

An Unusual Case of Accidental Carbon Monoxide and Ethanol Intoxication in Two Commorientes Deaths

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Death by intoxication represents an important cause of violent deaths which could be easily prevented. Accidental ethanol and carbon monoxide intoxications produce the most frequent causes of violent deaths among civilians in Romania. To provide an insight in these types of deaths and to bring attention upon the clinical and biological manifestations as well as of the typical morphologically findings, the authors present a strange case of fatal intoxication due to carbon monoxide in an 88 years old male, found in his bed. Moreover, because of the simultaneous death of the male's wife in the attic of the house, with ethanol intoxication, we would also like to bring attention to the juridical notion of commorientes, since in the establishing of its constituting characteristics the forensic expertise plays a decisive role.

Keywords: carbon monoxide, alcohol, intoxication, commorientes

Fatal intoxications are still an important problem of public health. In Romania, the most common types of such deaths are generated by ethanol, methanol, ethylene glycol and carbon monoxide [1-3]. Nonetheless, any possible substance, legal or illegal, depending on the dose, may prove to be fatal, hence some rare unusual causes of fatal intoxications could also be possible [4-7].

Carbon monoxide (CO) is an odorless and colorless gas generated by incomplete burning of organic substances [8]. With a molar mass of 28.010 g/mol and density of 1.145 kg/m³ at 25°C, 1 atm [9], its main action is generated upon the blood cells, being a hematic toxic [10]. Carbon monoxide (CO) poisoning causes myocardial toxicity and life-threatening arrhythmias, the carboxyhemoglobin (COHb) level being correlated with the prolongation of QT intervals and the release of cardiac enzymes [11]. The binding of carbon monoxide to cytochrome oxidase also interferes with aerobic metabolism and with efficient adenosine triphosphate (ATP) synthesis [11]. CO, along with nitric oxide (NO), appear to modulate intracellular cGMP levels, platelet aggregation, and smooth muscle relaxation [12]. Overall, CO has a lower affinity for soluble guanylyl cyclase (a heme protein) than NO (fig. 1).

Carbon monoxide \Rightarrow Soluble Guanylyl Cyclase

Fig. 1. Interaction of CO with guanylyl cyclase (Modified from Omaye, 2002)



The symptomatology of the acute intoxication depends of the blood concentration of carboxyhemoglobin. Thus, at a concentration of 15-25% of COHb, the patient will experience: frontotemporal headache, dizziness, nausea, maniacal excitation, decreased auditory and visual perception. More than 40% COHb, there will appear intense headache, muscle weakness, muscle pain, hypotension, irregular breathing, the individual being conscious but being in impossibility of leaving the place of intoxication and finally, at a concentration of more than 60% COHb, there will occur coma with hypothermia, intermittent seizures and death through depression of vital centers [10].

Morphologically, the blood has a red carmine color that it prints on the skin (livor mortis), muscles and organs that are also congestive, with vascular thrombosis; the lungs develop carmine edema, other modifications being the liver necrosis lesions and myocardial lesions of hemorrhagic necrosis [13-15]. From a legal point of view, more frequent are accidental intoxications, followed by suicide. There must be distinguished the CO intoxication with CO₂ (in the case of fermentation in closed rooms) or intoxication with other toxic gases, such as H₂S, in the septage workers [2, 15].

Ethanol (CH₃-CH₂-OH) is a volatile, flammable, colorless liquid with a slight characteristic pleasant odor. Its molar mass equals to 46.07 g·mol⁻¹ and density to 0.7893 g/cm³ (at 20°C) [16]. The absorption of ethanol is respiratory, cutaneous, but mainly digestive [17]. The distribution is predominantly plasmatic, the metabolism in hepatocytes (oxidative pathway 80%) and extrahepatic (20%) [15]. Alcohol is metabolized by several processes or pathways (fig. 2) [17].

