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Case Report

A Fatal Case of Ethyl Chloride Sniffing Using Head-Cleaning Spray

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Abstract: We report an accidental death due to the sniffing of ethyl chloride vapor using a spray for cleaning audio-video heads. An autopsy revealed edema and congestion of the lungs, profuse frothy fluid in the air passages and petechial hemorrhages beneath the conjunctivae, epicardium and pleural surfaces. By means of gas chromatography and gas chromatography mass-spectrometry, ethyl chloride was detected in the autopsy samples. The most probable cause of death was respiratory obstruction and suffocation caused by the relaxation of the tongue.

Key words: Forensic science, toxicology, ethyl chloride, body fluid and tissue analysis, sudden sniffing death

INTRODUCTION

Ethyl chloride (chloroethane) is a flammable gas at ordinary temperature (boiling point of 12–13°C) and pressure. It is easily, compressed into a highly volatile liquid which can be stored in a sealed container. When ethyl chloride is sprayed on the skin, it freezes the tissue and induces local anesthesia. In the past, this chemical was used for general inhalation anesthesia because it rapidly produces analgesia and narcosis and is only slightly irritating to the respiratory tract. However, accidental deaths during anesthesia occasionally occurred[1,2], and after a while it fell into disuse.

Recently, non-anesthetic deaths due to ethyl chloride have been reported[3–5]. In this paper, we describe a case of death resulting from the inhaling an ethyl chloride vapor using a spray for cleaning audio-video heads.

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CASE HISTORY

A 28 year-old man was found dead in a hotel room, naked and lying on his back in bed. His abdominal and genital region was covered with a towel and in his right hand was a metal spray can that contained head-cleaning solvent (Maximum Impact®, NY) (Figs. 1 and 2). By the bedside were two spays, one new and one almost empty. According to the information stated on

Fig. 1. The deceased held a metal spray can that contained head-cleaning solvent in his right hand.

Fig. 2. Maximum Impact.

the label, Maximum Impact contains 57 g of ethyl chloride (chloroethane) and is intended for use in cleaning audio-video heads. In the hotel room locker, used condoms and jelly tubes were also found.

AUTOPSY FINDINGS

An autopsy was performed 10-12 hours after death.

The body was that of a well-developed, well-nourished man measuring 160 cm in height and weighing 58 kg. Rigor mortis was established throughout and lividity was prominent over the dorsal aspect of the body and there was no evidence of traumatic injury. The face was congested and a few petechiae were seen under the conjunctivae.

The brain weighed 1,290 g and was slightly edematous.

The heart weighed 330 g and contained 250 m*l* of dark purple red fluid blood. There were a number of petechiae under the epicardium, but the myocardium was normal. Coronary vessels showed only slight atheromatous changes.

The larynx, trachea and bronchi were filled with abundant frothy bloody fluid. The left lung weighed 540 g and the right lung weighed 630 g. The lungs were swollen and expanded, and a few petechiae were seen under the pleural surface. On sectioning, the lungs exuded profuse frothy bloody fluid.

The stomach contained 50 m*l* of thick brownish-yellow material. The liver, pancreas, spleen and kidneys showed no pathologic abnormalities except mild congestion. The bladder contained 50 m*l* of yellowish clear urine.

TOXICOLOGICAL ANALYSIS

Specimens

Cardiac blood, urine, gastric content, brain, cardiac muscle, lung, liver, spleen, pancreas and kidney samples were collected during the autopsy and immediately frozen at −20°C until analysis.

Analysis of ethyl chloride was performed by gas chromatography (GC) combined with gas chromatography mass-spectrometry (GCMS).

