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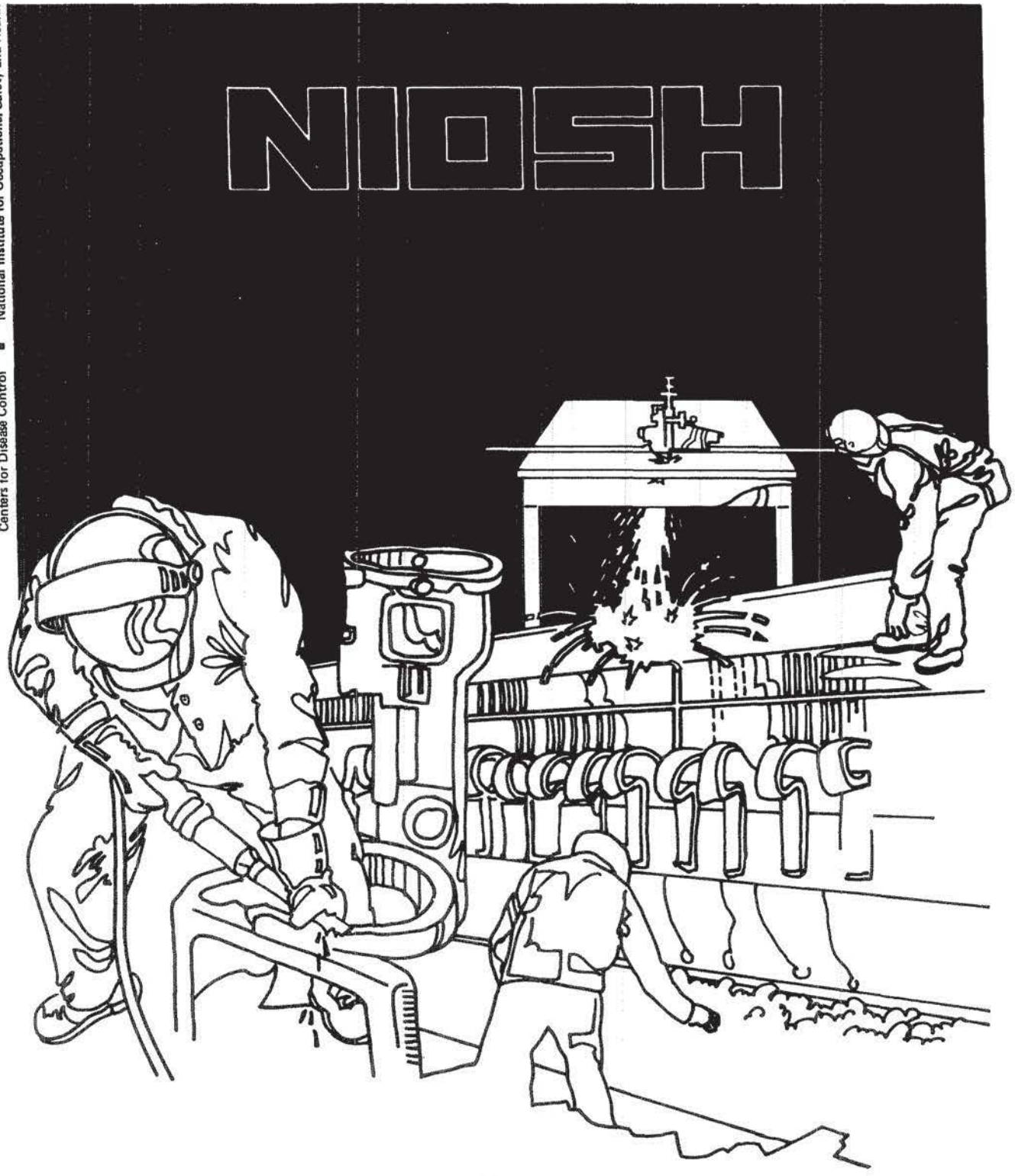

