Health Protection Agency

Division of Chemical Hazards and Poisons (London)
Guy's and St Thomas' NHS Foundation Trust
Avonley Road
London
SE14 5ER

TETRACHLOROETHYLENE

SUMMARY INFORMATION

Incident Summary

Key Points

- Tetrachloroethylene is a clear, colourless liquid that has an ether-like odour
- It is irritating to the respiratory and GI tract, as well as the skin and mucous membranes
- Tetrachloroethylene causes CNS depression and can sensitise the myocardium to endogenous catecholamines
- It may cause liver and renal damage
- ***In the event of a large spill, stay up wind and out of low areas. Ventilate closed spaces. Protective clothing, eye protection and breathing apparatus should be worn***

First Aid

- Terminate exposure and support vital functions
- The casualty should be moved to an uncontaminated area
- Rescuers should, ideally, be trained personnel and must be careful *not to put themselves at risk* and *so wear appropriate protective clothing and, if available, breathing apparatus*
- If the casualty is unconscious a clear airway should be established and maintained; give 100% oxygen if available
- **Inhalation Exposure:** If the patient stops breathing expired air resuscitation should be started immediately using a pocket mask with a one way valve, if available. It is important where the face is contaminated that expired air resuscitation is NOT attempted unless an airway with rescuer protection is used
- **Dermal Exposure:** Removed contaminated clothing, if possible under a shower and placed in double, sealed, clear bags and label; store the bags in a secure area away from patients and staff
- Wash the skin thoroughly with copious amounts of water
- **Eye Exposure:** Irrigate thoroughly with water or saline for 15 minutes
- **Oral Exposure:** Encourage small quantities of oral fluids (no more than 50-100 ml in total)

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Detailed Information

- Tetrachloroethylene is a clear, colourless non-flammable liquid that has an ether-like odour
- *Common synonyms* carbon dichloride, ethylene tetrachloride, PCE, perc, perchloroethylene, perk, tetrachloroethylene
- CAS 127-18-4
- UN 1897
- NIOSH/RTECS KX 3850000
- Molecular formula C_2Cl_4
- Molecular weight 165.83
- Tetrachloroethylene is used as a dry cleaning agent, in textile processing, as a scouring solvent, in manufacturing fluorocarbons, as a drying agent for metals, as a fumigant for insects and rodents, and as a degreasing solvent
- It is active against hookworms (*Ancylostoma* and *Necator*) and is still used in endemic areas although it has generally been superseded by drugs that are less toxic and easier to administer
- Tetrachloroethylene sinks in water and is not soluble; it is soluble in ethanol, ethyl ether, chloroform and benzene; it is miscible with alcohol, benzene, chloroform, ether, and most solvents and oils
- Tetrachloroethylene decomposes when heated, or when exposed to UV light, to give off phosgene and hydrochloric acid
- Mixtures of tetrachloroethylene and dinitrogen tetroxide are explosive when subject to shock; tetrachloroethylene reacts violently or explosively with certain alkali or alkaline earth metals

Summary of Human Toxicity

- Tetrachloroethylene is absorbed by inhalation, ingestion and to a lesser extent dermally
- 80 to 100% of inhaled tetrachloroethylene is the excreted unchanged by the lungs; once absorbed, the highest concentrations of tetrachloroethylene are found in the adipose tissue, liver, brain, kidney and lungs, reflecting its high lipid solubility[1]
- The metabolism takes place mainly in the liver and excreted in the urine
- The biological half-life of tetrachloroethylene on inhalation is between 3 to 72 hours and on ingestion 144 hours[2]
- It causes myocardium depression and sensitises the myocardium to endogenous catecholamines via inhalation and ingestion, this cardiac sensitisation is unpredictable in terms of exposure, duration and quantity
- The minimum lethal human exposure for PCE has not been established; an oral dose of 500 $mg.kg^{-1}$ was not fatal[3]
- Alcohol may increase tetrachloroethylene toxicity
- Tetrachloroethylene has been ingested and inhaled in the quest for pleasure and elation; habitual inhalation may lead to dependence
- Odour tolerance is exhibited in chronically exposed humans