Qualitative Analysis

One m*l* of the blood was poured into a 10 m*l* vial. The vial was then sealed with a rubber stopper and incubated at 55°C for 30 min. Approximately 0.2 m*l* of the gas phase was injected into a Shimazu GCMS QP1000EX gas chromatograph mass-spectrometer. Maximum Impact was sprayed into a 10 m*l* vial, which was then immediately sealed with a rubber stopper. Thus, the liquid phase accumulated at the bottom of the vial. One μl of the gas phase was subsequently analyzed in the same manner. The GCMS conditions were: column, GS-Q fused silica (30 m × 0.53 mm ϕ); column oven temperature, 130°C; injection port temperature, 200°C; ion source temperature, 200°C; carrier gas, He at 10 m*l*/min; detector make-up gas, He at 30 m*l*/min; ionization mode, electron impact (EI); current, 60 μA; voltage, 70 eV.

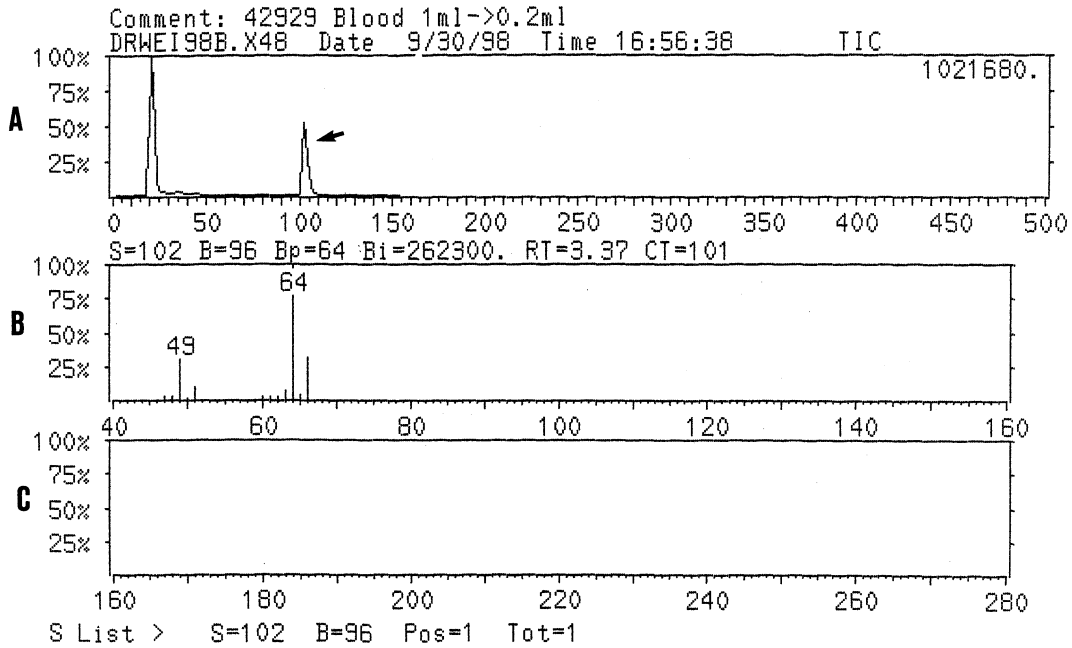

Fig. 3. Mass spectrum of ethyl chloride (arrow) obtained from a blood sample of the deceased (A) compared with the mass spectrum obtained from a spectral library (B and C).

The spray sample gave only one peak at a retention time of 3.37 min, but the blood sample produced two peaks at retention times of 3.37 and 0.77 min (Fig. 3). The peaks were identified by similarity searching using a library search program included in the GCMS system. The electron impact spectrum of the peak at a retention time of 3.37 min was consistent with the EI spectrum of ethyl chloride. The peak at a retention time of 0.77 min in the blood sample corresponded to that of carbon dioxide.

