOROETHYLENE (TCE)

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Dear Colleague:

The attached background material on trichloroethylene has been prepared by the Office of Occupational Health Surveillance and Biometrics, National Institute for Occupational Safety and Health, to alert members of the occupational health community to new information on a potential occupational hazard.

Your comments and suggestions for changes to future reports are solicited.

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Attachment

TRICHLOROETHYLENE

Summary

Preliminary evaluation of the carcinogenic activity of trichloroethylene in laboratory rodents by the National Cancer Institute indicates that this material is a potent liver carcinogen. Trichloroethylene is a significant commerical product with a wide variety of industrial uses. In light of the potential risks of human exposure in the work environment, the National Institute for Occupational Safety and Health (NIOSH) is alerting the occupational health community to these findings. Additional animal studies as well as detailed epidemiologic investigations are anticipated.

Introduction

On March 21, 1975, the Associate Director for Carcinogenesis of the National Cancer Institute (NCI) informed the DHEW Committee to Coordinate Toxicology and Related Programs of the possible carcinogenicity of trichloroethylene. Subsequently, the National Institute for Occupational Safety and Health was informed by the NCI that an unusual incidence of hepatocellular carcinomas was observed in mice given trichloroethylene by gastric intubation. Requests for more detailed information on these findings should be directed to the Carcinogen Bioassay and Program Resources Branch, Carcinogenesis, DCCP, National Cancer Institute, Bethesda, Maryland 20014. Because of the extensive use of trichloroethylene in the work environment and the potential for cancer induction in humans, NIOSH is alerting the occupational health community as an integral part of its current intelligence system.

Background Information

Trichloroethylene (TCE) is a colorless, volatile, nonflammable liquid that is immiscible in water with a vapor density of 4.45 and a boiling point of 87°C. It is miscible with alcohol, chloroform, and ether, and dissolves most fixed and volatile oils.

Trichloroethylene has a powerful solvent action for fats, greases, and waxes, and it is one of the most important chlorinated solvents for use in degreasing and drycleaning. Over 90 percent of TCE is consumed by the metal degreasing and drycleaning trades.(1) It is also used as an ingredient in printing inks, paints, lacquers, varnishes, and adhesives.(2) Trichloroethylene is used in minor quantities in a number of miscellaneous commercial products.(4)

A pharmaceutical grade of trichloroethylene is used as a general anesthetic in surgical and obstetrical procedures and as an analgesic in the treatment of trigeminal neuralgia.(3) TCE also has been used as an analgesic in dentistry for extractions, incisions of furuncles, and other short operative procedures.(4) In addition, TCE is used in the extraction caffeine for decaffeinated coffee.

Trichloroethylene was first produced in 1864 by Fischer, but did not not receive much attention as a potential chemical product until the early 1900's. It has been produced in the United States since 1925.(1) Trichloroethylene is produced from acetylene and ethylene; however, the amount produced from acetylene has been steadily declining. It is estimated that 85 percent of TCE was produced from acetylene in 1967 as compared with 51 percent in 1971.

Toxicity

Human:

The predominant physiological response is one of central nervous system depression. This is particularly true as a response from acute exposure. Visual disturbances, mental confusion, fatigue, and sometimes nausea and vomiting have been observed. The dangers of acute exposure to trichloroethylene may be accentuated by visual disturbances and incoordination, which may lead to poor manual manipulation and, therefore, unsafe mechanical operation.(6)

Prolonged skin contact may cause local irritation and blister formation and, under industrial conditions, intermittent, repeated immersion of the hands in TCE has caused paralysis of the fingers.(7) While TCE will penetrate the intact skin, it is considered unlikely that absorption of toxic quantities would occur by this route.(8)

Trichloroethylene is absorbed readily from the gastrointestinal tract, leading to respiratory failure or cardiac arrest causing death. Depending on the dose, signs and symptoms of toxicity may be delayed for several hours.(4)

Anesthetic doses frequently cause tachycardia or bradycardia and tachypnea. Cardiac arrhythmias are common but convulsions are rare.(4) Trichloroethylene, when inhaled by pregnant women, diffuses rapidly across the placenta.(9)

Deliberate inhalation of moderate concentrations of TCE induces a state of euphoria which has led to addiction.(1)(10) Sniffing commercial products containing TCE is a method for getting "high" among adolescents.(11)(12) The disappearance of disorientation, visual hallucinations, delusions, and other psychotic symptoms coincides with a fall in urinary levels of trichloroethylene metabolites.(10) It has been reported that the administration of glucose or insulin increases the amount and speed of excretion of metabolites of TCE.(13) Liver and kidney injuries attributed to overexposure to TCE are considered rare.(14) However, severe injuries to both the liver and kidneys have been reported.(1)

To date there have been no published reports of any association between TCE and cancer in humans.

