Neuroendocrinology Letters Volume 36 Suppl. 1 2015
ISSN: 0172-780X; ISSN-L: 0172-780X; Electronic/Online ISSN: 2354-4716
Web of Knowledge / Web of Science: Neuroendocrinol Lett
Pub Med / Medline: Neuro Endocrinol Lett

Unusual way of suicide by carbon monoxide

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Submitted: 2015-07-18 Accepted: 2015-09-09 Published online: 2015-10-15

Key words: **suicide; carbon monoxide; carboxyhemoglobin; gas chromatography; forensic toxicology**

Neuroendocrinol Lett 2015; **36**(Suppl. 1):147–149 **PMID:** 26757130 NEL360915C02

Abstract

OBJECTIVES: Authors discuss the case of a suicide of a 29-year-old man caused by carbon monoxide (CO) intoxication. What the authors found interesting was the unusual way of committing suicide that required good technical skills and expert knowledge.

METHODS: The level of carboxyhemoglobin (COHb) in the blood of the deceased man was routinely determined by the modified method by Blackmoore (1970), using gas chromatography/thermal conductivity detection. The level of saturation of the hemoglobin by CO in the collected blood sample is determined relatively to the same sample saturated to 100%.

RESULTS: In the blood sample of the deceased man the lethal concentration of COHb of 76.5% was determined. Within the following examinations the blood alcohol concentration of 0.05 $g.kg^{-1}$ was determined. Further analysis revealed traces of sertraline, its metabolite N-desmethylsertraline, omeprazole and caffeine in the liver tissue, traces of N-desmethylsertraline, ibuprofen and caffeine in urine sample, and only traces of caffeine in the stomach content and blood samples were proved. To commit suicide the man used a sophisticated double container-system equipped with a timer for controlled generation of CO based on the chemical reaction of concentrated sulphuric acid and formic acid. The used timer was set by an electromechanical timer switch that triggered the fatal reaction of the acids while the man was sleeping.

CONCLUSIONS: The authors discuss an unusual case of suicide by CO intoxication rarely seen in the area of forensic medicine and toxicology that is specific due to its sophisticated way of execution.

Abbreviations

CO	- carbon monoxide
COHb	- carboxyhemoglobin
GC-TCD	- gas chromatography with thermal conductivity detector
HPLC-DAD	- high performance liquid chromatography with diode-array detector
HS-GC-FID	- head-space gas chromatography with flame ionization detector
ID	- inner diameter
SSLI	- split/splitless injector
TEAP	- triethylammonium phosphate buffer
VOCs	- volatile organic compounds

CASE REPORT

INTRODUCTION

There are many ways to commit a suicide. One of the options is an intoxication using different substances, e.g. volatile organic compounds (VOCs), drugs, drugs of abuse, alkaloids, metallic compounds, agrochemical agents, etc. In some cases, the self-murderer selects the intoxication by carbon monoxide (CO). The most common way is the intoxication by exhaust gases from the exhaust pipe led to the car interior in such cases (CO content in exhaust gases of motor vehicles reaches up to 6%). There are also unusual cases where the person committing suicide by the application of CO is selecting somewhat more sophisticated source of CO that requires specific professional knowledge and technical skills. The authors present such case report below.

A 29-year-old man, educated in the field of information technologies and working as a programmer, was found dead lying on bed in his one-room flat. The day after the last documented contact of the deceased man with his parents he did not come to work and the following day he was found dead. Therefore, the time interval from his death to the time when the body was found was estimated to be approximately 2 days (the medical examiner was not present at the crime scene investigation). No apparent signs of violence or active defence were found by the inspection of the body. The cause of death of the deceased man was not identified within the examinations on the crime scene and the authorities involved in criminal proceedings ordered forensic autopsy. Some typical, but not specific, symptoms of intoxication by CO were found by the autopsy. Blood sample, urine and samples of liver, kidney, lungs and brain tissue were collected for subsequent toxicological examinations.

MATERIAL AND METHODS

Blood alcohol level was determined in accordance with the Methodological guideline for determining blood alcohol level for forensic purposes (MZ CR 2006), i.e. by two independent methods of head-space gas chromatography with flame ionization detector (HS-GC-FID; GC Focus, HS TriPlus, both Thermo Electron Corp., wide-bore capillary column DB-ALC1, 30 m × 0.53 mm ID, J&W Scientific, isothermal elution) and enzymatic one (Cobas Integra 400 plus, Roche, Ethanol gen. 2). In addition, the screening of VOCs in the brain and lung tissue samples was performed by HS-GC-FID (GC Fisons 8100, HS 850, packed column, 5% Carbowax 20M on Carbopack B, 2 m × 2 mm ID, gradient elution 85–130 °C). The screening of toxicologically relevant substances in the urine, stomach content, liver and kidney tissue samples was performed by immunochemical analysis on an immunoanalyser (Cobas Integra 400 plus, Roche) and high performance thin-layer chromatography (Silufol UV 254 and Silica gel 60, Merck). The confirmation analysis was performed by high performance liquid chromatography with diode-array detector (HPLC-DAD; Gynkotek, chromatographic column Kinetex 50 × 4.6 mm ID, Phenomenex, DAD UVD340U) using gradient elution (25 mmol.L^{-1} TEAP in 5% acetonitrile, 25 mmol.L^{-1} TEAP in 70% acetonitrile). The quantitative analysis of the blood sample was performed by the same HPLC–DAD method which was used for the confirmation.

