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Four Deaths Resulting from Abuse of Nitrous Oxide

Nitrous oxide is a weak anesthetic gas, used alone for dental work and as an adjunct to more potent anesthetics in major surgical procedures. It is the only inorganic gas that is practical for clinical anesthesia. Like all the anesthetic drugs, nitrous oxide has been subject to abuse. Unlike the other anesthetic agents, where the abuse is almost exclusively by medical personnel, nitrous oxide has been abused by the general public.

Nitrous oxide is an extremely safe gas, even when used without medical supervision. Under certain unusual circumstances, however, it can cause death. Herein are reported four deaths that resulted from nitrous oxide.

Case Reports

Case 1

A 26-year-old white male was found dead in bed, fully clothed, lying on his back. Beside the bed was a large (Size H) cylinder of nitrous oxide. A plastic tube ran from the nozzle of the tank into the deceased's mouth. The gas was on when the body was found.

The deceased was employed as a nurse at a local mental institution. A search of his house revealed three other cylinders of nitrous oxide. A history of nitrous oxide abuse was obtained from a friend. A complete autopsy was performed at the Dallas County Medical Examiner's Office. Autopsy findings were unremarkable except for acute visceral congestion. Toxicological analysis of the blood for acid, basic, and neutral drugs as well as alcohol and other volatile substances revealed the presence of nitrous oxide as well as small quantities of amobarbital and diazepam (Table 1).

Cases 2, 3, and 4

A farmer inspecting his field came upon a parked automobile whose emergency flasher lights were on. When he approached the car, he observed three persons in the vehicle, all apparently unconscious. He opened the doors and pulled all three out. At this time, he observed a large (Size H) blue cylinder of nitrous oxide in the front seat of the vehicle. The valve of the cylinder was on and gas was running from it. On arrival of a fire department ambulance, the three individuals were pronounced dead.

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TABLE 1—*Toxicological analyses.*

Case	Blood Concentration of Nitrous Oxide, ml/dl	Lung Air, %		Other Drugs
		Nitrous Oxide	Oxygen	
1	8.97	...	...	0.10 mg/dl amobarbital 0.01 mg/dl diazepam 0.01 mg/dl demethyldiazepam
2	4.8	13.6	4.9	...
3	9.3	13.6	12.6	...
4	4.6	22.7	4.7	0.01 mg/dl pentazocine

Victim 2, an 18-year-old white female, was found behind the wheel of the vehicle. Victim 3, a 17-year-old white male, was sitting in the front passenger seat. A canister of nitrous oxide was between him and the driver, leaning from the front seat to the back seat through the console area. Victim 4, an 18-year-old white male, was found in the rear seat of the vehicle.

Complete autopsies of all three victims revealed only acute visceral congestion. Complete toxicological screening for acidic, basic, and neutral compounds as well as alcohol and other volatile substances was performed. Nitrous oxide was present in all three victims. The only other drug detected was a small quantity of pentazocine in Victim 4 (Table 1).

The subsequent investigation revealed that the cylinder of nitrous oxide had been stolen from a local medical center.

Toxicology Analyses

A gas chromatograph with a 3-m (10-ft) long by 6.35-mm (0.25-in.) outside diameter column with a size 5A molecular sieve was used. Helium was the carrier gas. The inlet pressure was 69 kPa (10 psi); the injection port temperature was 150°C, the detector temperature 200°C, and the oven temperature (isothermal) 185°C. A thermal conductivity detector was used.

Method for Gases

Nitrous oxide concentrations in the blood samples were determined by bubbling room air through unopened tubes of blood, collected in 10-ml Vacutainers®, at room temperature, and 20 ml of headspace gas was collected in airtight syringes by inserting one unattached 20-gage needle through the stopper, then inserting another attached to the airtight syringe. The gas samples were analyzed by injecting 1 ml of this gas into a gas chromatograph under the conditions described. The peak heights were compared with gas samples containing known concentrations of nitrous oxide obtained from commercial 100% anesthetic gas tanks.

Concentrations of oxygen and nitrous oxide in lung air were collected by squeezing air from within the lung. Room air had been removed by vacuum after the tissue specimens had been frozen in airtight polyethylene bags and allowed to thaw before analysis. Gas concentrations were measured as described above.

Comment

Nitrous oxide was the first of the inhalation anesthetics to be discovered, having been prepared by Priestley in 1776. Davy, in 1799, was the first to announce its anesthetic

properties and to suggest its use during surgery. It is of interest that both Priestley and Davy described highly pleasurable sensations associated with inhalation of this anesthetic gas. In the 19th century both nitrous oxide and ether were inhaled at parties because of these pleasurable side effects.

Nitrous oxide is heavier than air and not flammable. It does not combine with hemoglobin, but it is carried in physical solution. Nitrous oxide is excreted unchanged through the lungs [*1*]. When properly administered, it is probably the safest of all anesthetic agents. During anesthesia, the concentration of nitrous oxide in blood is relatively uniform. There is no close correspondence between the depth of anesthesia and the range of concentration of gas in arterial blood. The range in arterial blood is between 16.4 and 22.7 ml/100 ml [*2*].

Nitrous oxide is a weak anesthetic but a good analgesic agent [*1*]. To achieve general anesthesia at atmospheric pressure a patient would have to inhale pure nitrous oxide, thereby becoming hypoxic. In addition to the simple mechanical displacement of oxygen, nitrous oxide also elevates the alveolar-arterial difference of oxygen tension [*1*]. Because of this, the concentration of nitrous oxide, mixed with oxygen, that can be inhaled for prolonged periods without producing hypoxia is only 65% [*1*].

The use of nitrous oxide is limited to dental procedures and to very brief surgical procedures as an adjunct to a more potent anesthetic agent. During brief exposures or during induction of anesthesia, it is safe to give concentrations of 85% nitrous oxide [*1*]. In obstetrics, 100% nitrous oxide is sometimes used during contractions to provide analgesia with 100% oxygen between contractions.

Unlike other anesthetic agents, abuse of nitrous oxide is not confined exclusively to medical personnel but has been practiced to some extent by the general public as well. One of the reasons for this is that nitrous oxide has other commercial uses and is more readily available to the general public. It has been used extensively as a propellant in aerosol cans of dairy products and cream topping. The other reason for its abuse is that the public is more familiar with this anesthetic and the pleasurable sensations it produces because of its widespread use by dentists.

In abuse situations, the nitrous oxide is inhaled either directly from its original container or from a balloon that has been filled with the gas. In one experimental study involving inhalation of nitrous oxide from balloons, the subjects reported that an "exhilarating high" was reached within 15 to 30 s after inhalation, with peak effects lasting 2 to 3 min [*3*]. A tingling or warmth around the face and head, as well as auditory illusions and hallucinations, were described by all the subjects. Rebreathing the nitrous oxide prolonged the effects of the gas. Subsequent trials with the same dosage produced more intense or prolonged feelings—"reverse tolerance."

In Cases 2, 3, and 4 the nitrous oxide was escaping from a large tank in considerable quantity in a relatively confined space. As nitrous oxide is heavier than air, it evidently settled on the floor of the car. As the flow continued, the air was displaced. Even discounting the central nervous system action of nitrous oxide, once three quarters of the oxygen had been displaced unconsciousness would have been rapid and death would have followed within minutes. Victim 2 must have realized what was happening before losing consciousness, as she apparently had turned on the emergency blinkers.

A search of the English-language medical literature for the past 20 years revealed only one brief reference to death from abuse of nitrous oxide [*4*]. Cited was an article in a London newspaper, describing the deaths of two youngsters in a car during a "laughing gas" party with a tank of nitrous oxide.

References

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