

CASE REPORT

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Tetrachloroethylene Intoxication in an Autoerotic Fatality*

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ABSTRACT: This case report describes an accidental death due to the inhalation of tetrachloroethylene during an autoerotic episode. Tetrachloroethylene was administered from a can of Fix-A-Flat tire repair. Analysis of tetrachloroethylene was performed using headspace gas chromatography and electron capture detection. The blood tetrachloroethylene concentration of 62 mg/L was consistent with acute tetrachloroethylene intoxication.

KEYWORDS: forensic science, toxicology, tetrachloroethylene, autoerotic death, inhalants, solvent abuse

Tetrachloroethylene (perchloroethylene) is a colorless, volatile solvent used as a dry-cleaning agent and degreasing fluid. In industrial conditions, pulmonary exposure is the primary route of entry although dermal absorption is possible (1). Tetrachloroethylene is classified as an occupational carcinogen by NIOSH and has a time-weighted average exposure limit of 25 ppm (170 mg/m³) (2). Pharmacologically, tetrachloroethylene is a central nervous system depressant and has a reported biological half-life of 65 h (3). It is distributed in the body based on the lipid content of tissues and is primarily excreted unchanged through the lungs (4). Small amounts of trichloroethanol and trichloroacetic acid have been detected in the urine after exposure to tetrachloroethylene (5). Symptoms of acute intoxication are similar to ethanol intoxication and treatment is primarily supportive.

Previous reports, in which blood tetrachloroethylene concentrations were measured, include occupational and chronic exposure (6–8), acute intoxication (9), and three fatalities (5,10,11). A summary of the blood concentrations determined in these published reports appears Table 1. In two of the fatal cases, tetrachloroethylene intoxication was associated with massive exposure to fumes in dry cleaning establishments (10,11). The third reported case is that of a 2-year child who died after inhaling tetrachloroethylene

TABLE 1—Blood tetrachloroethylene concentrations in previous case reports.

Exposure Type	Blood Tetrachloroethylene Concentration (Mean, mg/L; N; range)	Reference
Chronic	0.15 (N=21; 0–1.77)	6
Occupational	1.2 (N=26; 0.4–3.1)	7
Occupational	2.6 (N=6)	8
Acute	22 (N=1)	9
Fatal	44 (N=1)	10
Fatal	4.5 (N=1)	11
Fatal	66 (N=1)	5

fumes from curtains that had just been brought back from a self-service dry-cleaning establishment (5). The child was sleeping in close proximity to the curtains that had not been dried properly following improper use of the dry-cleaning machine. The case presented here is the first case reported in which a product containing tetrachloroethylene was deliberately inhaled in conjunction with an autoerotic experience resulting in death.

Case History

A 26-year-old white male while at work as a security guard at a car dealership was found dead in a conversion van located in a secured portion of the dealership parking lot after an apparent autoerotic sexual experience. He was lying face up on the floor between the seats and had a plastic bag containing a folded towel tightly secured around his head with a piece of panty hose. The subject was clad in a nylon body stocking which contained an opening in the crotch exposing his genitals. His penis was tied with an additional piece of stocking material and his waist was bound loosely with a buckled leather belt. A long piece of thin insulated wire loosely bound his wrists wide apart. No sexual paraphernalia was found at the scene other than the clothing present on the body. However, a pressurized can of Fix-A-Flat tire repair found close by the deceased. The can contained chlorodifluoromethane (FC-22), tetrachloroethylene, and a “trade secret.”

The autopsy, performed 24 h–36 h after death, revealed a normally developed 5-ft 9-in., 134-lb male. The body was cold with rigor and blotchy pink lividity present. The eyes showed no petechiae and the mucosa of the lips was dried. There was no evidence of injury. Internal examination indicated marked pulmonary congestion. The stomach contained approximately 350 mL of par-

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tially digested food and french fries. Some gastric contents were present in the esophagus. No other significant findings were noted.