The blood level of COHb was measured by gas chromatography with thermal conductivity detector (GC-TCD). In contrast to commonly used spectrophotometric techniques that may provide inaccurate results with cadaveric specimen, the GC-TCD method is more robust. This difference is even more noticeable in progressively decomposed blood samples. The blood sample was processed by modified method by Blackmore (Blackmore 1970). The principle of the method is the release of CO bound in COHb by the ferricyanide agent (mixture of potassium ferricyanide, carbonate buffer and nonionic surfactant Triton X-100) in gas-tight vial, using methane as an internal standard. This modified in-house method is patented (Dubský *et al.* 1982). The released CO was further determined by GC-TCD (Hewlett-Packard, HP 4890D, wide-bore capillary column Molsieve, 30 m × 0.53 mm, J&W Scientific, SSLI, carrier gas hydrogen, isothermal elution at 50 °C). The level of COHb in the blood sample was determined relatively to the same sample saturated to 100%.

RESULTS

The applied combination of gas chromatography and enzymatic method revealed a negligible blood alcohol concentration of 0.05 g.kg^{-1}. Traces of ethanol were also identified by HS-GC-FID in the sample of lung tissue; no VOCs were found in the sample of the brain tissue. Further analysis including thin layer chromatography and immunochemical screening and HPLC-DAD confirmation proved traces of sertraline, N-desmethylsertraline, omeprazole and caffeine in the liver and kidney tissues, traces of N-desmethylsertraline, ibuprofen and caffeine in the urine sample, and traces of caffeine in the stomach content. The quantitative analysis of the blood sample only revealed traces of caffeine. The target analysis of the blood sample determined the lethal concentration of COHb 76.5%. Based on the results of the toxicological analysis, it may be deduced that, among other things, the man had probably suffered from depression.

DISCUSSION

On the basis of the toxicological analysis results, the case was concluded as a suicide caused by CO intoxication although initially this possibility was not taken into account. Despite the fact that the apparatus producing CO was found under the bed within the primary crime

scene investigation, its function was unclear. The only thing that was performed within the investigation of the apparatus was the collection of a liquid sample from the container for further expertise. Another indicium was an empty blister of the Persen Forte – the dietary supplement used for sleeping and calming, containing extracts of herbs with mild anxiolytic and hypnotic effects (*Valeriana officinalis*, *Melissa officinalis* and *Mentha piperita)* found in the litter bin in the flat. Routine examinations of the biological material applied within the systematic toxicological analysis are not normally able to prove the presence of active substances of these plants.

Findings by the autopsy (cherry pink colouring of the blood and the same colouring of spots in the skin of the cadaver) indicate that this could be a case of carbon monoxide poisoning. This suspicion was finally confirmed by the results of the toxicological analysis. Based on the preliminary report, the police performed a re-examination of the crime scene with the assistance of the Fire Rescue Service of the South Moravian Region. The fire technician measured (using a detection device Gas Alert Micro 5) the concentration of 49–50 $mg.kg^{-1}$ of CO in the air inside the flat. When measuring the concentration of CO in the air above the generator of CO, the device detected a concentration exceeding its measurement range, i.e. 500 $mg.kg^{-1}$ (health threatening concentration is considered to be 50 $mg.kg^{-1}$).

The generating system (Figure 1) consisted of two containers, the smaller one inserted in the larger one. The smaller container was on one side of the container fastened by wires to the cover of the larger container. On the opposite side of the smaller container it was provided with a wire loop. This loop was threaded through the hole in the lid of the larger container and secured by a cotter pin. The cotter pin was made of wire and it was attached by its opposite end to the mechanical winding part of the electromechanical timer switch. The timer switch was attached to the lid of the larger container from the outside and connected with the socket through an extension cord. Several holes were carved in the lid of the larger container. The fire technician detected sulphuric acid in the concentration of approximately 75% and unidentified organic acid (identified later as formic acid) by the method of Raman spectrometry in both containers. The chemical reaction of sulphuric acid and formic acid is commonly used for the preparation of CO in laboratory conditions. The total volume amount of the liquid in containers was about three litres. The fire technician concluded that the detected amount of acids was certainly sufficient to achieve a fatal concentration of CO in the confined space of the flat (the area of about forty square meters). In addition, the distance of the head of the deceased man from the source of CO was only about 1 m. It is therefore clear that the CO concentration had to be significantly higher at the site of the head in comparison to the final concentration achieved subsequently in the space of the apartment due to diffusion.

Fig. 1. Double-container apparatus used for generation of carbon monoxide.

The apparatus described above was assembled with the aim to mix the two identified acids in a predetermined time and thereby start the fatal reaction during the man's sleep probably induced by the food supplement Persen Forte. Cases of suicide caused by CO intoxication are relatively frequent in the field of forensic medicine and forensic toxicology. However, the discussed case is exceptional concerning the careful preparation of the suicide, and the effort and skills needed to construct a sophisticated device as a source of CO.

ACKNOWLEDGEMENT

Authors would like to thank the investigators of the 11th Department of Common Crime Investigation, Municipal Directorate of the Police of the Czech Republic for cooperation, as well as to Petr Šimek, the professional translator, for the language correction of the manuscript.

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