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FATAL NITROUS OXIDE ABUSE

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ABSTRACT

Nitrous oxide (N_2O), or "laughing gas," is readily available from a variety of sources. Inhalation of N_2O is often regarded as safe by those who abuse the gas. We report a case of fatal accidental asphyxia due to nitrous oxide abuse.

RÉSUMÉ

L'oxyde d'azote (N_2O) ou "gaz hilarant" peut être facilement obtenu à plusieurs endroits. L'inhalation du N_2O est souvent considérée comme étant sans danger par les personnes qui l'utilisent à des fins abusives. Une enquête de décès résultant d'une asphyxie accidentelle causée par l'oxyde d'azote est présentée dans cet article.

INTRODUCTION

Nitrous oxide is commonly used by medical professionals as an analgesic/anesthetic agent. The gas is also used in food-processing and other industries. The relative availability of N_2O in these settings makes its acquisition rather simple. Consequently, inhalation abuse of N_2O is not uncommon. Many of those who abuse the gas erroneously believe that N_2O has no adverse side-effects. We present a case of asphyxial death related to the abuse of N_2O. We also discuss the morbidity and mortality associated with the abuse of this drug.

CASE REPORT

A recently married, 28 year old white male graduate student worked part-time in a research laboratory at a local teaching hospital. On an evening he was to be home early, his wife became worried when he had not returned by 2300. Several unsuccessful attempts at contacting him by telephone prompted her to contact hospital security. Security officers entered the laboratory and found the decedent laying on his back on the floor. A large black plastic bag was wrapped around his face and head (figure 1). Foul play was suspected, thus local police and the medical examiner were called to the scene.

Police and security officers initially suspected that the decedent had been strangled, but subsequent investigation by the medical examiner laid this suspicion to rest. Despite the fact that the plastic garbage bag appeared to be tightly about the decedent's neck and face (figure 2), examination at the scene revealed no evidence of trauma. An unusual finding was the presence of a large portion of the bag [about 8 inches (20 cm) in length] within the decedent's oral cavity. Further scene investigation uncovered a nearly-empty nitrous oxide tank (figure 3) in an adjoining room. Asphyxial death due to N_2O abuse was suspected.

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Figure 1. Decedent on floor of laboratory with black plastic bag wrapped around head and face.

A complete postmortem examination demonstrated no anatomic cause of death. Blood and lung N_2O levels were 35 μg/mL and 45 μg/mL, respectively. Subsequent inquiries revealed that the decedent had previously abused N_2O. No evidence of suicidal intent was detected. The cause of death was asphyxia secondary to N_2O inhalation. The manner of death was accidental.

DISCUSSION

Nitrous oxide is a tasteless, colorless, odorless gas (1,2) which is nonflammable and heavier than air (2,3). It was first prepared by Joseph Priestly in 1776 (2) and later used by Horace Wells as an anesthetic agent during dental extractions (4). Since that time, N_2O has been widely recognized as an analgesic/anesthetic agent. The gas is readily absorbed into the bloodstream through the lungs; N_2O does not bind to hemoglobin but instead enters directly into the blood solution (2, 3). Various studies suggest that N_2O-induced analgesia is mediated through the endogenous opioid system (5, 6). N_2O is a myocardial depressant but also activates the sympathetic nervous system, resulting in decreased cardiac output, increased systemic vascular resistance, increased blood pressure, and increased cardiac work (4). Since N_2O can displace oxygen within the lungs, oxygen should always be administered along with N_2O. The safest level of N_2O which can be administered in combination with oxygen is 70%, with short periods of 80% allowable in certain instances (2). Excretion of N_2O is via the lungs. It is not metabolized within the body and it is excreted unchanged (2, 3).

Nitrous oxide is ideal for use in food-manufacturing processes because of its bacteriostatic properties (1, 2). It is commonly used in whipped-cream cartridges (2, 6, 7) and in pre-mixed whipped-cream cannisters (6-9) throughout the United States and Canada.

Figure 2. Closer view of plastic bag around decedent's face. Note how bag appears to radiate from the position of the mouth; a portion of the bag was within the decedent's oral cavity.

