

## E4 Gone in 60 Seconds: A Fatal Case of Asphyxiation in a Confined Working Space

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**Learning Overview:** The goal of this presentation is to provide useful evidence regarding asphyxiation findings in confined space deaths in cases which, according to external inspection in a death scene, a Carbon Dioxide (CO<sub>2</sub>) poisoning could be expected.

**Impact on the Forensic Science Community:** This presentation will impact the forensic science community by establishing CO<sub>2</sub> poisoning cases when asphyxiation occurs in a confined space. When there are no specific CO<sub>2</sub> intoxication findings, the death scene and external investigation, gross anatomy, histology, and immunohistochemistry, as well as toxicological findings, are crucial to assessing asphyxiation features and to exclude other death causes.

CO<sub>2</sub>, a normal component of the atmosphere (0.02%-0.03%), a colorless and odorless gas, is physiologically produced by cellular metabolism and is widely used as an inert gas in fire extinguishers.<sup>1</sup> The toxicity of the CO<sub>2</sub> results from the effects to the respiratory center and from the replacement of oxygen. In low concentrations, it stimulates the respiratory center, and in high concentrations, it leads to respiratory depression and apnoea.<sup>2,3</sup> This data confirms how dealing with CO<sub>2</sub> is a great hazard. However, for forensic pathologists, the proof of CO<sub>2</sub> poisoning is still a great challenge.<sup>4</sup>

The presented case regards a 31-year-old man who was working as a fire extinguisher system maintenance person in the basement of a temporarily closed bank. There was only one main basement entrance. At that time, four other technicians were present. The anti-fire system was composed of several gas containers and many pipelines containing the inert CO<sub>2</sub> gas that was supposed to be released in case of fire and after the building evacuated. During maintenance activities, a massive gas leak from a container occurred. Four of the five men succeeded in escaping. The 31-year-old man was not able to get out and perished. Firefighters arrived and found his body without signs of life.

The forensic pathologist arrived and noted the position of the cadaver was a few meters from the gas container. The external examination revealed the presence of conjunctival petechiae, neck and face hypostasis localization, and no signs of injury. The autopsy, performed 24 hours after death, reported diffused brain and lungs edema, sub-pleural petechiae, and epicardial and myocardial petechiae. All vessels of the internal organs appeared to be congested. Histological investigation, with Hematoxylin and Eosin (H&E) stain, confirmed the gross anatomy findings. An increased number of alveolar macrophages were observed in the lungs as a consequence of protracted oxygen deficiency. Lung samples were processed for immunohistochemistry by using CD 68 and Hypoxia Induced Factor 1- $\alpha$  (HIF1- $\alpha$ ) antibodies. Positive reaction with macrophage marker CD 68 as well as HIF1- $\alpha$  was observed. Spectrophotometry analysis was performed in order to exclude high carboxyhemoglobin levels in periphery blood. Drug and alcohol concentrations in the periphery blood were not significant. Death scene information, and macroscopic, microscopic, and toxicological findings determined asphyxiation in a confined space as the cause of death.

Asphyxia in a confined space may be a consequence of oxygen exclusion because of depletion and replacement of another gas or as a result of chemical interference with its uptake and utilization.<sup>5</sup> In this case, a massive CO<sub>2</sub> leak from the fire extinguisher system occurred, and the basement was rapidly filled with CO<sub>2</sub>, which is denser than O<sub>2</sub> (1.98kg/m<sup>3</sup> vs 1.29kg/m<sup>3</sup>), leading to an oxygen exclusion. CO<sub>2</sub> intoxication is a diagnosis based on the scene investigation and circumstances surrounding a death with the exclusion of other causes of death.<sup>6</sup> There are no pathognomic autopsy findings and blood analysis for CO<sub>2</sub> content has no diagnostic significance, as CO<sub>2</sub> rapidly accumulates after death.<sup>7</sup>

In this case, the death scene investigation, autopsy, histological, immunohistochemical, and toxicological analysis were crucial to provide essential information in order to assess CO<sub>2</sub> intoxication. In such cases, CD 68 and HIF1- $\alpha$  antibodies use is essential in order to establish an oxygen deficiency and suggest asphyxiation death.

### Reference(s):

1. Langford, Nigel J. Carbon Dioxide Poisoning. *Toxicological Reviews* 24.4 (2005): 229-235.
2. Nattie, E. CO<sub>2</sub>, Brainstem Chemoreceptors and Breathing. *Progress in Neurobiology* 59.4 (1999): 299-331.
3. Ikeda, Noriaki et al. The Course of Respiration and Circulation in Death by Carbon Dioxide Poisoning. *Forensic Science International* 41.1-2 (1989): 93-99.
4. Rupp, Wolf-Rüdiger et al. Suicide by Carbon Dioxide. *Forensic Science International* 231.1 (2013): e30-e32.
5. Sauvageau, Anny, and Elie Boghossian. Classification of Asphyxia: the Need for Standardization. *Journal of Forensic Sciences* 55.5 (2010): 1259-1267.
6. Srisont, Smith, Thamrong Chirachariyavej, and A.V.M. Peonim. A Carbon Dioxide Fatality From Dry Ice. *Journal of Forensic Sciences* 54.4 (2009): 961-962.
7. Spitz W.U. Asphyxia. In: Spitz W.U., editor. *Medicolegal Investigation of Death*. Springfield: Thomas CC, 2006;783-845.

### Confined Space, Asphyxiation, CO<sub>2</sub> Intoxication