Volatile substance related deaths: a simple and safe autopsy procedure for sampling and preserving aliphatic hydrocarbons

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Abstract

Volatile substance abuse in order to “get high” is a widespread problem especially among adolescents and young-adults, with significant rates of morbidity and mortality.

Despite the studies conducted on this topic, collection and preservation of volatile substances in forensic context is still a matter of debate: there are several scientific papers describing materials and procedures for volatile substance sampling while performing post mortem examinations and how they influence the development of the forensic case. Most of the proposed techniques involve the use of specific, and sometimes expensive, gas tight materials that are not always available.

The aim of this paper is to share a simple method for rapid and effective volatile substance sampling that can be used in both evident and suspected VSA-related deaths. The strength of this procedure is to be applicable even in cases when specific gas tight instruments for sampling, collection and preservation of volatile substances are not available.

Key words: forensic science, forensic toxicology, volatile substance abuse, butane-propane poisoning, death in custody, sudden sniffing death syndrome, aliphatic hydrocarbons, forensic pathology

Introduction

Abuse of butane and propane in order to “get high” is a social problem in many countries; the issue rises because of the legally, affordable and easy way in which people can find these substances in the free market (e.g., as lighters, replacement cartridges for burners, gas lanterns, etc.) (1 - 4).

The phenomenon of inhaling volatile substances directly from gas refill cylinders, widely observed in Italian prisons because such cylinders are admitted into prison cells by law, resulted in the necessity for a special legal regulation that tried to hinder this potentially lethal behavior (5).

Volatile substance abuse (VSA) occurs by inhaling a substance directly from its container (“sniffing” or “snorting”), placing a rag soaked in the substance over the nose and mouth and inhaling (“huffing”), or pouring the substance into a plastic bag and breathing the fumes (“bagging”) (2, 6). It represents a widespread problem, especially among adolescents and young-adults, with significant rates of morbidity and mortality (7,8).

Propane and butane are both easily distributed to lipid-rich tissues because of their high lipid solubility (8); they act mainly as central nervous system (CNS) depressants or asphyxiating agent causing hypoxia by oxygen displacement with other side effects such as increasing of ROS (2,7,10).

Acute toxic effects of these substances include confusion, headache, diplopia, weakness, nausea/vomiting, dizziness, euphoria, hallucinations, convulsions, coma, cardiac arrhythmias, respiratory depression and death (11).

With regard to the toxic effects, butane has been reported to be more toxic than propane (12), the latter of which acts on oxygen depletion, having a weaker anesthetic effect than butane (13,14).

When death occurs, the mechanism of action has been presumed to be caused by cardiac arrhythmia sustained by ventricular tachycardia (15), ventricular fibrillation (16), vagal stimulation (17) and stimulation of endogenous catecholamine release (1); nevertheless, central neurogenic respiratory depression (7,18), aspiration of vomit and laryngeal edema (19) have been reported as well.

Despite the studies conducted on this topic, collection and preservation of volatile substances in a forensic context is still a matter of debate: there are several scientific papers describing materials and procedures for volatile substance sampling while performing post mortem examinations and how they influence the development of the forensic case. Most of the proposed techniques involve the use of specific, and sometimes expensive, gas tight materials that are not always available.

The aim of our paper is to share a simple method for a rapid and safe volatile substance sampling, that we have applied in a recent case of VSA-related death (20). This method can be used in cases of both evident or suspected VSA.

The strength of this procedure is to be applicable even in cases when specific instruments for collection and preservation of volatile substances are not available.
Materials and Methods

To perform the presented procedure, a 10 mL plastic syringe and Parafilm®; a Hamilton® 500 µL gastight syringe, with a gastight vial was used in order to compare the quality of the samples and to analyze if qualitative and quantitative differences in volatile substance sampling occurred between the use of normal syringes and gas-tight syringes.

The first step consists in collecting gas samples from bronchi, limiting contamination. To reach this target, the dissection of the neck was performed by skeletonizing the larynx and the trachea in situ; the dissection of the thorax was performed exposing the main bronchi in situ as well, without manipulating the respiratory tract, guaranteeing the anatomical continuity of the anterior mediastinum structures. If emphysematous bubbles are present, as in this case, these should be preserved.

In the presented case (20), the air contained in the right bronchus (Fig. 1a) and in the emphysematous bubbles (Fig. 1b) were collected using 10 mL plastic syringes, immediately wrapped in Parafilm® after the aspiration (Fig. 1c) in order to improve their seal capacity and sent to our laboratory of toxicology for further analysis.

Once in the laboratory, volatile compounds collected using plastic syringes, were treated according to validated gas sampling analysis protocols (21-23) by putting the syringe content into gastight vials containing stabilized water, before the headspace gas chromatography-mass spectrometry (GC-MS) analysis.

As a comparative method, air was collected from the left bronchus using a “Hamilton®” 500 µL gastight syringe (Fig. 1d), which content was immediately put in a gas-tight vial and later analyzed with the same procedures.

Samples of heart and peripheral blood, vitreous humor, brain, heart, lungs, liver, kidneys, subepidermal fat tissue, were also collected in separate gastight containers, stored at -20 °C for the same purpose.
Results

The collected substances, analyzed using an Agilent® 6890N GC, combined with a headspace gas autosampler, and coupled with an Agilent® 5973 mass spectrometer, identified butane and propane in all samples withdrawn using both 10 mL plastic syringes and “Hamilton®” 500 µL gastight syringe.

Toxicological data obtained from the analysis of post-mortem biological samples (e.g., heart and peripheral blood, vitreous humor, brain, etc.) were positive for both propane and butane, showing a complete distribution inside the body.

Discussion

Results obtained from the analysis of volatile substances collected with the plastic syringe sealed with Parafilm®, showed us that this method does not guarantee a total gastight closure, failing to avoid leaking of suspect volatiles. Nevertheless, these results permitted us to identify the presence of both butane and propane, allowing a reliable qualitative analysis of the samples.

The comparative analysis, performed using samples collected with the Hamilton® gas-tight syringe confirmed the qualitative analysis, without showing any differences in term of qualitative results.

In conclusion, even if the use plastic disposable syringes wrapped in Parafilm® do not allow a quantitative analysis of the collected samples, this collection technique provides a good and reliable qualitative identification of volatile substances, without showing any differences with the most expensive, and less common, gas-tight syringes. These results can be very helpful in all scenarios in which a suspected or confirmed VSA related deaths has occurred, and in which specific instruments and materials are not available in the autopsy room.

References

5. Spaces for the packaging and administration of the board, use of stove on Decree of the President of the Republic n. 230 - Regulations containing the provisions concerning the penitentiary and the measures which deprive or limit freedom (2000)


