

An autopsy case of fuel gas abuse

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Abstract: A case of fatal fuel gas poisoning in a teenager is presented. Quantitative toxicological analysis showed that the concentration of n-butane, isobutane and propane in the femoral blood were 1.22 μ l/ml, 0.20 μ l/ml and 1.16 μ l/ml, respectively. Severe congestion of the lungs was also observed. We concluded that the cause of death of the victim was due to cardiac arrhythmia induced by the abuse of the fuel gas containing butane.

Key Words: butane, inhalation, abuse, fuel gas, volatile substance.

The n-butane, a low molecular weight aliphatic hydrocarbon, is a colorless and flammable gas used commercially as a fuel source and/or a propellant [1]. It is usually mixed with propane and isobutane to produce a commercially available fuel [2].

In case of fuel gas abuse, the cause of death may be due to asphyxia, vagal inhibition, respiratory depression or cardiac arrhythmia [3, 4]. In Japan, approximately 10 cases of fatal fuel gas poisoning are reported annually [5]. Here we report a case of death caused by inhalation of fuel gas containing n-butane.

Case history

A male in his late teens (height 155cm, weight 62.5kg) suddenly collapsed on a vacant lot and was subsequently transferred to a hospital. He was in cardiopulmonary arrest at the time of arrival at the hospital, and resuscitation attempts were unsuccessful. Several bottles of lighter refills gas canisters were found during the subsequent investigation by the authorities, and the components of the gas were n-butane, isobutane and propane. His friend stated that he had sprayed the gas into a plastic bag, and sniffed the contents over the previous ten or twenty minutes.

Autopsy findings indicated no evidence of external injury. The heart weighed 303g contained 160ml of blood without coagula, and the brain weighed 1460g,

neither having any abnormal findings. The left and right lungs weighed 890 and 1006g, respectively, and were severely congested. The trachea contained reddish frothy fluid. Histological examination revealed that the lungs showed marked congestion, alveolar hemorrhage and edema.

Drug screening test using a TriageTM (Biosite Diagnostic Inc, San Diego, USA) panel was negative. No ethanol was detected by head-space gas chromatography. Postmortem blood and tissue samples were collected for toxicological examination and kept at -70 °C until analysis. Toxicological analysis was performed using gas chromatography-mass spectrometry, and the concentration of n-butane was determined by head-space gas chromatography, according to the method of Ago et al [6].

Results and Discussion

The n-butane, isobutane and propane were identified by toxicological examination. The concentration of each component in the blood and tissues are shown in Table 1. As the fuel gas was a mixture of n-butane, isobutene and propane [2], we have to consider the toxicity of each component. However, as n-butane is a main component in commercially available fuels, and more toxic than propane [6-8], the concentration of n-butane may be used as a good indicator for the

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Table 1: Blood and tissue concentrations of each component ($\mu\text{l/ml}$).

	blood	lung	liver	brain
n-butane	1.22	1.97 (1.61)	4.26 (3.49)	5.44 (4.46)
propane	1.16	2.71 (2.34)	2.92 (2.52)	4.95 (4.27)
isobutane	0.20	0.59 (2.95)	1.42 (7.1)	1.94 (9.7)

evaluation of toxicity [9].

Blood concentration in the present case was within the range of previously reported fatal cases of n-butane abuse (0.11-15.3 $\mu\text{l/ml}$) [6-14]. It has been reported that the fatal concentration of n-butane has a wide range, and in relatively lower concentrations (less than 8 $\mu\text{l/ml}$) the cause of death has been due to cardiac arrhythmia [15]. In fatal cases of inhalation of gases containing n-butane, the most common cause of death is cardiac arrhythmia due to the sensitization of the heart to adrenaline [4,16].

The concentration of propane and isobutane in the present case were also within the fatal ranges of previous reported cases (propane: 0.01-10.19 $\mu\text{l/ml}$ and isobutane: 0.03-1.8 $\mu\text{l/ml}$), respectively [7,8,10-13]. From the autopsy findings, histological findings and the

results of the toxicological examination, we concluded that the cause of death was cardiac arrhythmia due to fuel gas abuse.

In the present case, the blood or tissue concentrations of the gases were blood < lung < liver < brain for each component.

