Helium detection in the lungs in case of suicide by helium inhalation – Case report and literature review

Marek Wiergowski, Michał Kaliszan*, Barbara Sumińska-Ziemann, Tomasz Gos, Zbigniew Jankowski

Abstract: The paper presents a case of suicidal asphyxiation with helium inhaled from a gas cylinder through a tube with its end placed under a plastic bag taped around the deceased young man’s head. We attempted to detect helium in the deceased's lungs by means of gas chromatography with a mass spectrometry detector and it confirmed the presence of helium in the lung tissue. A modification of the method of helium isolation from the lung tissue before the chromatographic analysis was suggested.

Key Words: helium, asphyxia, suicide, gas chromatography, mass spectrometry.

Helium is a volatile, neutral, colorless and odorless noble gas with very low chemical and biological reactivity. It is used for cooling (e.g. superconductors), filling balloons and aircrafts. Due to its low solubility in blood plasma, it is one of the components of the breathing mixture for deep-water diving. Helium is a widely available gas and stored in compressed gas cylinders (with a helium purity of around 99.99%). Because of the very low density of helium, its medical application is gaining more and more importance, especially in surgery, neurology, radiology and high-resolution ionic microscopy [1].

Over recent years helium suffocation has also become frequently used method of suicidal death, including the terminally ill who are fighting for the right to legalize “assisted suicide” [2, 3]. The first case of asphyxiation with helium was described in 2002 and since then the number of such deaths all over the world, including Poland, has been growing [3, 4].

Using a neutral gas is intended to accelerate the suffocation process. Helium inhalation is overtly "promoted" as an "easy, quick and painless" method of committing suicide. Due to its properties, helium quickly replaces oxygen and other gases in the breathing mixture.

This decreases breathing effort and, if helium is inhaled from a bag put over the head, is thought to cause an almost instantaneous loss of consciousness [4, 5].

The present paper describes a case of suicidal asphyxiation with helium inhaled from a UN1046 gas cylinder with 99.99% helium, used for filling balloons. The fatal asphyxiation with helium was confirmed by means of a chemical-toxicological analysis using gas chromatography combined with mass spectrometry.

CASE REPORT

The body of a 29-year-old man was discovered in his rented, locked flat. The corpse was situated in a reclining position on a sofa. A plastic bag over the man's head was tightly wrapped around the neck with tape and connected to a cylinder with compressed helium on the floor by means of a narrow plastic tube (Fig. 1).

The ambulance team who arrived at the scene confirmed the patient's death, determining the cause as suicidal gas poisoning.
**MATERIALS AND METHODS**

The toxicological tests were performed using chemical reagents of analytical purity (over 99.9%), analyzing blanks and control samples.

**Sampling**

Due to the extreme volatility of helium and the necessity to replace the carrier gas in the gas chromatograph, i.e. helium, with nitrogen, the collection of gas samples and the instrumental analysis were initially divided into two phases. The gas samples were already taken during the forensic autopsy and the instrumental analysis in the GC/MS system was performed over the following days (3-5 days later). The gas sampling procedure described by Musshoff et al. [6] was modified for helium analyses. Before collecting the gas for tests, 20 glass containers of 20 ml volume were prepared for the purpose of headspace analysis. The containers were filled to the brim with deionized water and sealed with an aluminum cap with a Teflon gasket. Gas samples were taken in two ways (Fig. 2):

**Variant I:** a lung was placed in a 10 L plastic bucket which was filled with water. The bucket was put in a tub filled with water. Then the bucket was turned upside down in the water in such a way as to prevent air from getting inside. Any air left in the bucket was sucked out with a 20 ml syringe and the site of injection was sealed. The lung was vigorously pressed underwater to release gas which accumulated under the bottom of the bucket.

**Variant II:** a lung was placed in a grip seal plastic bag of approximately 1 L and tightly sealed. A silicone gasket was taped to the outer side and around the middle of the bag. The sealed bag was placed on a heating plate and heated at 50°C similarly as proposed in the recent report by Tanaka et al. [7] for 1 h. After that the bag was manually pressed for about 2 min just before collecting a gas sample.

A sample of the released gas was collected with a syringe and a needle through the bucket bottom (variant I) or the gasket taped to the bag (variant II) and transferred to a container with deionized water, sealed with a cap with a gasket. While the gaseous sample was pumped into the HS container, the deionized water was pushed out of the container through the other opening. A blank test (sudden death due to natural cause) and control helium tests were analyzed at the same procedure.

**Toxicological analysis**

**Gaseous samples**

The gaseous samples were analyzed by means of gas chromatography combined with a GC/MS-SIM mass spectrometer, using a DSQ Trace gas chromatograph from ThermoFinnigan, working under the following conditions: Rtx–5 MS capillary column (30 m x 0.25 mm x 0.25 µm); dispenser temperature: 100°C; isothermal furnace temperature: 120°C; carrier gas – nitrogen; ion analysis using the selected ion monitoring (SIM) technique for: helium (4 m/z), methane (16 m/z), water (18 m/z), oxygen (32 m/z), argon (40 m/z) and carbon dioxide (44 m/z). Before the GC/MC analyses began, the working conditions were stabilized using nitrogen (instead of the routinely used helium).

