Unexpected COHb Levels in monoxide related death: About Two Cases

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Abstract

Carbon monoxide (CO) poisoning remains a significant global issue, often linked to the use of gas heaters during winter, representing one of the most prevalent causes of fatal poisonings worldwide (termed the "silent killer"). These case reports focuse on two 16-year-old individuals. In the first case, despite carboxyhemoglobin (COHb) levels falling below typically fatal thresholds, the individual succumbed to death. Conversely, the second case displayed levels indicative of acute CO poisoning. Autopsy unveiled signs of asphyxiation and hemorrhagic lesions in this individual. Or Autopsies unveiled signs of asphyxiation and hemorrhagic lesions in both individuals. The toxicological analysis, conducted using the CO-OXIMETER device, accounted for potential chemical interferences. Variables including pre-existing medical conditions and medical interventions were explored to comprehend the spectrum of COHb levels. This study illuminates the intricacies surrounding CO-related fatalities and underscores the significance of considering a multitude of factors for an accurate interpretation of CO poisoning deaths.

Keywords: CO poisoning- CO Toxicological analysis- HbCO interpretation levels

1. Introduction

Carbon monoxide, a colorless and odorless, (silent killer) gas, produced during the incomplete combustion of hydrocarbons (1–4), is one of the most common causes of fatal poisoning in the world. CO quickly binds to hemoglobin (Hb) to form a compound called HbCO when present in the blood. This binding process significantly reduces the blood's ability to carry oxygen to tissues throughout the body (4). The incidence of poisoning worldwide in recent years has remained stable, however, The mortality rate and the percentage of deceased patients decreased by 36% and 40% respectively (2). Most CO-related deaths occur in winter due to the use of gas heaters (5). However, in the forensic medicine department of a university hospital of a university hospital center Mustapha, 9 cases of death attributed to CO were recorded during the 3 months of the last summer season (from June 21, 2023, to September 21, 2023). In toxicological investigations, HbCO is the most appropriate biomarker for the assessment of CO exposure (5). However, certain factors can make it more difficult to interpret the results.

2. Case Reports

2.1. Cases history

On August 15, 2023 at around 6:00 p.m., a 16-year-old young man (box 1), a college student, with no particular pathological medical history, was found unconscious at his home with his Friend (case 2) the inanimate body, also 16 years old, from Algiers, and with no known medical history. A relative evacuated them to the emergency room of the Mustapha University Hospital. Despite attempts to resuscitate him, the first youth was reportedly pronounced dead shortly after their arrival.

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2.2.Autopsy findings

The autopsy of the first case. revealed the following:

-Cyanosis of the face and extremities with conjunctival hyperemia and poly-visceral congestion, and Hypostasis on the back, colored cherry red.

-Bright red fluid blood and Deep rose coloration of the entire cervical-thoraco-abdominal musculature and viscera.

- Enlarged heart (cardiomegaly) weighing 341 grams **Figure 1**

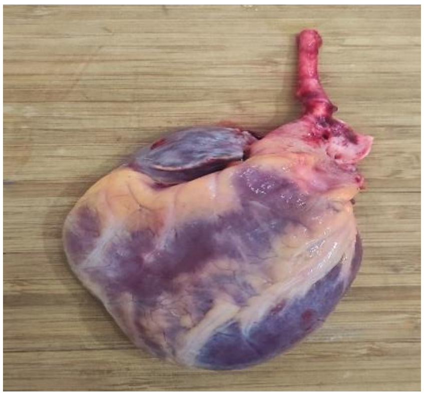

Figure 1*: Hypertrophic hear*

The autopsy of the second case revealed:

-Asphyxia syndrome made of blood fluidity, petechiae on the internal aspect (inner side) of the scalp, and poly-visceral congestion.

-Rosy coloration of all viscera and various muscular planes.

-Heavy, rosy-colored lungs occupying the thoracic cavity, firm and airless, displaying disseminated petechial hemorrhagic in both pulmonary fields.

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-The dissection of the trachea and bronchial tree revealed significant blood-tinged frothy foam and a rosy-colored mucosa ***Figure 2***.

-Highly congested and oedematose brain weighing 1624 grams.

- Globular heart, weighing 295 grams, and displaying pinpoint hemorrhagic on both anterior and posterior faces.