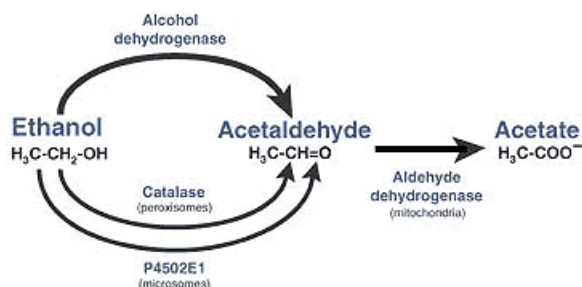


Fig. 2. Ethanol Metabolism [17]

The most common of these pathways involves two enzymes m- alcohol dehydrogenase (ADH) and aldehyde dehydrogenase (ALDH) [17]. These enzymes help break apart the alcohol molecule, making it possible to eliminate it from the body [17]. First, ADH metabolizes alcohol to acetaldehyde, a highly toxic substance and known carcinogen [18]. Then, in a second step, acetaldehyde is further metabolized down to another, less active byproduct called acetate, which then is broken down into water and

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carbon dioxide for easy elimination [19]. The enzymes cytochrome P450 2E1 (CYP2E1) and catalase also break down alcohol to acetaldehyde. However, CYP2E1 only is active after a person has consumed large amounts of alcohol, and catalase metabolizes only a small fraction of alcohol in the body [18]. Small amounts of alcohol also are removed by interacting with fatty acids to form compounds called fatty acid ethyl esters (FAEEs). These compounds have been shown to contribute to damage to the liver and pancreas [20].

Genetic differences in these enzymes may help to explain why some ethnic groups have higher or lower rates of alcohol-related problems. For example, one version of the ADH enzyme, called ADH1B*2, is common in people of Chinese, Japanese, and Korean descent but rare in people of European and African descent [21]. Another version of the ADH enzyme, called ADH1B*3, occurs in 15 to 25 percent of African Americans [22]. These enzymes protect against alcoholism [23] by metabolizing alcohol to acetaldehyde very efficiently, leading to elevated acetaldehyde levels that make drinking unpleasant [24]. On the other hand, a recent study by Spence and colleagues [25] found that two variations of the ALDH enzyme, ALDH1A1*2 and ALDH1A1*3, may be associated with alcoholism in African-American people.

From a forensic point of view, ethanol intoxication has 4 phases depending on the blood alcohol concentration: below 0.4 g% is oligosymptomatic; between 0.4 and 1.5 g% is manifested by excitement of intellectual functions; between 1.5 and 3.0 g%, symptoms of psycho-sensory disturbance occur; the last one (comatose drunk) occurs at alcohol concentrations of over 3.0 g%, and is characterized by hypothermia, metabolic acidosis, collapse and death [15]. Morphologically, the lesions from the acute intoxication are nonspecific. The official method for determining blood alcohol concentration is based on the following principle: after isolating the alcohol from the blood by distillation, the next step consists of cold oxidation with excess potassium chromate in the presence of nitric acid. The excess of potassium dichromate is titrated iodometrically in the presence of starch as an indicator [15].

The aim of this current study is to present the biological manifestations and necropsy findings in a simultaneous death of two spouses with two different types of fatal intoxications.

Experimental part

Cases presentation

Data used in this article was gathered from two cases in area of jurisdiction of Institute of Forensic Medicine Cluj-Napoca, both during the crime scene investigation and at the forensic autopsy. Data regarding the histopathological examinations and toxicology determinations were obtained by the specialized laboratories, both within the Institute of Forensic Medicine Cluj-Napoca, using specific methods.

In the afternoon of a cold September day, the on-call forensic doctor was requested by the police to attend a crime scene investigation in the center of Cluj-Napoca. According to the investigators, the bodies of an elderly couple were discovered in suspicious circumstances. At the site, there were two bodies discovered. Preliminary investigation information provided by the police stated that the elderly couple lived by themselves, without family or close friends visiting. The man was found dead downstairs, while the woman was found dead in the attic, with certain signs of putrefaction. Witnesses could state that the man was completely immobilized in bed for over 15 years, after a massive stroke. His wife was taking care of him, but also had the habit of going in the attic, where her husband couldn't see her, and frequently drink important quantities of alcoholic beverages.

In a room located at ground level of a house, with a gas heating central, there was a masculine body which was positively identified as being the 88-years old owner of the establishment. The body was placed on a bed, with his face upwards. Signs of real death were present as the temperature of the body was consistent with the temperature of the environment, rigidity was present at all main articulations and the lividity was in the imbibition stage, and bright reddish. The body presented no external signs of traumatic lesions. The putrefaction was not exteriorized.

In the attic, there was a feminine body that was identified as a 76-years old woman. The position of the body was horizontal, on a mattress, with the face oriented up. There were no certain signs of traumatic lesions at the external examination of the body, but the putrefaction was advanced, as the body presented dark-greenish colored teguments, global swelling of the soft tissue, best seen at the level of the cephalic extremity, and signs of postume circulation. Around the mattress there were many empty alcohol bottles.