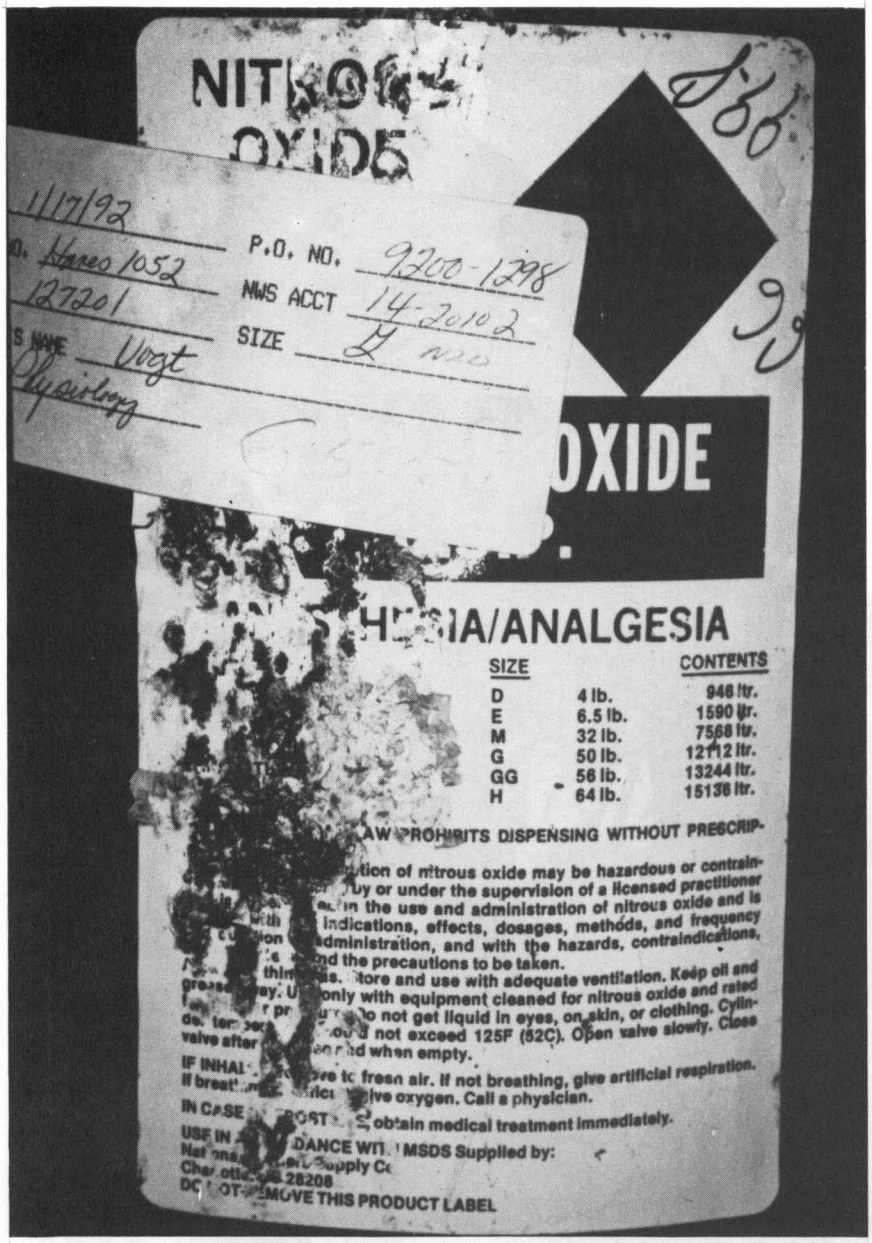

Figure 3. Close-up view of the label on the nitrous oxide tank found in an adjoining room.

The gas is available in large tanks for medical (2, 3, 6, 7, 9) and industrial/racing engine use (6, 10), and it can also be produced at home (8, 11). Directions for producing homemade N_2O and/or obtaining the gas by other means are readily available from various drug paraphernalia stores and publications (11, 12).

Methods of N_2O-inhalation include utilization of an anesthetic machine/mask (6, 10, 13), direct inhalation from tanks with or without regulator valves (2), direct inhalation from whipped-cream cannisters (8, 9), and inhalation from previously-filled reservoirs, such as plastic bags (1, 8), surgical gloves (13), and balloons (2, 3, 7, 8, 14).

Inhalation of N_2O causes pleasurable feelings and an exhilarating "high" (14). N_2O has been described as the "perfect drug" and "instant ecstacy" (8). One user reportedly exclaimed that N_2O was "everything I expected heroin to be and more" (8); another said that it was "better than coke" (8). Other N_2O-induced sensations include "head-rushes," tingling, auditory illusions (14), feelings of warmth (8, 14) and shudders of excitement similar to those produced by orgasm (8). Body spasms and convulsions can occur but may be related to lack of oxygen (8). N_2O is said to decrease inhibitions and make the user more spontaneous (8). Some religious groups use N_2O to aid in attaining deep, "quality" meditation (8, 15). Finally, some users describe an uncontrollable urge to suck while using N_2O (8); this may explain the presence of a large portion of the plastic bag within the oral cavity of the decedent in the present case.