-Hemorrhagic gastric mucosa with a small quantity of digested blood contained in the stomach

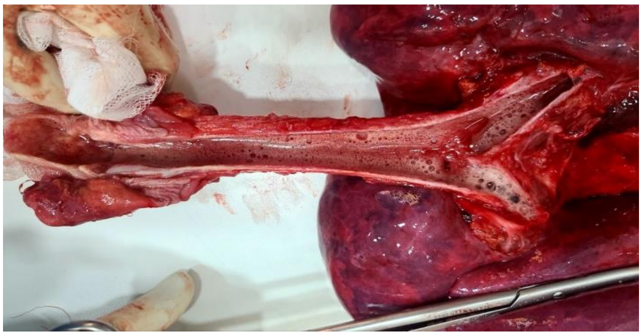

Figure 2: *Presence of a large aerated bloody moss and a pinkish tracheal and bronchial mucosa.*

2.3. Toxicology findings

2.3.1 Biological sample

Several samples were taken for toxicological analysis, namely: Two dry tubes of 15 ml of peripheral blood, and cardiac blood, these tubes were filled completely to the edge, two 10 ml tubes for urine, and one 2 ml tube for vitreous humor for each of the two deceased.

The analysis was carried out immediately after receipt of the samples.

2.3.2 Analytical Method

Due to the strong attraction of CO to Hb, it has been assumed that most, if not all, CO binds to Hb once introduced into the bloodstream. For this reason, HbCO is considered the most appropriate clinical marker for assessing exposure to CO poisoning (5).
The **SIEMENS rapid-point500e CO-OXIMETER** is a sophisticated device used to measure the concentration of different types of Hb in the blood, with a focus on the accurate determination of COHb levels. Analyzer frequently performs blood quality and integrity checks before, during, and after each patient sample. Three levels of quality control (low, medium and high) are automatically launched. This measurement method is based on multi-wavelength spectrophotometry, where the device uses a series of specific wavelengths to analyze the different forms of Hb present in the blood sample. Using this approach, the device can accurately distinguish between oxyhemoglobin (HbO2), deoxyhemoglobin (HHb), COHb, and methemoglobin (MetHb) present in the sample.
The device is easy to use, fast, and affordable. It offers high precision and accuracy in its measurements. These features make it an effective tool for quickly and accurately assessing patients' CO exposure status. However, this method comes with its limitations. Chemical interferences can affect accuracy in measuring COHb levels, particularly at lower concentrations (< 5%), where it might overestimate higher levels (> 30%) without consistently impacting clinical or legal assessments significantly (6).

2.3.3 Results

The results of the HbCO% analysis in both the peripheral and cardiac blood matrices are presented in Table 1

Table 1 : HbCO Analysis Result

The Matrix	**HbCO percentage %**		**HbCO lethal level (%)**
	Case 1	Case 2	
Central (cardiac) blood	**20.3 %**	**60.2 %**	>50% (8,9)
Peripheral blood	**16.8 %**	**77.97 %**	

3. Discussion:

In the 1st case, toxicological analysis of peripheral and central blood samples revealed HbCO levels of 16.8% and 20.3%, respectively. These values are below levels usually leading to death in the absence of a disease history.

Indeed, several potential sources of error in COHb determinations must be considered: the type of preservative used to store the blood sample can alter the results; the storage temperature can influence the measurements; the dead volume in the collection tube can also alter results due to the potential release of CO from Hb; the freeze-thaw cycles and the repeated reopening of collection tubes can also alter measurements. In addition, post-mortem modifications, such as thermocoagulation and putrefaction, are unpredictable sources of error (10) However, during toxicological investigation, all these factors were avoided.

Other pathological factors such as cardiovascular, bloodstream, and lung diseases can alter the way the body absorbs CO, potentially reducing or increasing the resulting COHb levels (10), and increasing mortality (11). Autopsy findings revealed the presence of a cardiac pathology (hypertrophic heart disease), which would explain the occurrence of death even at these non-lethal rates.

Consideration should also be given to the removal of the body from the toxic environment while it was presumably still alive, as well as resuscitation maneuvers, including normo-baric oxygen therapy, which could have contributed to the removal of CO from the body.

As a result, death was attributed to an asphyxia syndrome attributable to CO poisoning, on a hypertrophic heart disease, which was directly responsible for the death.

In the 2nd case, the levels of HbCO in peripheral blood of (77.97%) and central blood of (60.2%) as well as all autopsy findings were more than sufficient to attribute the death to CO poisoning.

4. Conclusion

The presented cases highlight the multifaceted nature of CO-related deaths. While one case had COHb levels below typical death thresholds, the presence of underlying cardiac pathology suggested a potential contributing factor to mortality. In contrast, the second case had significantly elevated COHb levels, consistent with fatal poisoning. These cases underscore the need for a nuanced approach in forensic assessments, considering not only toxicological findings, but also contextual factors and individual health conditions to determine the precise cause of CO-related deaths.

Table list

Figure list

Conflict of interest

Lokmane Dali Braham, Feriel Hadji, Imane Bekkouche, Yasmina Chegra, KoriYahia Abderrahmane, Pr Djamil Azzouz, Pr Rachid Belhadj declare that they have no conflict of interest.

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