Quantitative Analysis

One m*l* of fluid or 1 g of minced tissue was placed in a 10 m*l* vial and 2 m*l* of 1 N sodium hydroxide and 0.5 m*l* of internal standard solution (0.05% dichloromethane) was added. After vigorous shaking, the vial was sealed with a rubber stopper and incubated at 55°C for 30 min. Then, 0.2 m*l* of the gas phase was injected into a Shimazu GC14A gas chromatograph with a flame ionization detector. The GC conditions were: column, GS-Q fused silica (30 m × 0.53 mm ϕ); column oven temperature, 130°C; injection port temperature, 200°C; detector temperature, 200°C; carrier gas, He at 10 m*l*/min; detector make-up gas, He at 30 m*l*/min.

A standard of ethyl chloride was prepared by spraying Maximum Impact fully into a 10 m*l* vial, which was immediately sealed with a rubber stopper. A linear calibration curve was obtained using 2, 5, 10, $\cdots$ 50 μl of the upper gas phase ($y = 0.02157x - 0.07665$, $r = 0.99874$). Quantitation was performed using a Shimazu Chromatopack C-R4A data system, the results of which are shown in Table 1.

Table 1 Quantitation of ethyl chloride

Sample	Concentration
Cardiac blood	35.8 mg/*l*
Urine	12.1 mg/*l*
Gastric content	8.4 mg/*l*
Brain	87.2 mg/kg
Cardiac muscle	60.8 mg/kg
Lung	79.5 mg/kg
Liver	49.9 mg/kg
Spleen	26.4 mg/kg
Pancreas	38.3 mg/kg
Kidney	34.6 mg/kg

DISCUSSION

For the present case, ethyl chloride was detected in all body fluid samples and organ tissues examined. Autopsy revealed edema and congestion of the lungs, abundant frothy fluid in the air passages and petechiae in the conjunctivae, epicardium and pleural surface. The deceased was believed to have accidentally died of respiratory difficulties while inhaling ethyl chloride vapor.

In recent years, the inhalation of volatile organic substances with a view to seeking a pleasurable emotional experience has occurred with increasing frequency among teenagers in many countries. Deaths associated with this form of abuse are now called sudden sniffing death[6]. The preferred substances are solvents and thinners (benzene, toluene), glues, gasolines, refrigerants and aerosol propellants (fluorocarbons), cleansing agents (trichloroethylene, tetrachloroethylene, trichlorethane) and anesthetics such as ether, chloroform, and halothane[7–11]. As for ethyl chloride, a few fatal cases using an audio-video head cleaner have been reported only in the U.S.A.[3,5]. Since Maximum Impact is not commercially available in Japan, it is difficult to determine from where it was obtained. We hypothesize that the abuser purchased it on the black market or in a foreign country.

The mechanism responsible for death attributed to ethyl chloride sniffing is not well-documented. Henderson and Kennedy[1] reviewed the form of death for a series of 23 fatalities and 3 serious results occurring in connection with the use of ethyl chloride as a general anesthetic: 2 respiratory, 3 respiratory with spasm, 7 cardiac, 12 respiratory and circulatory, and 2 cause unknown. However, the ethyl chloride fatality reported here differs from accidental deaths during anesthesia in that the deceased sniffed the vapor without circulo-respiratory management. Experimental data on dogs and the effects seen with similar volatile compounds suggest ventricular fibrillation due to cardiac sensitization to epinephrine as the most likely mechanism responsible for death[12–14]. Among the tissues, we detected the highest concentrations in the brain and lung. However, we could not find anything specific to indicate the cause of death.

A blood concentration of ethyl chloride of 20–30 mg percent anesthetic and 40 mg percent is lethal[12–15]. The blood level in this case (3.58 mg percent) was too low to be designated the direct cause of death compared with the earlier case reports of 65, 110 and 42.3 mg percent[3,5]. The failure to detect a fatal level may be ascribed to rapid dissipation of the chemical from the autopsy materials because it is highly volatile. We feel that in this case, a state of unconsciousness caused the tongue to relax, leading to laryngeal obstruction and suffocation before the blood concentration reached the fatal level. The autopsy findings support our view.

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