**Biological samples**

The test for ethyl alcohol was performed using the reference method of headspace analysis and gas chromatography with flame ionization detection (HS-GC/FID) ("TriPlus" analyzer and "Focus GC" gas chromatograph from ThermoFinnigan). The immunochemical urine analysis was performed by means of plate tests, TOX/See Drug Screen Test, from BIO-RAD, to detect: amphetamine and its analogs, methamphetamine and its analogs, benzodiazepines, barbiturates, cocaine and its metabolites, cannabinoids, opioids, and tricyclic antidepressants.
Figure 3. GC/MS-SIM qualitative analysis of gas samples collected from the deceased man's lung including the detected helium (RT=1.5 min), prepared at a raised temperature of 50°C in variant II (a) and at room temperature in variant I (b) in juxtaposition with the negative result of the blank (c).

Table 1. Cases of suicidal helium asphyxiation 2002-2013 (M - male, F - female)

<table>
<thead>
<tr>
<th>No.</th>
<th>Age</th>
<th>Sex</th>
<th>Circumstances of death</th>
<th>Medical history</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>39</td>
<td>M</td>
<td>The man was found lying on the floor with a plastic bag over his head. The bag was tied with rubber tape around the neck and connected by a plastic tube to a 10-liter container with helium.</td>
<td>No information on medical history²</td>
</tr>
<tr>
<td>2</td>
<td>28</td>
<td>M</td>
<td>A 10-liter cylinder with helium was found near the body, connected by plastic tubes to a plastic bag over the head; in his suicide note the man wrote that his illness was the reason for suicide.</td>
<td>Paranoid schizophrenia²</td>
</tr>
<tr>
<td>3</td>
<td>39</td>
<td>M</td>
<td>The man was found in an empty bathtub with a plastic mask over his face. A plastic tube connected a nearby container with industrial helium to the victim's plastic mask; a suicide note and publications on suicide were found.</td>
<td>No information on medical history²</td>
</tr>
<tr>
<td>4</td>
<td>31</td>
<td>M</td>
<td>Apart from a plastic bag over the head, there was a system made of a plastic tube supplying gas from a cylinder; the autopsy showed petechiae in the conjunctivae and under the epicardium.</td>
<td>No information on medical history³</td>
</tr>
<tr>
<td>5</td>
<td>30</td>
<td>F</td>
<td>The woman was found dead in bed on her 30th birthday; a plastic bag over her head was connected via a tube to a cylinder with helium used for filling balloons; a suicide note and last will were found beside the victim.</td>
<td>No information on medical history⁴</td>
</tr>
<tr>
<td>6</td>
<td>30s</td>
<td>M</td>
<td>The man was found outside his house, leaning on a fence, with his head covered with a plastic bag connected to two helium cylinders by a vinyl tube. Helium was detected in the tracheal gas and lung tissue.</td>
<td>No information on medical history⁴</td>
</tr>
<tr>
<td>7</td>
<td>23</td>
<td>M</td>
<td>The man was found dead lying with a plastic bag over his head; next to him there was an almost empty bottle of tequila, a pack of diphenhydramine and ibuprofen.</td>
<td>No information on medical history⁴</td>
</tr>
<tr>
<td>8</td>
<td>25</td>
<td>M</td>
<td>Before death the man was an active member of web discussion forums on suicide and searched for information related to the topic. Five weeks before death he participated in an online questionnaire on depression.</td>
<td>Affective disorders. In psychiatric care for more than a year before death⁵</td>
</tr>
</tbody>
</table>
RESULTS

The results of the autopsy showed cerebral edema with signs of bilateral transtentorial herniation, pulmonary congestion and edema, features of sudden death; no traumatic lesions within the integuments and internal organs. Moreover, the inspection of the body revealed droplets of liquid on the inside of the plastic bag and on the face, which suggests that the person was breathing and alive at the time of putting the bag over his head.

The GC/MS-SIM chemical-toxicological examination of the lung samples showed that helium (retention time = 1.5 min) was present at a slightly higher concentration when the gas was collected at a temperature raised to 50°C according to Variant II (a) than at room temperature in Variant I (b). The blind test for helium was negative (c) (Fig 3).

Moreover, the chemical-toxicological examination of blood and urine collected during autopsy did not detect ethanol. The immunochemical analysis of urine was negative for the most common above-mentioned psychoactive substances.

DISCUSSION

Cases of suicidal asphyxiation with helium have recently been published in literature (Table 1) [2, 4, 6-9]. The suicides, usually young men, put plastic bags over their heads tightly sealed with a helium supply system attached. Literature points to the fact that in plastic bag suffocation cases there may be no changes characteristic of death by suffocation detected during an autopsy, while other findings (i.e. signs of sudden death, internal organs congestion, pulmonary edema, subconjunctival petechiae, cyanosis) are non-characteristic. In addition, the victims of this form of suicide often used a complex method (complex suicide) and took nervous system depressants, even in toxic and lethal concentrations.

The collection of a gaseous samples from lungs during the autopsy allowed, in both described variants, to confirm the presence of helium in the GC/MS-SIM analysis, which was the only method of determining the cause of death as sudden asphyxia. Otherwise, any conclusions about the cause of death would be based only on the circumstances of finding the body since in such asphyxia cases the autopsy does not usually reveal any morphological changes [10].

CONCLUSIONS

The cause of the man’s death was suffocation by helium inhalation, which was confirmed in a chemical-toxicological analysis in the GC/MS-SIM system and corresponded with the circumstances of death. The inhalation of helium caused oxygen to be driven out of the breathing gas mixture and consequently acute hypoxia of the brain.

The suggested modification of the sample collection technique and the research method used for the determination of helium in the lungs (GC/MS-SIM) proved effective. The study shows that in cases of suspected death by helium asphyxiation it is advisable to conduct a chemical-toxicological test to detect helium in the lungs instead of an autopsy alone. Such an analysis is possible and finally supports the conclusion of the asphyxia as a cause of death.

References