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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HEALTH HAZARD EVALUATION DETERMINATION REPORT HE 79-107-632

Larry Kotlow, D.D.S.
Albany, New York

November 1979

I. TOXICITY DETERMINATION

A health hazard evaluation was conducted by the National Institute for Occupational Safety and Health (NIOSH) in the dental office of Dr. Lawrence Kotlow in Albany, New York. On June 13-15, 1979, environmental samples were collected to determine airborne concentrations of waste anesthetic gas nitrous oxide and mercury.

Breathing zone samples of nitrous oxide (N_2O), ranging from 10 parts per million (ppm) to peaks of 300 ppm, were measured during the two day evaluation of the dental office. Also, multiple sampling techniques were used to evaluate atmospheric mercury concentrations in the dental office. Mercury levels ranged from non-significant levels for both long term sampling techniques, i.e., personal mercury vapor monitors and charcoal tube sampling techniques; to peaks of .02-.15 mg/M^3 recorded while using a portable mercury sniffer monitoring system to scan for mercury exposures in the operatories. These higher concentrations of mercury were found in the carpet and around the amalgamating units in the operatory. The above findings indicate that nitrous oxide levels were exceeding the present standard recommended by NIOSH, and therefore, measures should be taken to reduce exposure to N_2O to levels recommended as attainable by NIOSH, i.e., 50 ppm for dental operatories. The mercury levels found on the personal monitors did not show a health problem at this time, however, during the winter months when heating systems are in constant use the mercury found in the carpet, baseboards, and console areas could increase the mercury vapor levels in the work environment.

Recommendations are presented in this report which were discussed at length in a closing conference with Dr. Kotlow. Dr. Kotlow was very receptive towards reducing any exposure in the work environment, and therefore, it is hoped that these recommendations will reduce and/or eliminate such exposures in the future.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are currently available upon request from NIOSH, Division of Technical Services, 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:

a) Dr. Lawrence Kotlow
b) NIOSH - Region II
c) U.S. Department of Labor - Region II

For the purpose of informing the approximately five "affected employees" the employer shall promptly "post" for a period of 30 calendar days the Determination Report in a prominent place(s) near where the exposed employees work.

III. INTRODUCTION

Section 20(a)(b) of the Occupational Safety and Health Act of 1970, 20 U.S.C. 669(a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by an 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 National Institute for Occupational Safety and Health received such a request from Dr. Kotlow on June 15, 1979.

There were no specific alleged health problems at the time the request was generated. The recognition of the potential health hazards associated with chronic exposure to anesthetic gases and mercury, as well as Dr. Kotlow's concern for one female employee's problems with a previous pregnacy, were responsible for this health hazard evaluation request.

IV. HEALTH HAZARD EVALUATION

A. Process Description

Dr. Kotlow's dental office has been open since December 1974 and occupies the first floor of a two story office building. The dental office occupies the bottom floor and includes a waiting room; a receptionist area; a private office; a consultation room; one bathroom; one laboratory; two operatories, (located in the same room and divided by a center console) and one dental hygiene/X-ray room. Current staffing includes Dr. Kotlow, one dental assistant, one dental hygienist, and two receptionist. During the two day survey all of the procedures were evaluated for personal and area (background) sampling for both nitrous oxide and mercury.

Nitrous oxide has been in use since December 1974 and is normally used five days a week for approximately 4-5 hours per day. The majority of nitrous oxide use is performed from 8:30 a.m. to 1 p.m. and occasionally from 2-5 p.m. The scavenging system has been in use since April 1979 and N_2O is exhausted into a central section system. The basic sequence of nitrous oxide administration to a patient is as follows:

1. Administer oxygen at 4-5 liters/minute (l/m) for approximately 1 minute;
2. Add N_2O at 1-2½ l/m inconjunction with oxygen at 4-5 l/m;
3. Turn on scavenger system and central suction;
4. Add Rubber Dam*;
5. Nitrous oxide lowered to .5-1.5 l/m;
6. Approximate use of N_2O is from 10-45 minutes;
7. Oxygen is continued without N_2O for approximately 2-5 minutes after the procedure is complete.