The concentrations in the lungs were higher than those in blood. Although there is a report which describes a large variation of gas levels in lungs [17], this may simply indicate the inhalation of the high concentration of fuel gas. The brain / blood concentration ratio of n-butane in fatal cases ranged from 0.75-4.16, as in a previous report [6-8, 10-13]. The brain concentrations of lipophilic substances, such as toluene are relatively constant, but blood concentration decrease gradually in the postmortem period [18]. It has been pointed out that brain levels of toluene are useful for the estimation of blood toluene levels at the time of death [18].

Since n-butane has highly lipophilic properties, we may have to consider the effects of diffusion from blood to surrounding fat rich tissues in a postmortem interval. Thus n-butane levels in the brain may be useful for estimating the concentration in the blood at the time of death. Further studies will be required to clarify this.

References

- Baselt RC. Disposition of toxic drugs and chemicals in man. 5th ed. Foster City: Chemical Toxicology Institute; 2000.
- Naito H. Poisoning of industrial products, gases, pesticides, drugs and natural toxins –cases, pathogenesis and its treatment-. 2nd ed. Tokyo: Nankodo; 2001.
- Ashton CH. Solvent abuse. *BMJ* 1990; 300: 135-6.
- Shepherd RT. Mechanism of sudden death associated with exposure to volatile substance abuse. *Hum Toxicol* 1989; 8: 287-92.
- National Research Institute of Police Science. Annual case report of drug and toxic poisoning in Japan (No49-53). Kashiwa: National Police Agency; 2007-2011.
- Ago M, Ago K, Ogata M. A fatal case of n-butane poisoning after inhaling anti-perspiration aerosol deodorant. *Legal Med* 2002; 4: 113-8.
- Nishi K, Ito N, Mizumoto J, Wada K, Yamada T, Mitsukuni Y, Kamimura S. Death associated with butane inhalation: report of a case. *Nihon Houigaku Zasshi* 1985; 39: 214-6.
- Sugie H, Sasaki C, Hashimoto C, Takeshita H, Nagai T, Nakamura S, Furukawa M, Nishikawa T, Kurihara K. Three cases of sudden death due to butane or propane gas inhalation: analysis of tissues for gas components. *Forensic Sci Int* 2004; 143: 211-4.
- Tanaka N, Kinoshita H, Takatsu M, Kuse A, Jamal M, Ohkubo E, Nagasaki Y, Yoshioka N, Asano M, Ueno Y, Ameno K. A fatal case of butane gas inhalation. *Current study of environmental and medical sciences*. 2010; 3: 15-6.
- Aoki T, Namiki T, Fukuie N. A case of sudden death after inhalation gas which is used for gas lighters. *Acta Crim Jpn* 1982; 48: 202-4.
- Terada M, Watanabe T, Kashiwade H, Yoshimura S. An autopsy case of a sudden death due to inhalation on butane gas. *Nihon Houigaku Zasshi* 1983; 37: 696.
- Fuke C, Miyazaki T, Arao T, Morinaga Y, Takaesu H, Takeda T, Iwamasa T. A fatal case considered to be due to cardiac arrhythmia associated with butane inhalation. *Legal Med* 2002; 4: 134-8.
- Jackowski C, Römhild W, Aebi B, Bernhard W, Krause D, Dirnhofer R. Autoerotic accident by inhalation of propane-butane gas mixture. *Am J Forensic Med Pathol* 2005; 26: 355-59.
- Tanaka N, Kinoshita H, Haba R, Jamal M, Ohkubo E, Ameno K. An autopsy case of butane gas abuse. *Soud Lek* 2010; 55: 44-45.
- Naito H. *Yakubutu ranyou, tyuudoku hyakka*. Tokyo: Maruzen; 2011.
- Rohrig TP. Sudden death due to butane inhalation. *Am J Forensic Med Pathol* 1997; 18: 299-302.
- Nagata T, Kojima T, Makisumi S. Quantitative gas chromatographic determination of propane and LP (liquefied petroleum) gas in biological materials. *Nihon Houigaku Zasshi* 1971; 25: 439-44.
- Kiri T, Ameno K, Fuku C, Ameno S, Shinohara T, Sogo K, Ijiri I. Experimental studies of postmortem diffusion of toluene in blood, brain, muscle and fat of rats exposed to toluene vapor. *Nihon Houigaku Zasshi* 1993; 47: 29-32.