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CASE REPORT

PERCHLOROETHYLENE: ACUTE OCCUPATIONAL POISONING AND A PROPOSAL FOR ITS REPLACEMENT WITH OTHER LESS TOXIC SUBSTANCES

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Abstract

Perchloroethylene is used mainly as a solvent in dry cleaning, cleaning of electrical equipment, and degreasing of metal parts. The authors report a case of acute poisoning with perchloroethylene contracted by a maintenance worker when cleaning an electric transformer. Since perchloroethylene may cause severe poisoning and the International Agency for Research on Cancer has classified it as a probable carcinogen for humans, the authors have revised the main substances that may replace perchloroethylene in the workplace. Med Pr. 2019;70(3)

Key words: perchloroethylene, chlorinated solvents, acute occupational poisoning, occupational medicine, alternatives to perchloroethylene, preventive measures

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INTRODUCTION

Perchloroethylene (tetrachloroethylene) is a colorless volatile liquid, used mainly as a solvent in dry cleaning, cleaning of electrical equipment, and degreasing of metal parts.

The authors report a case of acute occupational poisoning with perchloroethylene, review its possible effects on health, and assess the properties of other substances that have been proposed as replacements [1–3].

CASE REPORT

A 32-year-old man had worked for 6 years in the maintenance unit of an electrical company. After 15 min of cleaning an electric transformer located underground he lost consciousness. He was quickly rescued by 2 colleagues and taken to a nearby hospital where he was admitted to the intensive care unit (ICU). His *Glasgow Coma Scale* (GCS) score was 2 and he presented acute respiratory failure that required tracheal intubation and assisted ventilation for 5 days. Seven days after the poisoning, he was discharged from hospital without any sequelae.

The chest X-ray, cranial CT and the general analytical parameters were within normal ranges. The concentration of perchloroethylene in blood on admission was 16 mg/l (the biological limit value in Spain: 0.4 mg/l [4]). The investigation revealed that the solvent used was perchloroethylene. The environmental concentration was 3400 ppm (the threshold limit value in Spain: time-weight average [TWA] of 20 ppm and the short-term exposure limit – STEL of 40 ppm [4]); the worker wore personal protective clothing, although this was not enough to avoid acute poisoning (he wore a mask with an activated carbon filter while working in a confined space but did not use autonomous breathing equipment).

DISCUSSION

Comments on the case report

Perchloroethylene may be absorbed through the digestive and respiratory tracts, and through the skin. Most of the perchloroethylene absorbed is eliminated by the exhaled air. Only around 10% is metabolized, and the major urinary metabolite is trichloroacetic acid.

Perchloroethylene vapor irritates the skin and mucous membranes. Concentrations higher than 2000 ppm may cause central nervous system depression and acute lung edema of non-cardiogenic origin [5]. Cases of fatal acute poisoning after inhalation of perchloroethylene have been reported, with blood perchloroethylene concentrations between 44 mg/l and 158 mg/l being detected in the body [6–8]. Chronic exposure to perchloroethylene may produce neuro-psychological alterations (fatigue, dizziness, impaired memory and alcohol intolerance) [5], and may also cause liver and kidney alterations [9,10].

Comments on other alternatives for replacing perchloroethylene

The main primary prevention measure should be to replace perchloroethylene with other chemical substances and/or industrial processes that entail a lower risk to health [1–3].

For use as a degreaser of metal parts in "cold" applications, perchloroethylene may be replaced with aliphatic hydrocarbons. Solvents of plant origin such as d-limonene (CAS No. 5989-27-5) may also be used. For cleaning electrical equipment, a solvent based on hydrochlorofluorocarbon, the HCFC-141b with CAS No. 1715-00-6 (1,1-dichloro-1-fluoroethane) [1,2] may be used.

The main use of perchloroethylene is that of a solvent in dry cleaning. The main chemicals and industrial processes used as replacements for perchloroethylene are wet cleaning, liquid carbon dioxide, aliphatic hydrocarbons, acetal (CAS No. 2568-90-3), propylene glycol ethers, cyclic volatile methyl siloxane (D5) with CAS No. 541-02-6) and n-propyl bromide (CAS No. 106-94-5)3.

The main health effects which substances that replace perchloroethylene may cause are as follows:

1. Aliphatic hydrocarbons may cause chemical pneumonitis in the lung, and those that are volatile may cause acute central nervous system effects, and/or ocular and respiratory irritation [11].
2. D-Limonene is a skin irritant and a potential sensitizer for humans [12].
3. HCFC 141 b is mildly irritating to the eye. High concentrations of HCFC 141 b in the heart raise the likelihood of cardiac tropism and may induce sudden death [13].
4. Carbon dioxide is an asphyxiant and acetal that may cause skin irritation [3].
5. Propylene glycol ethers are dermal, ocular and respiratory irritants. Acute exposure to high concentrations may affect the central nervous system, as well as cause liver and kidney damage [2,3].
6. Siloxane is a dermal and ocular irritant. Exposure to high concentrations of siloxane may cause effects on the reproductive system [3].
7. N-propyl bromide is a central and peripheral neurotoxic. It may cause effects on the reproductive system [3].

Perchloroethylene, besides being able to cause serious poisoning in exposed workers, is a very persistent substance in the environment (ambient air, indoor air, soil, drinking water and groundwater), being an important risk factor for the health of the general population [14]. The International Agency for Research on Cancer (IARC) classified perchloroethylene as being probably carcinogenic to humans (group 2A) on the basis of sufficient evidence in animals and limited evidence in humans [14].

Different international organizations and research groups have proposed the substitution of perchloroethylene by other industrial substances or processes in order to avoid or minimize the risks that perchloroethylene may cause to workers as well as to the general population [1–3].

If perchloroethylene cannot be replaced, special attention should be paid to providing the workers exposed with the necessary information and training; environmental inspections of each workspace must be performed, and specific health surveillance measures must be taken in order to prevent (or at least minimize) the negative health effects of this chemical agent.

CONCLUSIONS

Perchloroethylene is a solvent widely used in the workplace.

Perchloroethylene may cause acute severe poisoning and chronic poisoning, and the IARC has classified it as a probable carcinogen in humans.

Therefore, before using perchloroethylene, its possible substitution by other less toxic substances should be investigated..

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