Lethal Helium Intoxication. Determining the Context, Cause and Time of Death

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Helium is the chemical element with atomic number 2, represented by the symbol He. It is an inert, colorless, odorless, insipid monoatomic gas. It has the lowest boiling point and the lowest melting point among the chemical elements and appears only in gaseous state, except for extreme conditions. The use of helium for suicidal purposes is extremely rare. In Romania, suicide has a frequency of 12 per 100,000 inhabitants, which classifies us in the category of countries with low suicide rates. As methods, men use hanging most often while women use more softer methods such as poisoning. Helium is rarely used for suicidal purposes because it is relatively difficult to obtain. Basically, it is not poisoning in the true sense of the word, but rather the substitution of oxygen with helium, which cannot be carried by hemoglobin, and thus transport asphyxia occurs. At the end of the paper we shall exemplify a case of helium poisoning for suicide purposes, purchased from a cylinder for inflating balloons.

Keywords: helium, poisoning, suicide, death, CG real time analysis

In 1868, in the Guntur locality of India, on the occasion of a solar eclipse, French astronomer Pierre Janssen observed an unusual spectral line of intense yellow (wavelength - 587.49). Together with his colleague Norman Lockyer, they guessed that it is an unknown element until then called *helium* (sun - *helios*) believing that the element can be found only in the sun. On March 26th, 1895, the British chemist Sir William Ramsay isolated the helium by treating a mineral called cleveite with mineral acids. In 1903, large helium reserves were found in the United States of America, which is currently the largest supplier of this gas in the world. In 1908, helium was first liquefied by Dutch physicist Heike Kamerlingh Onnes by cooling the gas to less than one kelvin. He tried to get the solid state as well by continuing to reduce the temperature, but failed because the helium does not have a triple point of temperature (where the solid state, liquid and gaseous aggregate state are in balance). Willem Hendrik Keesom, eventually succeeded in solidifying 1 cm^3 of helium in 1926. When the planet Earth was formed from the condensed gas and dust cloud, the reduced weight of helium caused it to evaporate, which is why it is relatively rare. The helium present today is mainly created by the natural radioactive disintegration of heavy radioactive elements (thorium and uranium). This radiogenic helium is contained in natural gas at concentrations up to 7% where it is extracted industrially by a low temperature separation process called fractional distillation. The stability and low energy of the helium electronic cloud explains that it is the most inert chemical element, and also the lack of interaction of the helium atoms between them, which causes the lowest melting point or boiling point of all the chemical elements known. All the heavier elements (including those present on rocky planets such as the Earth) were created after the Big Bang, in stars that were hot enough to burn not only based on hydrogen but also to burn helium. Such massive stars are rare and therefore all the other chemical elements after hydrogen and helium weigh only 2% of the mass of atomic matter of the Universe. Helium-4, however, makes up about 23% of the matter in the ordinary universe-nearly all the ordinary matter that is not hydrogen.

Helium is used in cryogenic, underwater breathing devices, magnet cooling, radioactive helium dating, helium balloons and airships, to lift airplanes and spacecraft from ground and as a protective gas in many industrial uses (such as arc welding). Helium inertia has higher environmental benefits than conventional refrigeration systems, which contribute to ozone depletion or global warming. Because it is lighter than air, the airships and balloons are often inflated with helium. Helium-neon lasers have various applications, including bar code readers. Due to its low solubility in nervous tissue, helium mixtures such as trimix (respiratory gas), heliox and helair are used for diving and to reduce the effects of nitrogen-derived narcotics. In the form of gas, it is frequently used for gas chromatography. MRI scanners, for example, some of the most sensitive imaging equipment in hospitals, use helium on a large scale. A single scanner requires 10,000 L of helium to be used.

Under standard conditions the neutral helium is not toxic, it does not cause biological diseases and traces of this gas can be found in the blood. If a large amount of helium is inhaled so as to replace the oxygen required for breathing, it can cause asphyxiation [1-3]. The safety conditions for cryogenic helium is similar to those for liquid helium; its very low temperature can cause cold burns, and due to the gas-liquid expansion ratio, fires can occur if depressurizes are not installed.

