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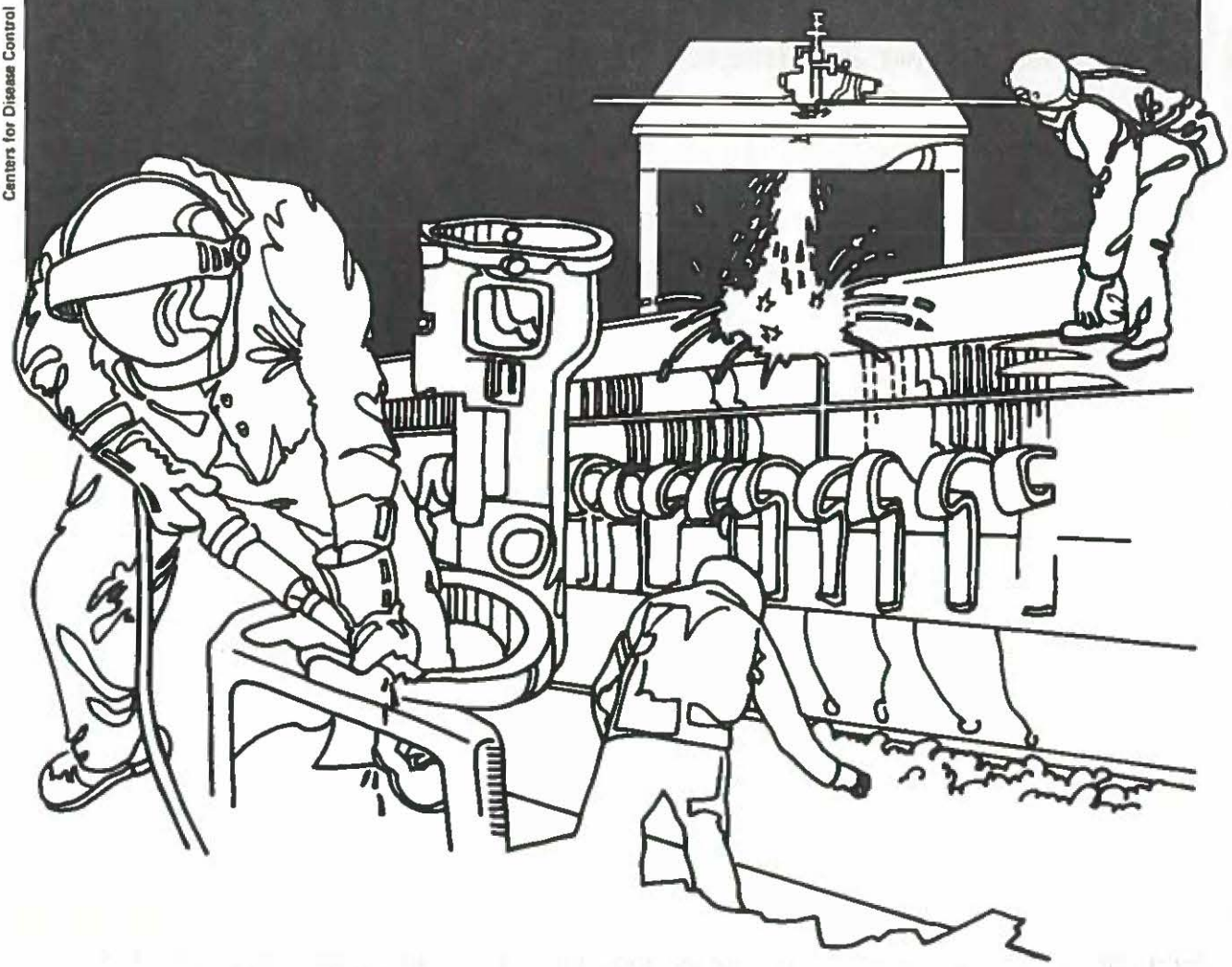

Health Hazard Evaluation Report

HETA 81-342-1005
EMORY UNIVERSITY
SCHOOL OF DENTISTRY
ATLANTA, GEORGIA

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.

Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

HETA 81-342-1005
NOVEMBER 1981
EMORY UNIVERSITY
SCHOOL OF DENTISTRY
ATLANTA, GEORGIA

NIOSH INVESTIGATORS:
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I. SUMMARY

On the morning of July 27, 1981, the National Institute for Occupational Safety and Health (NIOSH) conducted a health hazard evaluation at the main clinic of the Emory University School of Dentistry, Atlanta, Georgia. This evaluation was conducted in response to a request submitted by the Professor and Chairman of the Oral Biology Department. The department is planning to install nitrous oxide (N_2O) gas scavenging equipment in each of the 6 suites where nitrous oxide was used. To determine the extent of exposure for operators and dental assistants working in these suites, NIOSH monitored the nitrous oxide concentration in the area and collected personal exposure samples before, during, and after a 1.5 hour period of nitrous oxide administration.

Personal air samples were collected using battery powered air sampling pumps to fill inert plastic bags with air drawn from the person's breathing zone. These samples were later analyzed on site using a Wilks 103 portable infrared spectrophotometer which had been calibrated that morning just prior to conducting this evaluation. This instrument was also used for monitoring N_2O concentrations in the suite 1 - 6 area and at several other locations in the main clinic.

Results of this evaluation indicate that scavenging equipment is definitely required to protect clinic personnel from excessive exposure to nitrous oxide. The average personal exposure to N_2O during the period of administration was above 250 parts per million (ppm) in 4 of 5 samples collected. This was the maximum full scale reading for the Wilks 103. The lowest personal exposure was 175 ppm. The NIOSH recommended standard for N_2O in dental offices is 50 ppm. Area monitoring in suites 1 - 6 indicated that the atmospheric concentration of N_2O exceeded 250 ppm within one-half hour after administration of N_2O had begun and did not drop below 25 ppm for at least 10 minutes after all N_2O gas was turned off. Specific recommendations for controlling N_2O exposure can be found in section VI of this report.

KEYWORDS: SIC 8221 (colleges, universities, and professional schools), dental offices, nitrous oxide, anesthetic gases

II. BACKGROUND

The main clinic in the Emory University School of Dentistry is a large, open room, partitioned to provide individual suites for 122 dental chairs. Suites 1 - 6 are located in the southwest corner and are the only suites in the clinic equipped for N_2O administration. The gas is administered through a nasal mask and the excess is allowed to escape directly into the atmosphere. General ventilation is provided from air conditioning supply vents located in the ceiling. No special exhaust systems or ventilation is provided to the main clinic except that supplied from the building's central heating, ventilation, and air conditioning (HVAC) system.

III. EVALUATION CRITERIA

Reports by Vaisman (1967), as well as 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.[1,2] 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 to 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 the female was found.[3]

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 -- 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.

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 a halogenated agent.[4] 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.[5]

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. Similar decrements were not observed at 25 ppm nitrous oxide with 0.5 ppm halothane.[6]

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.[7]

Mortality and epidemiological studies have raised the question of possible carcinogenicity of anesthetic gases, but sufficient data are presently lacking to list nitrous oxide or halothane as suspected carcinogens.

Based on the results of a study published in 1980, nitrous oxide does not appear to be neurotoxic. Extensive neurological examinations were given to dentists who use N_2O extensively and those who use little or none. No significant differences in neurological signs or symptoms were observed between the two groups. Rats exposed to a concentration of 70% N_2O for 4 hours per day, 5 days per week, for 6 months, did not show any neurologic or neuromuscular abnormality.[8]

In a recent study, Cohen et. al. (October 1979)[9] 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) 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.