Note: The Rubber Dam is not used during oral surgery procedures and this adds to the amount of N_2O exhausting into the dentist's and dental assistants breathing zone.

Nitrous oxide and oxygen are piped into the operatories, via copper tubing, from cylinders which are located in a closet. The copper tubing runs to outlets in the operatories and each of the anesthesia machines are connected directly to these outlets. The anesthesia machines consists of two flow meters with one control for nitrous oxide and another for oxygen. The gas mixture is supplied to the patient through flexible rubber tubing which terminates in a scavenging nosepiece. Suction/exhaust for the scavenging nosepiece, as well as for the aspirator is provided by a vacuum pump which is located in the same closet as the N_2O and O_2 tanks.

The amalgam (mercury) fillings are prepared by placing an alloy tablet in a plastic capsule; adding a drop of pre-measured mercury into the capsule; and then agitating this mixture on a machine.

B. Evaluation Design/Methodology

Personal breathing zone and area samples for nitrous oxide were obtained by filling 25 liter inert plastic bags via vacuum battery powered sampling pumps. These pumps are specially modified for bag filling and are utilized to draw air through tygon tubing (¼ inch I.D.) and into the bag. Both personal and area samples were analyzed on site with a Wilks Miran® I General Purpose Gas Analyzer* at a wavelength 4.47 micrometers; a slit width of 0.50 millimeters, and a pathlength of 5.25 meters. The infrared analysis was pre and post calibrated on site and the lower and upper limits of detection were approximately 0 and 1050 parts of nitrous oxide per million parts of contaminated air by volume respectively. A chart recorder was utilized (chart speed of 1 inch per minute) to record the sampling results. The infrared analyzer response time was approximately 10-15 seconds. The sampling pumps were calibrated at a flow rate of 700 cubic centimeters per minute (cc/m) for personal samples and 400 cc/m for area samples. Personal air samples were taken in the breathing zone of the exposed subjects while area samples were taken at various locations in the dental facility. Direct measurements (leak testing) were also made by using a 25 foot ¼ inch I.D. tygon tubing (connected to the infrared analyzer) and placing this tygon probe at various locations in the facility, i.e., N_2O tanks, high and low pressure lines, analgesia machines, vacuum systems, scavenging masks, etc. Using this method, short term exposures could be measured and any source of nitrous oxide contamination could be located.

A Bacharach Model MV2 Mercury Sniffer®, which is a portable direct reading instrument, was utilized the first day for screening purposes to evaluate the facility for mercury contamination. This instrument utilizes the principle of ultra-violet absorption to determine the mercury vapor concentrations present in the environment. Based on the first day's findings it was determined that long term breathing zone sampling would be necessary in order to determine personal exposures. Therefore, over the next two days a total of nine personal and four general area samples for inorganic mercury vapor was collected using either the impregnated charcoal tube or the film badge technique. Sampling pumps, operating at air flows of approximately 50 cc/min, were used to draw the air through the charcoal tubes. The mercury monitor badges operate on a positive diffusion dosimeter principle.

C. Environmental Criteria

The environmental evaluation criteria used for this investigation are presented in Table I. Recommended environmental limits and/or general information concerning each substance are also listed, i.e., the source of the recommended limits; the present OSHA standard, and a brief description of the primary health effects known to date.

* Mention of a commercial product does not constitute endorsement by the National Institute for Occupational Safety and Health.

1. Nitrous Oxide

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 (further discussion on this subject will be given in the summary and conclusions section). 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 a 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:

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. Results of a more recent and comprehensive nation-wide survey of occupational disease among operating personnel were published in 1974 by 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 to 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 the female 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.

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.

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 in their practice. 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 for the unexposed. This data 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 if a halogented agent was used. However, in a review of that study, NIOSH (1977) concludes 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 assuming 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.