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Toxicity of tetrachloroethylene[4,5]

Concentration/exposure	Clinical effects
0.17 $mg.l^{-1}$	Taste threshold
1.0 ppm, in air	Odour threshold
0.3 ppm, in water	Odour threshold
50 ppm for 8 h	No effect, faint odour
60-450 ppm for 2 -20 y	Abnormal ECG recordings
400 ppm for 2 h	Eye and nasal irritation, ataxia and strong tolerable odour
600 ppm for 10 min	Numb mouth, dizzy, ataxia and very strong odour
1500 ppm for 30 min	Gagging, eye and respiratory irritation, loss of consciousness and almost intolerable odour
5,000 ppm for 6 min	Vertigo, nausea and confusion

- Occupational Exposure Standards[6]:
  Long-term exposure limit: 50 ppm (345 $mg.m^{-3}$)
  Short-term exposure limit: 100 ppm (689 $mg.m^{-3}$)

Acute Clinical Effects

Inhalation Effects
- Depending on the dose and duration of exposure, inhalation leads to respiratory irritation, coughing, wheezing, pulmonary oedema, increasing cyanosis and respiratory failure following large inhalation exposure
- Tetrachloroethylene vapours are irritant to nasal, ocular and respiratory mucosa
- Headache, fatigue, ataxia, dizziness, nausea, vomiting, hypotension, mental confusion and temporary blurred vision have been reported after inhalation
- Inhalation may lead to systemic effects; see below

Dermal Effects
- Tetrachloroethylene is irritant to the skin, dry, scaly skin, blisters and dermal burns
- Erythema and a severe burning sensation may occur if tetrachloroethylene is left on the skin for 40 minutes or longer
- Dermatitis is caused by defatting of the skin
- Significant exposures may cause systemic symptoms; see below

Eye Effects
- Tetrachloroethylene vapours are irritating to eyes at high concentrations
- An ocular splash exposure is expected to cause lacrimation and burning but no permanent damage

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Oral Effects
- Ingestion of tetrachloroethylene may cause gastric irritation with nausea and vomiting
- Aspiration may lead to respiratory irritation, coughing, wheezing, pulmonary oedema and increasing cyanosis
- Ingestion of tetrachloroethylene has been associated with the development of toxic epidermal necrolysis[7]
- Ingestion may cause systemic effects; see below

Systemic toxicity
- CNS depression, dizziness, inebriation, light-headedness, mental dullness, ataxia, drowsiness and coma, respiratory depression or death may occur
- Hypotension, cardiac arrhythmias, hepatic and renal injury, proteinuria and haematuria
- Tetrachloroethylene may sensitise the myocardium to adrenaline and other catecholamines which may cause arrhythmias and sudden death after massive acute exposures

Chronic Clinical Effects

Chronic occupational exposure has been known to produce multiple ventricular premature beats, peripheral neuropathy, hepatitis, confusion, disorientation, muscle cramps, fatigue, agitation and damage to liver, kidney and spleen[4].

Dependence may follow habitual inhalation of small quantities of tetrachloroethylene vapour.

Chronic skin exposure may cause reddening and chapping of the skin. Dry, scaly and fissured dermatitis may also occur from repeated skin contact.

Management

Blood tetrachloroethylene concentrations have no clinical relevance other than to confirm exposure when this is in doubt.

Inhalation Management
- Maintain a clear airway, give humidified oxygen and ventilate if necessary
- If respiratory irritation occurs assess respiratory function and if necessary perform a chest x-rays to check for chemical pneumonitis
- See systemic management below

Dermal Management
- Remove any remaining contaminated clothing, place in double, sealed, clear bags, label and store in a secure area away from patients and staff
- Irrigate with copious amounts of water
- An emollient may be required
- Treat irritation symptomatically
- for significant exposure, see systemic management below

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Eye Management
- Irrigate thoroughly with running water or saline for 15 minutes
- Stain with fluorescein and refer to an ophthalmologist if there is any uptake of the stain