Why does helium thin the voice? When a person speaks, the air comes from the lungs through the larynx where it meets the vocal cords. They vibrate when touched by air, and this vibration excites the air molecules in the vocal tract, emitting certain frequencies. Vibration of vocal cords influences the height of the sound, and the vibration of the air in the vocal tract influences the ring of the voice. Once the air travels through this path (the lungs - the vocal cords - the oral cavity), it exists between the lips in the form of sound waves generating the voice. The air in the

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atmosphere in which most people speak (Mental Floss states) is 78.08% nitrogen, 20.95% oxygen, 0.93% argon and 0.038% carbon dioxide. Nitrogen has a mass seven times higher than helium. Thus, since helium is a gas lighter than air, the sounds cross faster a gas formed mostly of helium. In a room where the temperature is 20 degrees Celsius, the sound has a speed of 344 meters per second by air and 927 meters per second by helium. When we inhale the helium, we change the type of gas molecules that pass through the vocal system and thus increase the speed of our voice. Many people think that when we inhale helium, the vocal cords vibrate at a higher frequency, but this does not change. In fact, the ring changes because helium circulates faster and changes the resonance of the vocal tract, making it more responsive to high-frequency sounds.

It has been noticed that after inhalation of helium the oxygen level has fallen to a worrying level in just a few seconds. The clinical effects we encounter are similar to hypoxia:

-mild effects are headaches, throat inflammation, dizziness, nausea, and light feeling of dyspnea. Helium produces much faster sound vibrations and as a result, sore throat or temporary or permanent voice impairment may occur.

-if too much is inhaled, there is loss of consciousness, and if the time is too short, death can occur.

Fast helium or even air inhalation or from a pressurized container can create helium bubbles in the body causing fatal lung or brain embolic [4]. However, unlike carbon monoxide, helium does not combine with hemoglobin in the blood [5-7].

In the forensic practice, a small number of cases, such as 3, are quoted as *suicide by helium inhalation* [8-10]. The first suicide by helium asphyxia was reported in September 2000, shortly after articles on the effects of this gas on the human body were published.

Intoxication and death with gases is reported in many cases [7, 11, 12], either accidents or suicides. Gases such as nitrogen [13, 14], carbon monoxide [6, 7], carbon dioxide [15, 16], helium [8-12], air [4], butane [17], hydrogen sulfide [18-20], nitrous oxide [21] were reported as cause of death.

Thus, at the Department of Forensic Medicine of the University of Chisinau, Republic of Moldavia, it was quoted such a case: C.I., 26 years old, was found lying on bed in the room of the apartment where he lived. Also on the bed, beside the corpse, two Helium balloons were found, which penetrated through a plastic tube into a pouch applied to the head and hermetically sealed with elastic band on the neck. The bag and the system used were similar to those described by Derek Humphry. The external examination of the body did not reveal bodily injury, with only general signs of asphyxia and compression of the elastic band on the neck. A farewell letter was also found on the spot, where C.I. reports the reasons for suicide, indicating data on social networks and other personal information that allowed investigators to classify the case as self-aggression [22]. The histopathological and toxicological examination did not provide additional information. The toxicology examination was a standard test, for researching biological fluids. The forensic diagnosis and findings were largely based on on-site data. Cause of death was established as mechanical asphyxiation by inert gas (helium).

This paper presents data from the death caused by helium inhale, analyzed from a toxicological and anatomopathological point of view, corroborated with the evidence of the on-site research.

Experimental part

A 17-year-old male corpse was brought to Iasi Institute of Forensic Medicine for performing autopsy which was found in bed in dorsal decubitus, alongside a helium cylinder and a plastic bag, alongside the proof of having bought the kit from the online environment (invoice) which results from the on-site investigation and the discussion with the criminologist.

Police officers were alerted by his sister because the above-mentioned individual did not respond to verbal stimuli, the door being locked on the inside.

From the discussion with the criminologist, his sister declares autolytic attempts in the victim's history.

The external examination of the corpse revealed intensely violet lividities, asphyxia petechial, cyanosis of the lips and the nail bed, subconjunctival hemorrhages and the presence of scars in the posterior part of the right forearm.