Health Hazard Evaluation Report

HETA 81-200-999
CONIFER DENTAL GROUP
CONIFER, COLORADO

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

HETA 81-200-999
NOVEMBER 1981
CONIFER DENTAL GROUP
CONIFER, COLORADO

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I. SUMMARY

In February 1981 the National Institute for Occupational Safety and Health (NIOSH) received a request from the dentist at the Conifer Dental Group, Conifer, Colorado, to evaluate possible health hazards from exposure to waste anesthetic gas (nitrous oxide, N_2O) and mercury in his dental operatories. Direct reading breathing zone air samples were taken on the dentist and his assistant. Area air samples were taken in the clinic. Leak testing was also performed on the anesthetic gas administering machine. Work practices and techniques were observed; employees were informally interviewed.

Direct reading area air samples indicated that personnel were exposed to breathing zone N_2O concentrations which exceeded 1000 parts per million (ppm) during administration with usual background levels of 200 ppm approximately 15 minutes after administration. These exposures were well above the NIOSH recommended standard for N_2O of 25 ppm, a time-weighted average concentration during anesthetic administration.

This dental office did not have a scavenging system. Waste nitrous oxide from the patient's breathing and from the anesthesia machine went directly into room air. The use of a dental dam did seem to lower N_2O concentrations.

Direct reading mercury air samples showed levels far below the evaluation criterion of 0.05 milligrams per cubic meter (mg/M^3). Mercury was not detected in the breathing zone of the dentist or his assistant. Mercury was not found inside the amalgamation area.

On the basis of the data obtained in this investigation, NIOSH has determined that the personnel in this dental office were overexposed to N_2O. Mercury levels were not found to pose a health hazard during the survey. Recommendations to reduce N_2O exposures were given at the time of the survey and are presented in Section VIII of this report.

KEYWORDS: SIC 8021 (Offices of Dentists), nitrous oxide, dental operatories, waste anesthetic gas, mercury.

II. INTRODUCTION

In February 1981 NIOSH received a request from the dentist at Conifer Dental Group, Conifer, Colorado, to evaluate potential hazards of exposure to nitrous oxide (N_2O) and mercury in his dental clinic at Conifer, Colorado. On September 21 and 25, 1981, NIOSH investigators visited the clinic and obtained direct reading breathing zone, area, and leak test samples for N_2O. Direct reading area and breathing zone air samples were also taken for measurement of mercury concentrations. Verbal recommendations were given at this time for lowering exposure levels.

III. BACKGROUND

The dentist at this clinic routinely uses N_2O during dental procedures usually for about two hours per day. A scavenging system for exhausting waste H_2O was not in use during the time of this evaluation. Patients were receiving approximately two liters per minute of N_2O in conjunction with one liter per minute of oxygen. The use of N_2O lasts from 10 to 45 minutes per patient.

Mercury is mixed with powdered metal, placed in a capsule, agitated, and then used to fill cavities in teeth. During this process mercury exposures are often observed. This is usually due to the capsules leaking mercury. Another source of mercury exposure is leftover amalgam that is stored improperly.

IV. ENVIRONMENTAL DESIGN AND METHODS

All measurements for N_2O were performed on site with a Wilks Miran^R 103 Gas Analyzer at a wavelength of 4.5 micrometers and a pathlength of 13.5 meters. A Bacharach^R Direct Reading Mercury Vapor Detector was used to perform direct reading mercury measurements. Throughout the evaluation direct reading air samples were taken at the breathing zone of the patient, dentist, and the chairside assistant. General area samples were taken on the N_2O administering equipment and throughout all areas of the dental operatory and waiting room.

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

V. EVALUATION CRITERIA

A. Environmental

Three sources of criteria were used to assess the workroom concentrations of chemical substances: (1) NIOSH criteria for a recommended standard; (2) American Conference of Governmental Industrial Hygienists Threshold Limit Values (TLVs), 1981; and (3) Occupational Safety and Health Administrations Standards, July 1980.