IV. EVALUATION CONDITIONS

Five of the six suites were set up to administer nitrous oxide. Two student volunteers were administered N_2O as simulated patients and 3 other suites were in actual use. The sixth suite (suite 3) was also used but no N_2O gas was administered. The times and rates of administration are presented below:

Suite 2	Suite 1
N_2O on 9:16 a.m. N_2O off 10:46 a.m.	N_2O on 9:19 a.m. N_2O off 11:05 a.m.
37.5% N_2O @ 8 LPM	45% N_2O @ 7.7 LPM
Suite 4	**Suite 3**
N_2O on 9:48 a.m. N_2O off 10:40 a.m.	N_2O not used
65% N_2O @ 9 LPM	
Suite 6	**Suite 5**
N_2O on 9:22 a.m. N_2O off 10:50 a.m.	N_2O on 9:22 a.m. N_2O off 10:52 a.m.
60% N_2O @ 9 LPM (Simulated)	54% N_2O @ 6.9 LPM (Simulated)

V. EVALUATION RESULTS

Area monitoring and personal exposure results are presented in the attached table. All samples were well above the NIOSH recommended standard of 25 ppm. The nitrous oxide concentration monitored in Suite 6 was above 80 ppm by 9:55 a.m. and above 145 ppm by 10:05 a.m. By 10:06 a.m. the concentration in Suite 4 exceeded the maximum reading detectable on the Wilks 103 (250 ppm) and remained above this level until 10:50 a.m.

VI. RECOMMENDATIONS:

In view of the evidence which as been building in recent years, showing that significant health problems appear to be associated with the use of nitrous oxide alone, dentists should take appropriate precautions in controling their own exposure as well as the exposure of their office staff. The Emory University School of Dentistry has an obligation to set the example for their students in demonstrating proper methods and procedures for controlling nitrous oxide exposure. Control measures recommended by NIOSH to reduce exposure to the lowest reasonable achievable concentration includes the following:

1. Purchasing, installing, and using scavenging equipment to capture anesthetic gases before they reach the breathing zones of dental clinic personnel. Such gases should be vented to the outdoors in a manner which precludes the re-entry of contaminated air.

2. Venting suction machines to the outside of the building.

3. Minimizing speech by the patient during dental procedures.

4. Regular preventive maintenance procedures for anesthetic equipment.

5. Frequent leak testing of the anesthetic equipment by in-house personnel. "Low leakage" anesthetic techniques should be taught and stressed as part of the curriculum.

6. Use of an air sweep fan when necessary to dilute the concentration of nitrous oxide in the breathing zone of the dental operators and their assistants (see Figure 1).

7. Performing air monitoring at the inception of the N_2O control program and at least every 4 months thereafter. A reasonably achievable concentration of N_2O appears to be as high as 50 ppm when the above recommended control measures are applied. In the event that higher concentrations are found, repairs must be promptly completed with verification by additional air monitoring.

Students and staff should be alerted to the health hazards associated with anesthetic gases and taught how to minimize personnel exposure by following the above recommendations. A detailed discussion of the above control methods is contained in NIOSH Publication No. 77-171 (Ref. 5).

VII. AUTHORSHIP AND ACKNOWLEDGEMENTS

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VIII. DISTRIBUTION AND AVAILABILITY

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Publications Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After ninety (90) days the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from the NIOSH Publications Office at the Cincinnati, Ohio address.

Copies of this report have been sent to:

1. Department of Oral Biology, Emory University
2. U.S. Department of Labor (OSHA), Region IV
3. NIOSH, Region IV
4. Designated State Agencies

For the purpose of informing the "affected employees", the employer will promptly "post" this report for a period of thirty (30) calendar days in a prominent place(s) near where the affected employees work.

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EMORY UNIVERSITY
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NITROUS OXIDE SAMPLING RESULTS
July 27, 1981

Personal Exposures

Location	Job	Sampling time	Concentration (ppm)
Suite 1	Assistant	9:19am-11:05am	>250
Suite 2	Operator	9:16am-10:46am	>250
Suite 4	Assistant	9:48am-10:40am	>250
Suite 5	simulated	9:22am-10:52am	175
Suite 6	simulated	9:22am-10:50am	>250

Area Monitoring in Suites 1 - 6

Location	Monitoring Time	Concentration (ppm)
Suite 6 (gas on 9:30am)	9:55am	80
	10:05am	145
Suite 4 (gas on 9:48am)	10:06am	>250
	10:08am-10:16am	>250
Between Suite 4 a 6 (all gas off 11:05am)	10:55am-10:50am	>250
	10:50am-10:58am	>250
	10:58am-11:09am	40
	11:09am-11:13am	35