Some proponents of N_2O-abuse claim that the gas is not addictive (8); however, more reliable sources report that tolerance, psychological dependence and addictive behavior are associated with N_2O-abuse (1).

Acute adverse effects reported with N_2O use include nausea (7, 8, 14), bloating, dry throat, head pressure, mild suspiciousness (14), uncomfortable feelings, cyanosis (7), and convulsions (8). Significant deficiencies in cognitive function occur transiently during the "high" produced by N_2O (14) and severe respiratory problems can result from impurities present within homemade nitrous oxide (11).

Bone marrow suppression with megaloblastic changes can occur in persons exposed to N_2O for prolonged periods (15, 16). Such changes suggest that N_2O interferes with deoxyribonucleic acid metabolism, perhaps by inhibiting the action of vitamin B12 (16).

Neurological disturbances have also been reported with prolonged N_2O exposure (8, 13, 17). Symptoms include weakness, numbness, tingling (13, 17), incoordination (8, 13, 17), impotence, sphincter disturbances, ataxia (13), aphasia, and amnesia (17). Lhermitte sign (an "electric shock" radiating up and/or down the back and legs induced by neck flexion) can also be present (13, 17). N_2O-induced neurologic manifestations, which are at least partially reversible, are similar to those seen in subacute combined degeneration of the spinal cord and suggest that N_2O may also interfere with the action of vitamin B12 in the nervous system (13).

Other adverse effects of N_2O abuse are related to the mechanics of inhalation. Pneumomediastinum can result from the pressure of the gas if it is inhaled directly from pressurized tanks (1). In addition, users can cause freeze injuries to their lips if they inhale directly from the nozzle of a tank (8). Most importantly, however, is the fact that severe hypoxia can occur with inhalation of N_2O. Asphyxial death can result if the user becomes unconscious and reservoir devices, such as plastic bags, prevent respiration of ambient air (2, 6, 8). Improper use of anesthesia equipment can similarly prevent inhalation of oxygen (6, 18). Alternatively, N_2O-induced unconsciousness within an enclosed space, such as an automobile, can lead to asphyxial death due to displacement of ambient oxygen

by N_2O (3, 6, 8). Traumatic deaths can also result from impaired cognition caused by N_2O inhalation (6).

Most deaths from N_2O use are accidental (1, 2, 6, 18, 19). Occasional anesthesia misfortunes occur (19), but most accidental N_2O-related deaths are due to abuse. Accidental death due to N_2O-induced hypoxia during an autoerotic episode has occurred (10), and suicide by N_2O-inhalation has been reported (20).

A thorough scene investigation is essential to detect N_2O-related deaths. The presence of plastic bags, balloons, whipped-cream containers or N_2O tanks must prompt the investigator to consider N_2O abuse. Autopsy findings are nonspecific in deaths due to N_2O-inhalation. Visceral congestion with or without petechiae may be present (2, 3, 6). Occasional cases indicate the presence of vivid pink skin (10, 20), but this is not a consistent finding.

Nitrous oxide is not detected in routine urine or blood drug screens (6). Consequently, the toxicology laboratory should be specifically asked to test for N_2O when its presence is suspected. Toxicologic studies may be performed on a variety of tissues, including blood, lungs, liver, and kidneys (2). Aspiration of intratracheal gas or headspace gas from rubber-stoppered tubes of blood or lung are suitable samples for analysis (2). Unlike some gaseous substances, N_2O is not absorbed by rubber-stoppers (2); therefore, collection of blood or other tissues in rubber-stoppered glass tubes is adequate for toxicological analyses. Care should be taken to leave some air (headspace) above the tissue so that gas can be aspirated from the tubes. Gas chromatography (2, 3), infrared spectroscopy, and mass spectroscopy (2) can be used to reliably measure N_2O levels.

SUMMARY

Nitrous oxide is a readily available, legal drug which can cause significant morbidity and mortality. Medical examiners and other persons who investigate deaths need to be aware of the various means by which N_2O is inhaled. The present case serves to illustrate the importance of scene investigation and proper sample collection for toxicological analysis in such cases.

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