	Permissible Exposure Limits Time-Weighted Average (TWA) Exposure Basis
Nitrous oxide.....	25 ppm (NIOSH) TWA during administration
Mercury.....	0.05 mg/M^3 (NIOSH) 8-hour TWA
	0.1 mg/M^3 (OSHA) Ceiling

ppm = parts of vapor or gas per million parts of contaminated air by volume.

mg/M^3 = milligrams of substance per cubic meter of air.

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 50 ppm of N_2O in dental operatories are attainable at this time. Present research on the effects of nitrous oxide, however, state 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.

B. Toxicological

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 abortion 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 increase 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 reducng 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 2.4 to 2.9 cases per 100, and an increase 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 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 also cause dermatitis, vision disorders, chronic gingivitis, and pharyngitis. Occupational poisoning due to mercury or its inorganic compounds is usually chronic in nature. Acute mercury poisoning may occur due to massive inhalation of mercury vapor. Acute conditions are limited to the bucco-pharyngeal area. Other acute symptoms of mercury poisoning include blood in sputum and stools. Cases of mercury poisoning with neurological symptoms have also been reported (Reference 16). Compliance with 0.05 mg/M^3 of mercury for an 8-hour day, 40-hour work week over a working lifetime should protect workers.

VI. ENVIRONMENTAL RESULTS

N_2O levels measured directly with the Miran 103 Infrared Gas Analyzer showed levels ranging from 100 to greater than 1000 ppm. (The highest reading on the scale is 1000 ppm.) The average level was approximately 500-600 ppm in the breathing zone of the dentist and chairside assistant during the procedures. Refer to Table 1 for results.

Mercury was not found in the breathing zone of the dentist or his assistant.

VII. DISCUSSION AND CONCLUSIONS

Based on the data obtained during this survey, a definite health hazard existed from overexposure to N_2O. A nitrous oxide scavenging system and better dilution ventilation would lower the exposures.

VIII. RECOMMENDATIONS

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

1. The most immediate concern for this environment is to install a working scavenging system. There are a number of such systems on the market today and some are better than others; however, the best system is one that will remove the contaminant at the pop-off valve, as well as around the nose pieces. Nitrous oxide scavenging should be accomplished at a vacuum flowrate of approximately 45 liters per minute.

2. Routine maintenance should be performed on all anesthetic and suction equipment. Periodic visual checks should be made of tubing, masks, breathing bag, connections, etc., and any cracked or broken items should be replaced. Leak tests should be made with soap solution at all high pressure fittings such as cylinder connections and anesthetic machine inlet.

3. Once the engineering and/or exhaust systems have been instituted, a follow-up evaluation of the environment should be made.

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

5. More dilution ventilation should be installed such as a large fan in the roof of the building that would periodically bring in fresh outside air.

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XI. DISTRIBUTION AND AVAILABILITY

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia. Information regarding its availability through NTIS can be obtained from NIOSH, Publications Office, at the Cincinnati address.

Copies of this report have been sent to:

1. Conifer Dental Group.
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

Average Levels of N_2O Observed During Dental Repair Procedures

Conifer Dental Group
Conifer, Colorado

September 25, 1981

Location	Time of Sample	N_2O (ppm)
6 inches from patient's mask	3:15 PM	> 1000
6 inches from patient's mask	3:20 PM	700
Breathing zone of dentist	3:25 PM	500
Breathing zone of dentist	3:30 PM	500
Breathing zone of dentist	3:35 PM	700
Breathing zone of dentist	3:40 PM	200
General room concentration	3:45 PM	400
Background	3:50 PM	600
Hallway between 2 operatories	3:55 PM	250
15 minutes after work completed in operatory	4:30 PM	150
EVALUATION CRITERIA		25
LIMIT OF DETECTION		1

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