2. Mercury

In a document recommending a standard for occupational exposure to mercury, NIOSH (1973) recommends a maximum exposure of 0.05 mg/M^3. Mercury can be absorbed by inhalation or in the case of soluable mercury salts by ingestion. Mercury and its organic compounds may cause headache, fatigue, weakness, loss of memory, fine tremors, neurological disturbances, and personality changes. The OSHA standard for mercury exposure is 0.1 mg/M^3, and this is a ceiling value.

D. Evaluation Results and Conclusions

1. Nitrous Oxide

The results from the personal and area samples for nitrous oxide are presented in Tables II and III. Personal breathing zone samples for N_2O ranged from 10-300 ppm and area (background) samples ranged from 10-135 ppm. One very important consideration in a few of the higher levels obtained during the survey was the dentist's ability to manage the patient, i.e., by reviewing Tables II and III certain of the very high levels (263 ppm, 270 ppm, 250 ppm, etc.) are levels that were received while the dentist was attending to a patient that is referred to as a cryer or a patient who is difficult to manage during the procedure. This was also the case for the dental assistant, i.e., the higher exposure levels of 210 ppm, 100 ppm, etc., were obtained during the same circumstances.

In addition to the nitrous oxide samples taken above the infrared analyzer was also used to check for leaks and general background levels at various points and/or locations. Therefore, leak testing and background testing was performed at various times during both survey days while nitrous oxide was in use. As reported in Table IV, all the rooms outside the main entrance door to the operatories had N_2O levels of less than 50 ppm and these ranged from 20-45 ppm. The remaining data shown in Table IV was for leak testing of the various points of concern on the anesthetic equipment and the exhaust points. Except for the drain where the main copper exhaust pipe empties, all of the levels were less than 20 ppm. The level obtained at the exhaust drain, located in the closet, was 60 ppm. Those area/background levels obtained using the bag sampling method ranged from 10-135 ppm. With the exception of the one 135 ppm value, which was received during a cryer patient evaluation, the average background level for June 14 was 61 ppm. The average background level for June 15 was 63 ppm and the overall average ppm for the two days was 62 ppm.

In conclusion, based on all the information collected on the use of N_2O in Dr. Kotlows dental office it is felt that this evaluation was representative of normal operating conditions. Many of the N_2O measurements obtained for the personal breathing zone samples were in excess of the recommended standard. This was also the case for the average area (background) samples collected during the survey. It should be noted that these higher levels of N_2O are not unusual when problems exist like those that were found here, i.e., problems controlling patients, inappropriate scavenging exhaust flow rates, etc. Therefore, the recommendations presented in Section V of this report should help reduce and/or eliminate the N_2O exposures as found in this environment.

2. Mercury Vapor

Measurements by direct reading instruments for mercury vapors indicated levels up to 0.15 mg/M^3 on counter tops, carpeting, etc. However, personal monitoring indicate that mercury levels were within acceptable limits on the day of this evaluation. Therefore, the recommendations presented in Section V should be implemented in order to reduce those exposures found with the direct reading instrument, i.e., counters, carpeting, etc.

3. Medical

This employee was interviewed and it appeared, based on her statements concerning discussions with her personal physician, that this was not an unusual situation that would appear to be associated with exposure to N_2O.

V. RECOMMENDATIONS

The following recommendations are offered to assist in reducing and/or eleminating exposures to nitrous oxide and mercury:

A. Nitrous Oxide

1. Place a cap over the exhaust drain in the closet in order to prevent nitrous oxide from backing up and into the closet. This cap could be designed to encircle the exhaust lines, and thus, reduce the potential exposure from this source.

2. An air sweep system should be installed in both operatories, that is, a fan with its intake located away from the sources of N_2O. Therefore, exhaust is directed to carry concentrated anesthetics, exhaled by the patient, away from the breathing zone of the personnel (refer to Figure II).

3. The present "low vacuum" suction system is not, at present, adequate for nitrous oxide scavenging. Nitrous oxide scavenging should be accomplished at a vacuum flowrate of approximately 45 liters per minute. Therefore, the manufacture or distributor should be contacted and this system evaluated to determine and set the proper flow rate.

