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DOCTOR LEVIN
DENVER, COLORADO

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I. SUMMARY

In February l986, the National Institute for Occupational Safety and Health (NIOSH) received a request from two employees of Doctor Stanley Levin, a dentist located in Boulder, Colorado. The request was for an evaluation of nitrous oxide and mercury exposures during their use in dental procedures.

In February of l986, direct reading measurements were taken throughout the dental clinic and the surrounding areas for nitrous oxide and mercury levels. This clinic had a nitrous oxide scavenging system, therefore, the entire system was evaluated during several dental procedures.

Nitrous oxide is not used for an entire workshift. The day of this evaluation nitrous oxide was used from 2:00 pm until 5:00 pm. Concentrations of nitrous oxide ranged from 0 ppm to over l000 ppm. Levels of nitrous oxide can be substantially lowered with additional experience with the best ventilation flow rate determined on the current nitrous oxide scavenging system. During this evaluation, a simple adjustment lowered nitrous oxide levels from 500 ppm to 50 ppm in less than two minutes. Mercury contamination was not found in the clinic. When mercury is used in the amalgams it is handled properly. The waste amalgam is also stored in an acceptable manner.

Two dental assistants and the dentist were informally interviewed. None had medical problems compatible with either nitrous oxide or mercury exposure. During the evaluation, a brief explanation was given on the acute and chronic toxicological effects of nitrous oxide and mercury exposures.

On the basis of data obtained during this evaluation, it has been determined that the dentist in this clinic was overexposed to nitrous oxide. Recommendations to reduce nitrous oxide exposures are presented in this report. Mercury contamination was not found in any area of the clinic.

Keywords: SIC 802l (office of dentist), nitrous oxide, mercury, dental operatories, waste anesthetic gas.

II. INTRODUCTION

In February of l986, NIOSH received a request from two employees of the Levin dental clinic in Boulder, Colorado, to evaluate nitrous oxide and mercury exposures during various dental procedures. On February 24, l986 an environmental investigation was performed in this clinic. Direct reading measurements were taken throughout the clinic for nitrous oxide and mercury levels. Verbal recommendations were given at this time for lowering nitrous oxide exposure levels.

III. BACKGROUND

The dentist at this clinic routinely uses nitrous oxide during various dental procedures. Small children and adolecents are the majority of the patients seen at this clinic. Nitrous oxide is the preferred anesthetic agent when dealing with this age of patient. The time and amount of nitrous oxide used varies greatly. There are days when nitrous oxide is not used. During the February 24, l986 survey, N_2O was used for about 2 hours and 45 minutes. During its use, a nitrous oxide scavenging system was used.

IV. ENVIRONMENTAL DESIGN AND METHODS

All measurements for N_2O were performed on site with a Wilks Miran R l03 Gas Analyzer at a wavelength of 4.5 micrometers and a pathlength of l3.5 meters. Mercury measurements were made with a direct reading Bacharach R mercury vapor detector. General room and breathing zone air levels of nitrous oxide and mercury were taken throughout the dental operatory, around the nitrous oxide scavenging system, the anesthetic cart, the anesthetic administering mask, hoses, and patient's breathing zone.

Work practices and techniques were observed; employees were informally interviewed.

V. ENVIRONMENTAL CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy). In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department of Labor (OSHA) Occupational Health Standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV's usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended standards, by contrast, are based solely on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet only those levels specified by an OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8 to 10 hour workday. Some substances have recommended short-term exposure limits or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

Toxicology

At present there is no OSHA standard for nitrous oxide; however, NIOSH has recommended a 25 ppm environmental limit for N_2O based on research gathered prior to April 1977. Also, NIOSH feels that based on present technology, personal exposure levels as low as 25 ppm of N_2O in dental operatories are attainable at this time. Present research on the effects of nitrous oxide, however, indicates that while the majority of the information available on occupational exposure to waste anesthetic gas concerns exposure to a combination of nitrous oxide and other halogenated agents, enough evidence is available on the effects of N_2O alone so that it should be considered potentially toxic under conditions of chronic exposure. The following is a summary of these investigations.