The test for ethyl alcohol was performed using the method gas chromatography with flame ionization detection.

The immunochemical urine analysis was performed to detect traces of intoxication with drugs.

Results and discussions

Internal examinations also included features specific to asphyxia syndrome: stasis and cerebral edema, fluid blood in the right cavity of the heart, sub pleural and subepicardial petechial, pulmonary stasis and edema, renal stasis, liver stasis.

The autopsy, together with the results of the complementary tests, indicate that the most probable death mechanism has been a cardiogenic shock secondary to extensive myocardial necrosis due to helium intoxication.

Biological samples were collected for the dosing of toxic substances, drugs and medicines and histopathological samples. Corroborating the results of the necrotic, toxicological, histopathological examination with on-site research, it was concluded that the death of the named G.S. had been violent. It was due to anoxic asphyxia (oxygen depletion) most likely produced by prolonged helium inhalation in a closed environment. The case once again highlights the importance of studying the place of the scene and of the collaboration between the forensic, criminologist, prosecutor, in order to learn the truth in the performance of the act of justice.

It is unlikely that the toxicological standard tests (HS-GCMS) to reveal inert gases such as helium or argon. The standard GCMS test uses helium as carrier and that is why it cannot be detected without a replacing gas.

The presented case was representative for the mechanism of accidental violent deaths by intoxications. In recent studies [23,24], show that, in case of accidental carbon monoxide and ethanol intoxication, 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. The necropsy of the body revealed the absence of traumatic injuries, edema and stasis at cerebral level, pulmonary edema and stasis,

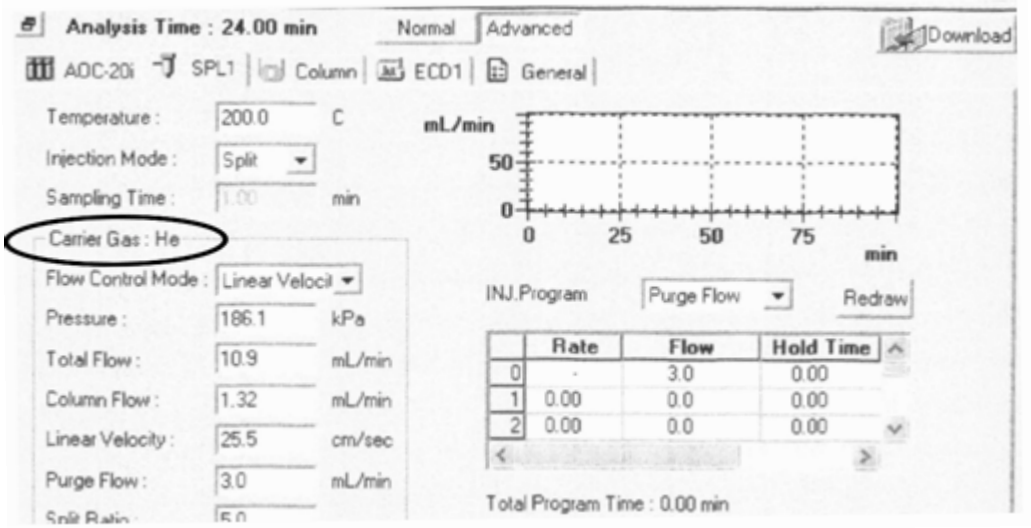

Fig. 1. GC Real Time Analysis

dilatative cardiomyopathy and hepatic dystrophy. Histopathological examination confirmed the macroscopic diagnostics, cause of death was established as mechanical asphyxiation by helium.

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 (the immunochemical analysis of urine was negative for the most common psychoactive substances). Death was violent and was produced about 24 h by asphyxiation with helium and acute alcohol intoxication.

Conclusions

On-site investigation and the analysis on the deceased environment are very useful and they highly contribute at determining the death cause (asphyxiation with helium and acute alcohol intoxication) and time (about 24 h).

The asphyxia with inert gases does not produce any identifiable, typical postmortem changes, so, it represents a challenge for the forensic pathologists, for the toxicologists and police.

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