Background Information on Trichloroethylene

See also p. 581

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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 commercial 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.

On March 21, 1975, the Associate Director for Carcinogenesis, National Cancer Institute (NCI) informed the DHEW Committee to Coordinate Toxicology and Related Programs of the possible carcinogenicity of trichloroethylene. Subsequently, NIOSH was informed by the NCI that an unusual incidence of hepatocellular carcinomas was observed in mice given trichloroethylene by gastric intubation. 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 87C. 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% 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 (see Table).

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 of caffeine for decaffeinated coffee.[5]

Trichloroethylene was first produced in 1864 by Fischer, but did 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% of TCE was produced from acetylene in 1967 as compared with 51% in 1971.[5]

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] Trichloroethyl-

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Representative Commercial Products Containing Trichloroethylene

Brush Top Spot Remover, Regular†
(Product Sales Co.)
Espersol 2530 (xylene) 87%
Trichloroethylene 10
Perchloroethylene 1.5
Methylene chloride 1.5

Brush Top Spot Remover, Super†
(Product Sales Co.)
100% chlorinated solvents
Triethane
(1,1,1-trichloroethane) 50%
Trichloroethylene 25
Perchloroethylene 10
Methylene chloride 5

Carbona Cleaning Fluid
(Carbona Products Co.)
Trichloroethylene 44%
Petroleum hydrocarbons 56

Carbona No. 10 Special Spot Remover
(Carbona Products Co.)
1,1,1-trichloroethane 10%
Trichloroethylene 40
Petroleum hydrocarbons 50

Carbona Spray Spot Remover
(Carbona Products Co.)
Trichloroethylene
1,1,1-Trichloroethane
Cab-O-Sil
Freon 12

Crater 2X and 5X Fluid
(Texaco, Inc.)
Petroleum lubricating oil
Trichloroethylene
Pine tar

DuPont Dry Clean
(du Pont)
Trichloroethylene

Dux
Water Repellent
(Detrex Corp.)
Piccotex 120 Solution 25%
(synthetic resin)
Wax (paraffin)
Trichloroethylene

Glamorene Dry Cleaner for Rugs
(Formerly Glamorene Wool Rug Cleaner)
(Glamorene Products Corp.)
Chlorinated hydrocarbon
(trichloroethylene)
Petroleum distillate
Wool flour

Glamorene Rug Cleaner
(Glamorene Products Corp.)
Trichloroethylene
Ethylene dichloride
Heavy naphtha

Helmac Spot Pic-Up
Aerosol spot remover
(Helmac Products Corp.)
Perchlorethylene
Methylene chloride
Trichloroethylene

HH Tree Wound Healer
Protective seal for pruned and
damaged tree and shrubs
(Hubbard-Hall Chem. Co.)
Asphaltum
Petroleum oils
Phenylmercury oleate
Allantoin
Inert ingredients:
Dichlorodifluoromethane
Trichloroethylene
Methylene chloride

Instant Chimney Sweep
Aerosol spray application
(Miracle Adhesives)
%w/w
Trichloroethylene 34
Active chemicals 41
Propellant (Freon) 25

Joy Solvent†
(Joy Chem. Inc.)
Trichloroethylene

Kwik Kleen Drug Shampoo*
Dry Shampoo
(Royal Bond, Inc.)
Trichloroethylene

Lash Bath
Cleanser for false eyelashes
(Revlon)
Naphtha
Trichloroethylene

O'Cedar Sea-Spray†
(O'Cedar)
Methylene chloride
Trichloroethylene
Cellosolve acetate
Wax
Freon propellent

Perm-A-Clor NA
(Detrex Corp.)
Trichloroethylene

Sears Air Freshener

Sears Odor Neutralizer
(Sears, Roebuck & Co.)
26-725
Essential oils 55.2%
Perfume 10.4
Trichloroethylene 34.5

Spot Chief†
Aerosol ring-free spot remover
(White Frost, Inc.)
Trichloroethylene
Perchlorethylene
Solvent 310 (petroleums)

Solvent 310 (petroleum solvent)
Paradichlorobenzene
Lanolin
1,1,1-trichloroethane
Freon 12

Surfisan Spray*
Surface disinfection, preservation
and deodorizing
(Royal Bond, Inc.)
Chloroform
Kerosene
Camphor
Trichloroethylene

Triad Metal Cleaner
Trichloroethylene

Triad Metal Polish
Trichloroethylene

Trichlor
Solvent
(P.P.G. Industries, Chem. Div.)
Trichloroethylene 100%

Tri-Close Dry Clean
Trichloroethylene

*No longer contains trichloroethylene but listed since some products may still be in use.
†No longer marketed, but some may still be in use.
The above product descriptions are not to be construed as current or accurate since changes in product composition are being made continually by manufacturers.

Source: Adapted from Huff, J.E., Industrial Medicine, Vol. 40, p. 31, 1971.

ene, 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.[19]

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.

Producers and Suppliers

The following is a list of the major producers and suppliers of trichloroethylene in the United States:* Diamond Shamrock Corp., Electro Chems. Div., Deer Park, TX; Dow Chemical U.S.A., Freeport, TX; Ethyl Corp., Baton Rouge, LA; Occidental Petroleum Corp., Hooker Chem. Corp., subsid., Electrochemical & Specialities Div., Taft, LA; PPG Indust., Inc., Chem. Div., Indust. Chem. Div., Lake Charles, LA.

*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 Mfg.	162
Paper Products Mfg.	2,240
Printing Trades	2,876
Chemical Mfg.	9,552
Petroleum Products	713
Rubber/Plastics Mfg.	4,985
Leather Products	725
Stone/Clay Products	2,685
Primary Steel Mfg.	11,672
Metal Fabrication	11,709
Machinery Mfg.	7,481
Electrical Equipment	66,727
Transportation Equipment	54,174
Instrument Mfg.	4,815
Miscellaneous Mfg.	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
Misc. Business Services	27,759
Auto Repair	5,246
Misc. Repair	17,198
Amusement Services	7,987
Mechanical Services	20,053
Misc. Unclassified	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.[20]

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.

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