Nitrous Oxide – Reports by Vaisman (1967), as well as by Askrog and Harvald (1970), were among the first to identify an increased incidence of spontaneous abortions in women exposed to anesthetic gases and in wives of men exposed to anesthetic gases. Results of a more recent and comprehensive nationwide survey of occupational disease among operating personnel were published in 1974 by the American Society of Anesthesiologists (ASA). The results of this study indicate "that female members of the operating room exposed group were subject to increased risks of spontaneous abortion, congenital abnormalities in their children, cancer, and hepatic and renal disease." This report also showed an increased risk of liver disease and congenital abnormalities in offspring of male operating room personnel. No increase in cancer was found among the exposed males, but an increased incidence of hepatic disease similar to that in females was found.

In a study published by NIOSH (1976), "nitrous oxide and halothane, in respective concentrations as low as 50 parts per million (ppm) and 1.0 ppm, caused measurable decrements in performance on psychological tests taken by healthy male graduate students. Nitrous oxide alone caused similar effects. The functions apparently most sensitive to these low concentrations of anesthetics were visual perception, immediate memory, and a combination of perception, cognition, and motor responses required in a task of divided attention to simultaneous visual and auditory stimuli".

Headache, fatigue, irritability, and disturbance of sleep were also reported.

Epidemiological studies have raised the question of human carcinogenicity of anesthetic gases, but data are presently insufficient to list nitrous oxide or halothane as suspected carcinogens.

In an epidemiological study among dentists, Cohen et al. (1975) compared exposed persons in that profession who used inhalation anesthetic more than three hours per week with a control group in the same profession who used no inhalation anesthetic. The exposed group reported a rate of liver disease of 5.9 percent in comparison with a rate of 2.3 percent in the control group. Spontaneous abortions were reported in 16 percent of pregnancies of the wives of exposed dentists, in comparison with nine percent of the unexposed. This difference was statistically significant. This study did not identify the specific anesthetic being used by the dentists surveyed, that is, whether they used N_2O alone or together with a halogenated agent. However, in a review of that study, NIOSH (1977) concluded that "the halogenated anesthetics alone do not explain the positive findings of the survey and that N_2O exposure must be an important contributing factor, if not the principal factor." This conclusion is based on a calculation which assumed that as many as one in ten of the dentists using an inhalation anesthetic employs a halogenated agent. If the actual fraction is less than one in ten, then this conclusion would be even more significant.

In a document recommending a standard for occupational exposure to waste anesthetic gas, NIOSH (1977) recommends a maximum exposure of 50 ppm on a time weighted average basis during the anesthetic administration in dental offices. This recommendation is based primarily on available technology in reducing waste anesthetic gas levels.

In a recent study, Cohen et. al., (October 1979) reported results on questionnaires sent to 64,000 dentists and dental assistants. Respondents were asked to estimate their occupational exposure to anesthetic gases, e.g., N_2O, halothane, etc., and to complete a health history for the period 1968-1978.

Over 22,000 dental assistants and 23,000 pregnancies which occurred during the sample period were reported.

Among the dentists who responded, 42 percent said they used anesthetic gases regularly in their practices. Approximately one-third of that group were "heavy users," using agents more than nine hours per week. The study concluded that:

(1) Among heavily anesthetic-exposed dentists, an increase in liver disease from 1.9 to 3.2 cases per 100, an increase in kidney disease from 0.35 to 1.35 cases per 100 in non-specific neurological

disease (numbness, tingling, and weakness) occurred relative to the group reporting no exposure to the anesthetic gases;

(2) Among heavily exposed female dental assistants, an increase in liver disease from 1.0 to 1.6 cases per 100, and an increase in non-specific neurological disease from 0.45 to 1.98 cases per 100 relative to the non-exposed group of assistants;

(3) The rate of spontaneous miscarriage was increased from 6.7 per 100 in the control group to 11.0 per 100 among wives of heavy anesthetic-exposed dentists, and from 7.6 cases per 100 in the non-exposed to 17.5 cases per 100 in heavily exposed female dental assistants;

(4) Birth defects increased from 3.6 to 5.9 per 100 among children of exposed female assistants; however, no increase in birth defects was reported in children of exposed male dentists; and

(5) Cancer incidence was unchanged among male dentists, but the rate among exposed female assistants appeared somewhat higher than among those unexposed.

Finally, because dentists work close to the patient's mouth and tend to use larger volumes of the gases to maintain effective anesthetic, they may receive two to three times the dose of anesthetic gases as operating room personnel. Also, a study of individual anesthetic gases used in dental offices revealed that nitrous oxide was the sole agent reported by 81 percent of those dentists using anesthetic gases. Cohen concluded that nitrous oxide, commonly known as "laughing gas," has always been considered to be inert and nontoxic. However, this study indicated that "significant health problems appear to be associated with the use of nitrous oxide alone."

