



H4 Carbon Dioxide Asphyxiation Due to Pulmonary Embolism: A Case Report

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Learning Overview: After attending this presentation, attendees will be familiar with the findings in confined space carbon dioxide asphyxiation and understand the importance of autopsy findings and death scene investigation in determining cause of death.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by discussing an unusual case of confined space asphyxiation as the result of pulmonary embolism and the importance of collaboration between death scene investigators, police, and the forensic pathologist for an accurate evaluation of these fatalities.

A 38-year-old man working as a special effects technician using a commercial Carbon Dioxide (CO₂) tank to create a fog effect within a theatre was operating the shut-off valve in a contained room under the stage when he was unable to be contacted via portable radio for 12–13 minutes. He was found unresponsive with seizure-like activity by two coworkers, who also became unresponsive. A third coworker was able to turn off the CO₂, allowing the removal of the three victims from the room. Both coworkers were revived and transported to the hospital along with the primary patient, who remained unresponsive. Arterial blood gas performed en route to the hospital revealed a CO₂ level of greater than 100mm Hg with the level decreasing to 40mm Hg upon arrival at the hospital. Therapeutic hypothermia protocol was initiated due to continued unresponsiveness and seizure-like activity. Upon rewarming, Computed Tomography (CT) of the head revealed severe encephalopathy, diffuse cerebral edema, and downward herniation. Brain death was declared, care was withdrawn, and death was pronounced four days after the incident.

Autopsy performed the following day revealed a thromboembolus within the main trunk of the pulmonary artery and completely obstructing the right pulmonary artery. A healing hemorrhagic pulmonary infarct, as well as multiple deeper shower thromboemboli and dilated cardiomyopathy, were also present. The right lower extremity was swollen and a massive residual organizing thrombus adherent to the deep vein endothelium was found. Microscopic examination of the pulmonary thromboembolus demonstrated interlacing gray fibrinous bands indicative of a long-standing organizing blood clot consistent with at least a week-long process. The deep vein thrombus from the right leg was similar in appearance. Further investigation of the decedent's history revealed a recent lower extremity injury. Based on the autopsy findings, it was concluded that the collapse at work was due to an episode of pulmonary embolization by deep vein thrombi, which partially occluded the pulmonary artery tree. The sudden incapacitation and collapse prevented the decedent from operating the shut-off valve on the CO₂ tank. The unencumbered release of CO₂ from the tank led to an exclusion of oxygen, resulting in confined space asphyxia and, ultimately, death due to anoxic encephalopathy.

CO₂ is a colorless, odorless gas present in low percentages in normal room air (0.02%–0.04%). At low concentrations, it has little toxicological effect.¹ At higher concentrations, it leads to increased blood pressure, tachypnea, tachycardia, respiratory acidosis, and cardiac arrhythmias.^{1,2} It acts as both an asphyxiant and toxicant, causing neurological changes, such as headaches, clouded awareness, and impaired consciousness.^{1,2} Seizure, coma, and death occur at concentrations greater than 10%.^{1,3} At levels above 20%, there is a high risk of fatality.⁴ At such high levels, loss of consciousness can occur within seconds, which can lead to severe accidents also involving rescuers, as in this case.⁴ Deaths due to CO₂ often involve storage tanks or wine cellars as CO₂ is a by-product of fermentation, and the enclosed spaces allow the accumulation of high concentrations.² CO₂ has a greater density than oxygen, causing it to accumulate near the ground and displace oxygen from the area.¹ Asphyxiation occurs in the confined space as a consequence of an oxygen-deficient atmosphere.¹ Toxicity may be expedited by the body's failure to eliminate CO₂ resulting from respiratory failure or obstruction, such as pulmonary embolism as in this case. Autopsy findings are non-specific and the rapid accumulation of CO₂ after death renders postmortem CO₂ levels of little diagnostic value.⁵ Therefore, the diagnosis of CO₂ intoxication is based on the scene investigation and circumstances of the death with the exclusion of other possible causes.¹ This is an unusual but not to miss diagnosis where close communication among all parties is critical, especially those participants at the scene.

Reference(s):

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3. Langford, Nigel J. Carbon Dioxide Poisoning. *Toxicological Reviews* 24, no. 4 (2005): 229-35. doi:10.2165/00139709-200524040-00003.
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Asphyxia, Dioxide, Embolism