Experimental Studies

Specimen Collection

Blood, urine, liver, lung, tracheal air and a portion of the Fix-A-Flat can contents were collected at autopsy. Blood and tracheal air were collected using a syringe and injected into a sealed 20 mL capacity headspace vial. The can contents were sprayed directly into a headspace vial that was then immediately sealed. Other specimens, including additional blood preserved with sodium fluoride, were collected in specimen containers normally used by the Medical Examiner's Office and immediately frozen at -15°C until analysis. Headspace vials were qualitatively analyzed the same day the autopsy was performed.

Qualitative Analysis

Qualitative analysis was performed on the specimens collected in the headspace vials in order to determine if tetrachloroethylene and FC-22 were present. The headspace vials were heated at 60°C for 10 min after which $2\ \mu\text{L}$ of the headspace was injected on a Hewlett-Packard 5995 gas chromatography/mass spectrometry system (GC/MS) equipped with a 15-meter DB-5 capillary column with a film thickness of $25\ \mu\text{m}$ and a diameter of $0.25\ \text{mm}$. Gas chromatographic analysis was performed at 75°C under isothermal

conditions using an injection port temperature of 200°C . Mass spectrometry was performed using electron impact ionization in the full scan mode. The heated zones were maintained at 200°C , 220°C , and 250°C for the source, analyzer and transfer line, respectively.

Quantitative Analysis

Quantitative analysis was only performed for tetrachloroethylene since FC-22 was not detected in either the blood or tracheal air samples collected in the headspace vials. Calibrators were prepared by fortifying pooled negative postmortem blood with tetrachloroethylene at 2, 4, 8 and 16 mg/L. Tissue specimens (1 g) from the decedent were homogenized with 4 mL distilled water before sampling. Using a pipettor-diluter, 0.5 mL of calibrator, negative blood control, and unknown specimen were diluted with 4.5 mL of internal standard solution (0.1% trichloroethylene in distilled water) in a headspace vial. The vials were sealed and incubated at 60°C for at least one hour. Analysis of tetrachloroethylene was conducted by injecting $40\ \mu\text{L}$ of headspace on a Perkin-Elmer Sigma 3B gas chromatograph equipped with an electron capture detector (GC-ECD) and a 6-foot by $1/8$ -in. stainless steel column containing 5% Carbowax on 60–80 mesh Carbowax B. The injection port was set at 180°C while the detector was set at 300°C . The analysis was performed isothermally using an oven temperature of 110°C . The carrier gas was 10% methane in argon at a flow rate of 30 mL/min. Specimens were quantitated by com-