Mercury

Mercury is a general protoplasmic poison that can be absorbed by inhalation or by ingestion. Mercury and its inorganic compounds may cause dermatitis, visual disturbances, chronic gingivitis, pharyngitis and renal insufficiency. Occupational poisoning due to mercury or its inorganic compounds is usually chronic in nature. Acute mercury poisonings may occur due to massive inhalation of mercury vapor. Acute conditions are usually limited to the bucco-pharyngeal area. Cases of mercury poisoning with neurological symptoms have also been reported.l Compliance with 0.05 mg/M3 of mercury for a 40-hour work week over a working lifetime should protect workers.

VI. ENVIRONMENTAL RESULTS

Nitrous oxide levels measured directly with the Miran l03 infrared gas analyzer showed levels during nitrous oxide administration ranging from 0 ppm. to greater than l000 ppm. The average level in the dentist's breathing zone during a dental procedure lasting for about l hour was 200 ppm. If the scavenging system could be set to scavengage at a vacuum rate of approximately 45 liters per minute levels should be considerably lower.

Mercury exposure was not found in the dental office or operatories. The scrap amalgam was stored in a very acceptable manner.

VII. SUMMARY AND CONCLUSIONS

Based on data obtained during this evaluation, a health hazard existed from overexposures to nitrous oxide during its use as an anesthetic agent. Mercury exposure did not exist. Adjustments to the existing nitrous oxide scavenging system, opening of windows when weather permits, and decreased use of nitrous oxide should eliminate the health hazard. Refer to table l for nitrous oxide levels found during this survey.

VIII. RECOMMENDATIONS

The following recommendations are offered to assist in either reducing or eliminating exposures to nitrous oxide.

l. Check with the company who installed the nitrous scavenging system and see if it would be possible to increase the vacuum to 45 liters per minute. This should lower the exposure to the dentist immediately.

2. Routine maintenance should be performed on all anesthetic and suction equipment. Periodic visual checks should be made of tubing, mask, breathing bag, and all high and low pressure connections. Cracked or worn items should be replaced. Leak tests should be made with soap solution on all high pressure fittings such as cylinder connections and the anesthetic machine inlet.

3. All dentists and other personnel working in the dental clinic should be advised on the adverse health effects of overexposure to nitrous oxide.

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XI. DISTRIBUTION AND AVAILABILITY

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Copies of this report have been sent to:

1. Levin Dental Office
2. U.S Department of Labor/OSHA - Region VIII
3. NIOSH - Region VIII.
4. Colorado Department of Health.
5. State designated agency.

For the purpose of informing affected employees, a copy of this report shall be posted in a prominent place accessible to the employees for a period of 30 calendar days.

Table 1
Direct Reading Levels of N_2O
observed during dental procedures at
Dr. Levin Dental Clinic
Boulder, Colorado
February 24, 1986

	Location	Sampling Time	ppm N_2O
1.	Scavenging (at mouth of patient)	2:00 pm	500
2.	Shut off N_2O (patients request)	2:10 pm	0
3.	Rubber hose from N_2O storage cylinder	2:15 pm	50
4.	Breathing Zone (BZ) of Dentist	3:45 pm	500
5.	Breathing Zone (BZ) of Dentist	3:50 pm	250
6.	Breathing Zone (BZ) of Dentist	3:55 pm	250
7.	Breathing Zone (BZ) of Dentist	3:57 pm	1000
8.	Breathing Zone (BZ) of Dentist	4:00 pm	200
9.	While drilling tooth	4:02 pm	100
10.	While drilling tooth	4:03 pm	50
11.	Turned off gas	4:06 pm	150
12.	Off gas BZ of patient	4:07 pm	300
13.	Off gas BZ of patient	4:08 pm	100
14.	Off gas BZ of patient	4:10 pm	150
15.	Off gas BZ of patient	4:15 pm	200
16.	Off gas BZ of patient	4:20 pm	50
17.	Off gas BZ of patient	4:22 pm	40
18.	Start new procedure	4:30 pm	300
19.	Patient talking BZ	4:35 pm	600
20.	Patient singing BZ	4:40 pm	1000
21.	Dentist BZ	4:00 pm	300
22.	Close down of gas	4:45 pm	150
	Evaluation Criteria		25
	Laboratory Limit of Detection		1