Oral Management
- Encourage oral fluid for small ingestion
- DO NOT INDUCE EMESIS due to risk of aspiration
- For substantial ingestion, consider gastric lavage within 1 hour of ingestion, ensuring the airway is protected
- Contact a poisons information service for further guidance on gut decontamination
- An abdominal X-ray may be of use in confirming ingestion as tetrachloroethylene is radiopaque
- Controlled hyperventilation to enhanced pulmonary elimination may be considered although this has only been demonstrated to be effective in one case; this has not been demonstrated elsewhere[8]
- Symptomatic and supportive care, see systemic management below

Systemic Management
- Patients should be kept at rest
- With severe exposures the patient should be kept on a cardiac monitor for 12 hours, avoiding the use of all stimulants except for resuscitation
- Monitor level of consciousness and respiration, ECG, renal and liver function
- Daily urinalysis for proteinuria and haematuria may be useful after massive exposures

Summary of Environmental Hazards
- Tetrachloroethylene is likely to be persistent in the atmosphere
- Tetrachloroethylene reacts with photochemically produced hydroxyl radicals or chlorine ions with a half-life of 1 hour to 2 months
- Volatilisation also appears to be the major pathway by which tetrachloroethylene is lost from water, the half-life of tetrachloroethylene is estimated to be 3-30 days for river water and 30-300 days for lake- and ground-water[9]
- Spills on the soil may be expected to leach slowly into the ground water
- Tetrachloroethylene does not concentrate in the food chain
- Drinking Water Standards[10]:
  Other individual pesticides: 0.1 $\mu g.l^{-1}$ (European Directive requirements)
  Total pesticides: 0.5 $\mu g.l^{-1}$ (European Directive requirements)
- Soil Guidelines: Dutch Criteria: 0.01 mg kg^{-1} (Target)
  4 $mg.kg^{-1}$ (Intervention)
- Air Quality Standards[11]: 0.25 $mg.m^{-3}$ averaging time 1 year (WHO guideline value)

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More detailed information can be generated at the Division of Chemical Hazards and Poisons (London) which is available for medical professionals and emergency service enquirers.

Emergency Enquiries Telephone: 0870 606 4444 or 020 7639 8999 (24 hours)
Administration Telephone: 020 7771 5383 Fax: 020 7771 5309

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References

1. Ware GW (ed). In Reviews of Environmental Contamination and Toxicology, vol 106. Springer-Verlag, 1988
2. Gosselin RE, Smith RP & Hodge HC. Clinical Toxicology of Commercial Products, 5th ed. Williams & Wilkins, Baltimore, 1984
3. Clayton GD & Clayton FE (ed). Patty's Industrial Hygiene and Toxicology, 4th ed. John Wiley & Sons, Inc, New York, 1994
4. Baselt RC & Cravey RH. Disposition of Toxic Drugs and Chemicals in Man, 4th ed. Chemical Toxicology Institute, 1995
5. Ellenhorn MJ, Schonwalds S, Ordog G & Wasserberger J. Ellenhorn's Medical Toxicology - Diagnosis and Treatment of Human Poisoning, 2nd ed. Williams and Wilkins, London, 1997
6. Health & Safety Executive. *EH40/2002 Occupational Exposure Limits 2002*. The Stationery Office, London, 2002
7. Potter B et al. Tetrachloroethylene (perchloroethylene). Arch Dermatol 1960 82:903
8. Koppel C, Arendt U & Koeppe P, 1958. Acute tetrachloroethylene poisoning - blood elimination kinetics during hyperventilation therapy. Clin Toxicol; 23(2-3): 103-115
9. Hall AH & Rumack BH (Eds). TOMES System ® Micromedex, Englewood, Colorado. CD ROM. Vol 41 (Expires 31 July 1999)
10. Interim Guidance on the water supply (water quality) regulations 2000 (England) and the water supply (water quality) regulations 2001 (Wales). Edition 1. Drinking Water Inspectorate, September 2003
11. Air Quality Guidelines for Europe. World Health Organization Regional Publications, European Series No. 91. World Health Organization Regional Office for Europe, Copenhagen, 2000

IF CASUALTIES ARE TRANSFERRED TO HOSPITAL OR OTHER TREATMENT CENTRES PLEASE ENSURE A COPY OF THIS INFORMATION GOES WITH THEM