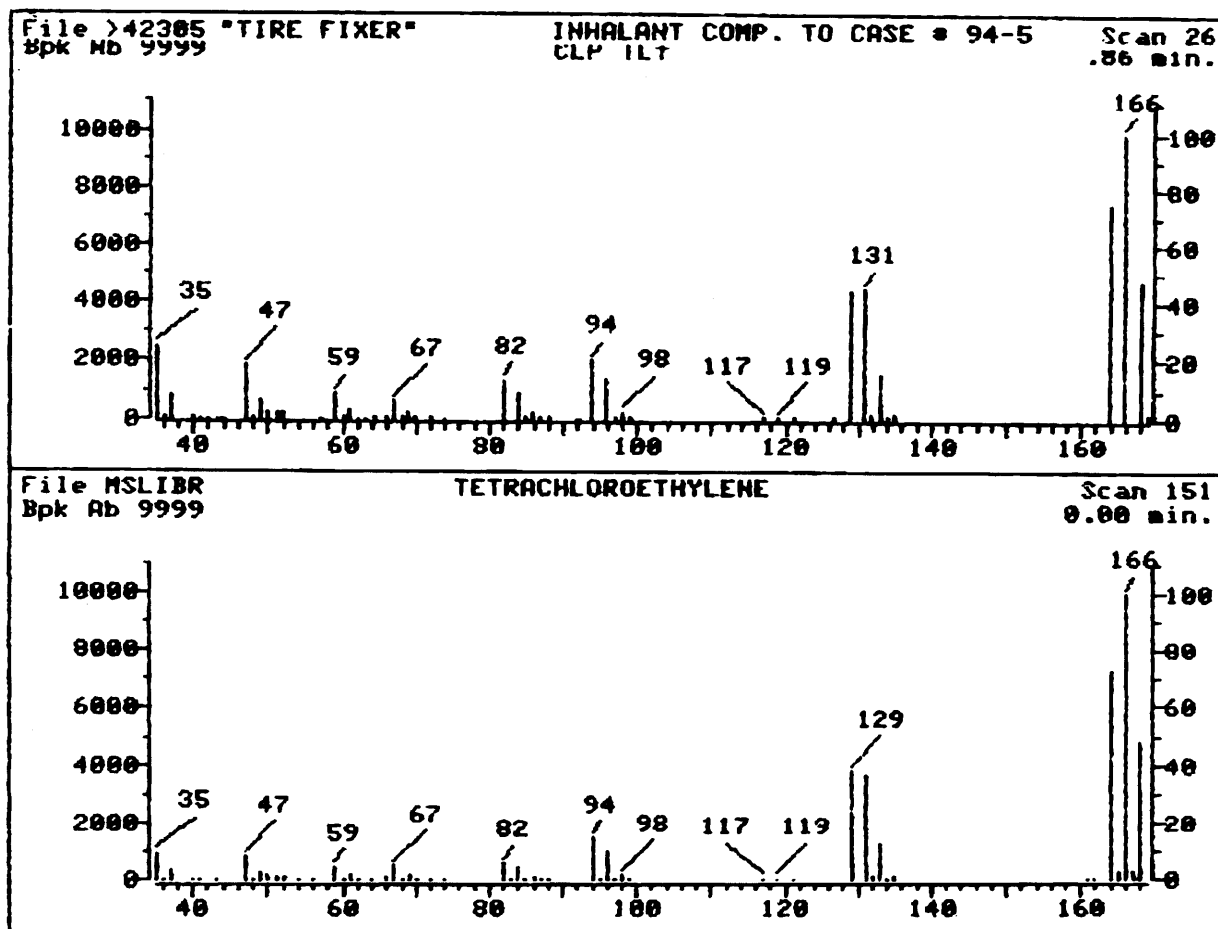


FIG. 1—Full scan mass spectrum of tetrachloroethylene obtained from the headspace vapor of a can of Fix-A-Flat tire inflator (top) compared with the mass spectrum obtained from a spectral library (bottom).

paring the area of tetrachloroethylene with the area of the internal standard, trichloroethylene, against the four-point calibration curve ($y = 0.1153x - 0.1091$; $r = 0.9967$). Dilutions of the unknowns were performed as necessary to obtain a quantitative result within the range of the calibration curve. The retention times for trichloroethylene and tetrachloroethylene were 2.40 and 6.02 min, respectively.

Results and Discussion

Qualitative analysis performed by headspace GC/MS analysis indicated the presence of tetrachloroethylene and FC-22 in the Fix-A-Flat can contents but just tetrachloroethylene in the blood and tracheal air. Identification was made by comparing full scan mass spectra obtained from the unknowns with reference spectra. Figures 1 and 2 show the spectra obtained from the Fix-A-Flat can contents.

Concentrations of tetrachloroethylene, obtained by headspace GC-ECD analysis, were 62 mg/L in blood, 341 mg/kg in liver and 47 mg/kg in lung. Figure 3 illustrates the chromatogram obtained from the analysis of the lung tissue from the decedent. The urine was negative for tetrachloroethylene as expected after an acute death. Comprehensive toxicology, performed on the fluoridated blood and urine, was negative for ethyl alcohol and other drugs.

Concentrations of other tetrachloroethylene fatalities are compared with our findings in Table 2. The tetrachloroethylene concentrations found in this case were almost identical to the findings reported by Gaillard et al. (5).

The tetrachloroethylene fatality reported here is unique from earlier case reports (5,10,11) in that the source of tetrachloroethylene was from a pressurized can used to inflate tires (Fix-A-Flat, Snap Products, Durham, NC) not from dry-cleaning solvents. The product label clearly indicated that "intentional misuse by deliberately concentrating and/or inhaling can be harmful or fatal." A recent visit to an auto parts store revealed that Fix-A-Flat is now sold in a "new non-explosive" formula. No contents are listed on the can of this new formulation.