Area Monitoring in other Locations

Location	Monitoring Time	Concentration (ppm)
Hallway north of clinic	10:20am	4
West corridor inside clinic	10:25am	8
Center of clinic	10:28am	20
Suite 41	10:30am	50

NIOSH Evaluation Criteria = 25 ppm
(average concentration during period of administration)

N_2O concentration range detected by Wilks 103 = 0-250 ppm

The air sweep (Figure 1) assured that the personnel inhaled N_2O concentrations which were only slightly higher than the average prevailing in the room. This technique was employed in offices where air samples obtained in the breathing zones of personnel contained more than 30 ppm N_2O. The apparatus consisted of a quietly operating fan located to take in relatively fresh air

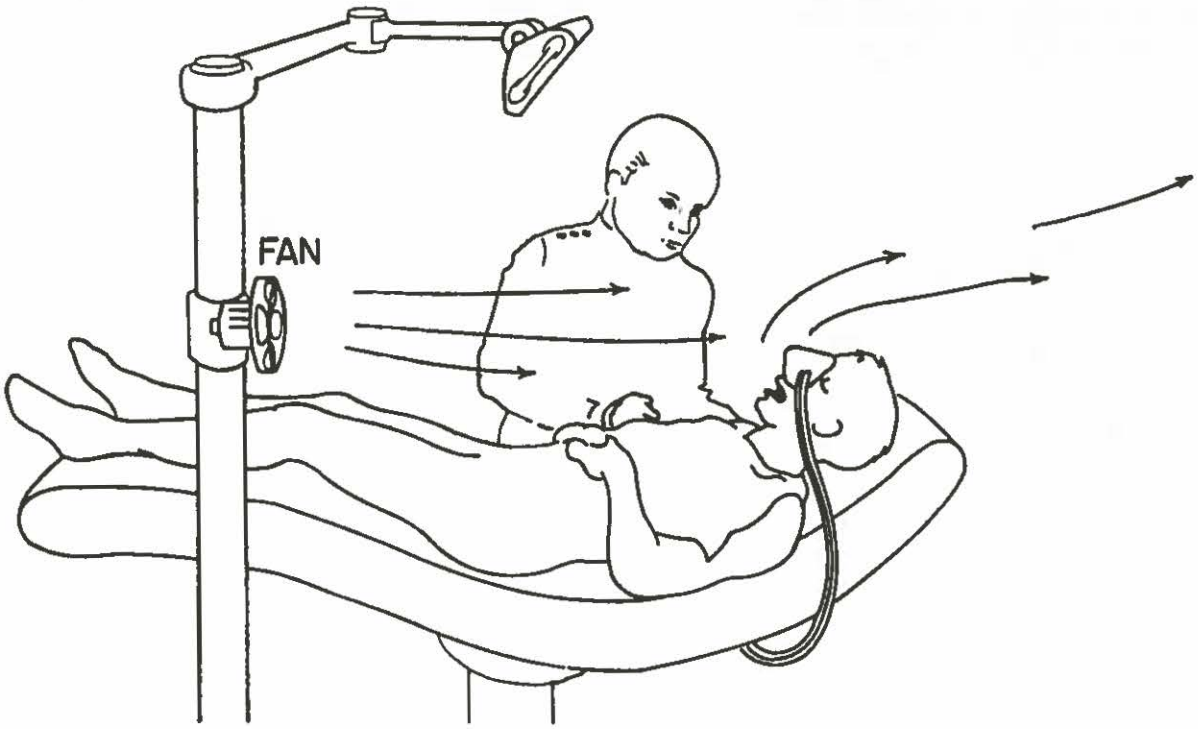

Fig. 1 AIR SWEEP

Fan intake is located away from sources of N_2O. Exhaust is directed to carry concentrated anesthetics, exhaled by the patient, away from the breathing zone of the personnel.

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