Animal:

Clinical experience from acute exposure in animals has come mainly from the use of TCE as an anesthetic. TCE has been used as an inhalation anesthetic for a variety of animals. It has also been used as a disinfectant and detergent for the skin, minor wounds, and surgical instruments.(4)

Death in laboratory animals from an acute exposure to TCE vapor may result from respiratory failure or cardiac arrest.(6)(15) Trichloroethylene is reported to have direct action on the bone marrow of rabbits causing myelotoxic anemia.(16) It causes residual brain damage in rats(17), and produces liver and kidney changes and growth depression in a variety of laboratory animals.(6)

The National Cancer Institute (NCI) tested trichloroethylene by gastric intubation in both sexes of Osborne Mendel rats and B6C3F mice. Two dose levels were given in each animal group, five times weekly. Both sexes of rats were given either 1000 mg/kg or 500 mg/kg doses. Male mice were given 2400 mg/kg or 1200 mg/kg doses; female mice were given 1800 mg/kg or 900 mg/kg doses. No hepatocellular carcinomas were seen in the rats; 30 of 98 (30.6%) of the mice given the low dose, and 41 of 95 (43.2%) of the mice given the higher dose had hepatocellular carcinomas. Only one of 40 (2.5%) control mice developed these carcinomas.*

It should be noted that the National Cancer Institute information is the first report associating TCE with cancer in animals.

Permissible Occupational Exposures

The current Occupational Safety and Health Administration, Department of Labor standard for trichloroethylene is 100 ppm (525 mg/m^3) and is based on the threshold limit value established by the American Conference of Governmental Industrial Hygienists.(18)

On July 23, 1973, the National Institute for Occupational Safety and Health transmitted criteria for a recommended standard on trichloroethylene to the Department of Labor.

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*Unpublished preliminary report issued by the National Cancer Institute, 1975. Requests for further information should be directed to the National Cancer Institute, Bethesda, Maryland.

Producers and Suppliers

The following is a list of the major producers and suppliers of trichloroethylene in the United States:

Company	Location
Diamond Shamrock Corp. Electro Chems. Div.	Deer Park, Texas
Dow Chemical U.S.A.	Freeport, Texas
Ethyl Corp.	Baton Rouge, Louisiana
Occidental Petroleum Corp. Hooker Chem. Corp., subsid. Electrochemical & Specialities Div.	Taft, Louisiana
PPG Indust., Inc. Chem. Div. Indust. Chem. Div.	Lake Charles, Louisiana

Source: Adapted from the 1974 Directory of Chemical Producers, USA, Stanford Research Institute, Menlo Park, California, 1974

Occupational Exposure

Estimated Number of Workers Exposed to Trichloroethylene by Industry

Industry	Estimated Number Exposed*
Agricultural Services	124
Oil and Gas Extraction	267
Ordnance	57
Food Products	2,502
Textile Mill Products	1,014
Apparel/Textile Products	858
Lumber Products	72
Furniture Manufacturing	162
Paper Products Manufacturing	2,240
Printing Trades	2,876
Chemical Manufacturing	9,552
Petroleum Products	713
Rubber - Plastics Manufacturing	4,985
Leather Products	725
Stone/Clay Products	2,685
Primary Steel Manufacturing	11,672
Metal Fabrication	11,709
Machinery Manufacturing	7,481
Electrical Equipment	66,727
Transportation Equipment	54,174
Instrument Manufacturing	4,815
Miscellaneous Manufacturing	1,516
Trucking/Warehousing	642
Air Transportation	23
Communication	5,560
Wholesale Trade	3,327
Automotive Dealer	223
Furniture Stores	597
Banking	2,391
Personal Services	583
Miscellaneous Business Services	27,759
Auto Repair	5,246
Miscellaneous Repair	17,198
Amusement Services	7,987
Mechanical Services	20,053
Miscellaneous	4,138
Estimated Total	282,653

*Projections based on preliminary data obtained from the National Occupational Hazard Survey, Hazard Surveillance Branch, Office of Occupational Health Surveillance and Biometrics, NIOSH. (Does not include anesthetic use or use in tradename products).

Anesthesia Survey

It is estimated that approximately 5,000 medical, dental, and hospital personnel are routinely exposed to trichloroethylene as an anesthetic gas.*

Epidemiologic Studies

The Division of Field Studies and Clinical Investigations, NIOSH, is attempting to identify human populations at risk of trichloroethylene exposures for epidemiologic study.

*The 1974 Hospital Inhalation Producer Survey, conducted by the Division of Field Studies and Clinical Investigations, NIOSH, and a personal communication from a representative of the American Dental Association, 1975.

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