This case also differs from previously reported cases in that tetrachloroethylene was deliberately inhaled during an autoerotic sexual fantasy and in previously reported cases was inhaled by involuntary exposure. Deaths due to inhalant abuse have been reviewed, but no cases were discussed that involved an autoerotic event (12). A recent review of autoerotic asphyxiation discussed previous cases in which chemical asphyxiation was used during an autoerotic episode, but not combined with bondage and masochistic behavior (13).

Inhalant abuse is recognized as a growing problem in America today particularly among junior high and high school students (14). Solvents are just one of the many types of inhalants abused. In this case, the product containing tetrachloroethylene was found lying next to the decedent who was found with a plastic bag containing a towel secured over his head. It was suspected that the decedent had applied some of the contents of the can onto the towel found inside the plastic bag prior to securing it over his head. This finding may be consistent with a practice known as "huffing"

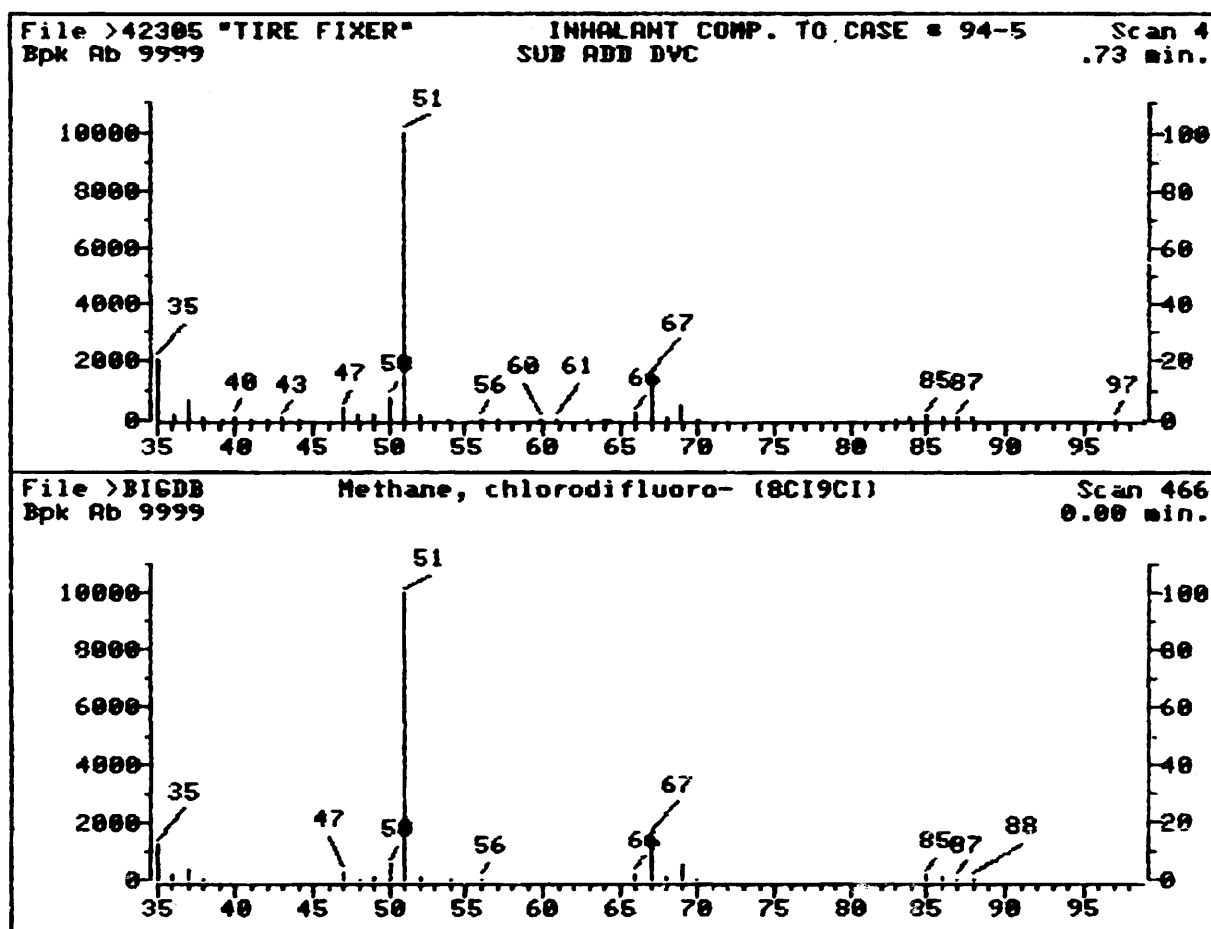


FIG. 2.—Full scan mass spectrum of chlorodifluoromethane (FC-22) obtained from the headspace vapor of a can of Fix-A-Flat tire inflator (top) compared with the mass spectrum obtained from a spectral library (bottom).

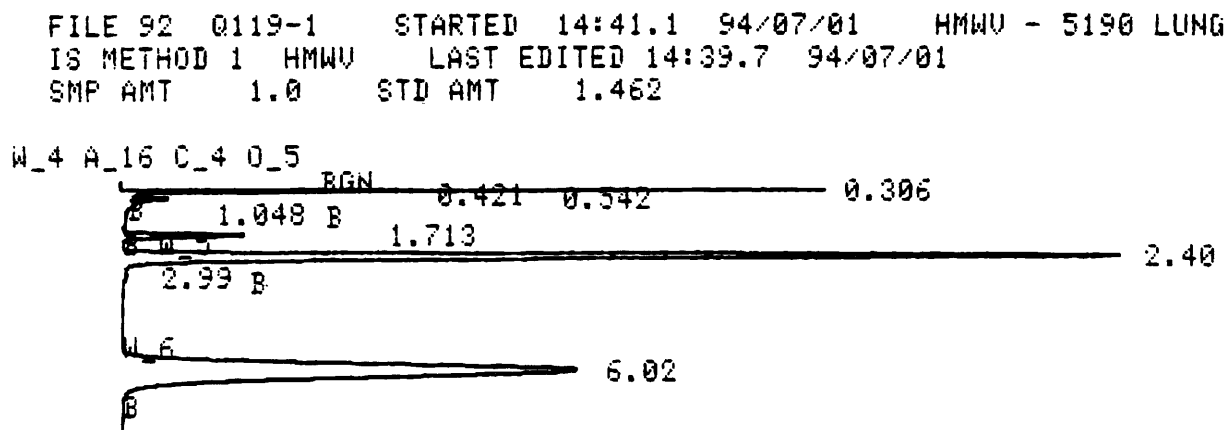


FIG. 3—GC-ECD chromatogram obtained from the headspace vapor of the decedents homogenized lung tissue demonstrating the presence of tetrachloroethylene (6.02 min) and the internal standard, trichloroethylene (2.40 min).

TABLE 2—Comparison of tetrachloroethylene concentrations in fatalities (mg/L of mg/kg).

Blood	Brain	Kidney	Liver	Lung	Reference
44	360	NA	NA	3	10
4.5	69	71	240	30	11
66	79	NA	NA	46	5
62	NA	NA	341	47	This study

NA = not analyzed.

in which abusers soak a rag with a solvent and then insert the rag in the mouth to inhale the fumes (15). In this case, the towel was not found in the mouth of the victim at autopsy, but it may have been expelled before death or during transportation to the Medical Examiners Office. Alternatively, the subject may have simply placed the towel in the plastic bag.

It is unclear what role, if any, the FC-22 listed on the can contents may have played in this case. Although FC-22 was detected by analysis of the can contents, it was not present in the biological specimens. However, a fatal concentration of tetrachloroethylene was detected in the blood of the decedent. Based on these analytical results, and the absence of other toxicological findings, the cause of death was determined to be acute tetrachloroethylene intoxication and the manner of death was accident.

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