The forensic autopsy was conducted for both bodies in the following day. The external examination of the bodies did not provide additional information to what was discovered during the on-site examination.

Results and discussions

The internal examination of the male body revealed no traumatic injuries, a massive parieto-temporal scar colored brown-yellowish with the altering of the normal cerebral architecture in the right hemisphere of the brain consecutive to an old stroke, advanced pulmonary emphysema, myocardial fibrosis, advanced atheromatosis of the coronary arteries and nephroangiosclerosis. The gastric lumen was empty, and the gallbladder was significantly dilated, containing green-yellowish liquid and no calculus. Histopathological examination confirmed the macroscopic diagnostics. Toxicological analysis showed a level of blood carboxyhemoglobin of 49%. Death was established to be violent, by lethal carbon monoxide intoxication.

The necropsy of the female body revealed the absence of traumatic injuries, edema and stasis at cerebral level, pulmonary edema and stasis, dilatative cardiomyopathy and hepatic dystrophy. Histopathological examination confirmed the macroscopic diagnostics. Toxicological analysis determined a 3.5 g/L alcohol concentration in the blood sample taken from the body and ruled out any other type of intoxication. Death was established to be violent and produced by lethal alcohol intoxication.

Violent death is a category of deaths in which the death occurs due to factors that are sourced outside the human body. Those are one of the primary concerns of legal medicine, as all death that are violent or suspected to be violent must be subjected to a forensic autopsy (see the alternative virtopsy [26]), to establish beyond reasonable doubt, the type of death, the causes and the mechanisms through which the external damaging factor has induced the thanatogenerating chain of reactions inside the body.

Whereas the juridical aspects of this circumstance are concerned, the type of violent death described can be classified in homicide (willingly or non-willingly), suicide or accident and in other countries execution and euthanasia [27]. Although these types of death are the primarily concern of legal medicine, nonviolent deaths, mainly due to cardiovascular factors constitute most of the forensic autopsies [28].

The presented cases are representative for the mechanism of accidental violent deaths by intoxications. Based on the information gathered during our specific procedures, we could pinpoint the mechanisms of deaths for both persons and to establish the chronology of the events. We presume the elderly woman died first, of a violent death ethanol toxic-induced.

Table 1
CHARACTERISTICS OF THE COMMORIENTES OR SIMULTANEOUS DEATHS

1. The death of two or more persons
2. This occurs in circumstances where it is difficult to tell who died first
3. From the juridical point of view in such cases there is an existing presumption of simultaneous death in the Romanian law, whereas in the "common law" (e.g. Great Britain, USA) the deaths are presumed to have occurred in order of seniority, so the younger is deemed to survive to elder.
4. Examples: plane accident, earthquake, bombing etc.

In the case of the man, the autopsy revealed no signs of traumatic lesions, but important serious chronic diseases, with the potential to induce a state of incapacitation. However, the chronic diseases did not present certain signs of acute complications, such as a new, recent, stroke or an acute myocardial infarct. The compiling of this data led us to the conclusion that the death was violent and it was due to accidental carbon monoxide intoxication, although the COHb value was of 49%. This is value might prove to be fatal in elderly persons, skinny and with other pathologies. Combining the information from the presented case, we concluded that the woman died first, and this lead to the consecutive death of her impaired husband, by CO poisoning, since he was not able to get out of the room.

We would like to point out the *commorientes* (table 1.) notion or simultaneous death, due to its very important juridical (especially in the inheritance cases) consequences. From the forensic pathologist's point of view such types of deaths are rare [29], and pose real difficulties especially in the cases in which the time of deaths are very close to one another. Luckily, in the two cases presented, we could clearly state the sequence of death, this solving the possible inheritance issues. We would like to state that as in other cases [30-34] of forensic expertise, in the commorientes cases there arise some ethical issues such as the absence of caregivers and therefore the dilemma of who should bury the deceased.

Conclusions

Beyond being a detached professional, a forensic doctor must not restrain at the specific forensic activities, but also, he or she can help the society by providing as often as possible, through accepted ways of communication, any suggestions that might improve the overall quality of life, and especially of the less fortunate categories of population. From this point of view, the presented cases were not meant to be only introspection in the rare cases of violent death due to intoxications, but also a way to raise general awareness upon the difficulties that some categories, such as the elderly, are prone to encounter.

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