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Volatile lipophilic substances management in case of fatal sniffing

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ABSTRACT

Death due to inhalation of aliphatic hydrocarbons such as butane and propane is a particularly serious problem worldwide, resulting in several fatal cases of sniffing these volatile substances in order to "get high". Despite the number of cases published, there is not a unique approach to case management of fatal sniffing. In this paper we illustrate the volatile lipophilic substances management in a case of a prisoner died after sniffing a butane-propane gas mixture from prefilled camping stove gas canisters, discussing the comprehensive approach of the crime scene, the autopsy, histology and toxicology.

A large set of accurate values of both butane and propane was obtained by gas chromatography–mass spectrometry analyzing the following post-mortem biological samples: peripheral blood, heart blood, vitreous humor, liver, lung, heart, brain/cerebral cortex, fat tissue, kidney, and allowed an in depth discussion about the cause of death. A key role is played by following the proper sampling approach during autopsy.

1. Introduction and background

Inhalants' abuse in order to "get high", now commonly referred to as volatile substance abuse (VSA) or volatile substance misuse (VSM) has become increasingly popular among young people and represents a social problem in many countries worldwide. Propane and n-butane are two volatile alkanes having respectively 3 and 4 carbon atoms in line. They are both easily distributed to lipid-rich tissues such as the brain and have sedative effect on the central nervous system. Propane is less toxic than n-butane or isobutane, having a weaker anesthetic effect.[1] Hypoxia of the tissues by oxygen depletion can therefore be the mechanism of death of victims of such gases.[2] Butane has adverse effects on the central nervous system, and butane-associated encephalopathy has been reported. The cause of death due to butane inhalation is primarily presumed to be cardiac arrhythmia, even though butane is also known to cause other organs, including the central nervous system, and the lungs to fail.[3] Moreover butane is reported to sensitize the heart to circulating catecholamines, such that sudden alarm or exercise (for example fright or running) may precipitate sudden death.[4] In Italy, one of the most common forms of VSA consists in sniffing gas directly from camping gas refill cylinders, which is a widespread phenomenon among the prison population that is allowed to use camping gas stoves.

There are reported cases of ventricular fibrillation in patients misusing butane,[5] and both propane and butane are reported to precipitate fatal arrhythmias through the stimulation of the vagus nerve.[6] Moreover several fatal intoxications due to butane,[7] propane[6] or mixtures containing both propane and butane[8,9] are reported.

Authors want to give their contribution by reporting for the first time accurate values of both butane and propane in a large set of post-mortem biological samples (peripheral blood, heart blood, vitreous humor, liver, lung, heart, brain/cerebral cortex, fat tissue, kidney). Starting from a lethal case occurred in a prison, where a 29-year-old prisoner was found dead by his cellmate, we describe the forensic investigation that led us to determine the cause of death.

2. Case report

2.1. Summary

A 29-year-old man, well nourished, was found unconscious by his cellmate on the floor of the bathroom of his cell. The cellmate, awakened by the strong smell of gas, rushed into the bathroom and

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found the man unconscious next to a camping gas stove with gas escaping (Fig. 1). The Emergency Medical Technicians attempted cardiac massage, but the man was declared dead shortly after and the body was moved to the morgue.

2.2. Site survey

The prison cell was examined in cooperation with scene of crime officers (SOCOs), two camping stoves were found, one in the bathroom and the other on the table of the cell. These proofs, jointly to a white glue pack, two capsules and one circular tablet were collected, recording the site of their retrieval in the scene of crime notes, for further forensic examination and chemical analysis.

2.3. Autopsy findings

2.3.1. External examination

The deceased was a male, 185 cm in height and 84.5 kg in weight; he was transferred to the morgue after being declared dead at the prison cell, where the clothes were removed during resuscitation. The autopsy was performed 26 h after the death.

External examination showed no evidence of injuries and the presence of subepidermal petechial hemorrhages on the rear region of the chest.

2.3.2. Internal examination

The internal examination of the head showed an intense passive congestion of the meningeal vessels. Specimens were collected from the brain for histological and toxicological analysis. In order to collect gas samples from the trachea and the bronchi limiting contamination, the dissection of the neck was carried out skeletonizing the larynx and the trachea *in situ* without manipulating the respiratory tract below the larynx. The dissection of the thorax allowed the exposure of the main bronchi *in situ*, as well. The gas contained in the trachea and the two main bronchi was drawn before any discontinuation of the airways occurred. In particular, the gas content of the right bronchus was collected using a 10 ml plastic disposable syringe while a Hamilton gas-tight syringe was used to draw air from the left bronchus (Fig. 2); the collected syringes were wrapped in Parafilm® M (Pechiney Plastic Packaging Company, Menasha, WI, USA) and further submitted to toxicological examination.

Proceeding with the autopsy, the entire surface of the right lung showed emphysematous bubbles, mostly gathered on the inferior lobe. Evidence of rarer and smaller bubbles was visible on the left lung. The exploration of the tracheobronchial mucosa revealed intense hyperemia with mucous material mixed with air bubbles. Given the young age of the victim the macroscopic examination of the heart was deferred until complete formalin fixation of the eviscerated organ, only a small specimen of the heart was immediately collected in a gas tight container and stored at −20 °C for further toxicological examination.

Samples of heart blood, peripheral blood, gastric content, urine, bile, vitreous humor, in addition to specimens of subepidermal fat tissue, lungs, liver, kidneys were also collected in separate gas-tight containers, stored at −20 °C for the same purpose.

Macroscopic examination of the body did not reveal any other elements of interest. Specimens of the lungs including the areas showing macroscopic evidence of emphysema, specimens of the liver, kidneys, spleen and pancreas were collected for further histological analysis.

The macroscopic examination of the heart after formalin fixation identified a bilateral dilatation of ventricular cavities (3.5 cm left and 3 cm right), a diffuse opacification of the endocardium and focal fibrosis of the myocardial tissue with pervious coronary arteries; specimens of the heart including the coronary arteries were collected for histological analysis.

2.3.3. Histological findings

A routine microscopic histopathological study was performed on specimens fixed by using buffered formalin 10%, embedded in paraffin and stained with hematoxylin/eosin. All specimens were examined with a light microscope (DMLB 100T Leica, Wetzlar) connected with a photo-camera computer system (DFC 320 Leica, Heerbrugg); all the images were saved using IrfanView v. 4.22.

The observation of the specimens showed the following significant elements. The heart sections revealed stretched and wavy myocells consistent with dilation of the ventricular chambers; the nuclei of the myocells appeared enlarged and the intramural

Fig. 1. Camping gas stove found on the floor close to the victim.

Fig. 2. Air withdrawal from the right bronchus with a 10 mL disposable syringe.