4. 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.

5. Once the engineering and/or exhaust have been evaluated a follow-up evaluation of the environment should be made.

B. Mercury

6. The pads used under the amalgamators should be disposed of due to the potential for mercury collection on this porous material.

7. Housekeeping personnel should be made aware of the problems associated with mercury and the proper procedures for cleaning up areas where mercury is used.

8. Mop heads should be washed separately and discarded periodically to prevent accumalation of mercury.

9. The procedure for waste mercury disposal or mercury spill decontamination should be formalized and brought to the attention of all persons working in areas where mercury is used, including housekeepers.

10. The recommendations in mercury hygiene as set forth by the American Dental Association should be consulted as they represent further methods of reducing employee exposures to mercury vapors (refer to Attachment I and II).

11. The carpeting in the reception area and staff dentists offices should be removed to help reduce contamination sites.

VI. REFERENCES

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12. Control of Occupational Exposure to N_2O in the Dental Operatory, HEW Publication No. (NIOSH) 77-171, Cincinnati, National Institute for Occupational Safety and Health, 1977.

13. U.S. Department of Labor, Occupational Safety and Health Administration, (29 CFR 1910.1000), January 1, 1978.

14. Criteria for a Recommended Standard -- Occupational Exposure to Waste Anesthetic Gases and Vapors. HEW Publication No. (NIOSH) 77-140, Cincinnati, National Institute for Occupational Safety and Health, 1977.

15. Criteria for a Recommended Standard -- Occupational Exposure to Inorganic Mercury. HEW Publication No. HSM 73-11024, 1973.

VII. AUTHORSHIP AND ACKNOWLEDGEMENTS

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Dr. Kotlow and Employees:

NIOSH is thankful to Dr. Kotlow and the employees at his office for their cooperation and assistance with this Health Hazard Evaluation. The information gathered from this study will not only assist in maintaining the health and safety of those persons working in this office, but also other dental offices we investigate.

Table I

Environmental Evaluation Criteria

Larry Kotlow, D.D.S.
Albany, New York

October 1979

Substance	Recommended Environmental Limit[1]	Reference Source	Primary Health Effects	OSHA Standard
Nitrous Oxide	25 ppm[2]	NIOSH	Reproductive Effects and Audiovisual Performance Decrements	None
Mercury Vapor[3]	0.05 mg/M^3	NIOSH	Central Nervous System and Mental Effects	0.1 mg/M^3 (ceiling[4])

(1) All air concentrations are expressed as time-weighted average(TWA) exposures for up to a 10 hour workday unless designated "ceiling".
(2) Available data indicate that with current control technology, exposure levels of 50-ppm and less for nitrous oxide are attainable in dental offices.
(3) Presently enforced by OSHA as a TWA.
(4) A "ceiling" limit should not be exceeded.

Table II

Nitrous Oxide Concentrations

Larry Kotlow, D.D.S.
Albany, New York

June 14, 1979

Sample Location	Sample Type	Sampling Time	Sampling Pump Flow Rate (cc/m)[1]	Nitrous Oxide Concentration (ppm)[3]
Operatory-Dentist	Personal[2]	0830 - 1000	600	44
Operatory-Assistant	Personal	0830 - 1000	600	10
Operatory-Hallway	Area[4]	0900 - 1030	600	10
Operatory-Center Console	Area	0900 - 1030	600	135
Operatory-Assistant	Personal	1000 - 1120	600	210*
Operatory-Center Console	Area	1030 - 1145	600	62
Operatory-Hallway	Area	1030 - 1145	600	87
Operatory-Dentist	Personal	1000 - 1200	600	263*
Operatory-Dentist	Personal	1200 - 1220	700	270*
Operatory-Assistant	Personal	1120 - 1230	600	82
Operatory-Center Console	Area	1145 - 1300	600	87
Operatory-Hygiene Area-A	Area	1115 - 1330	600	60
Operatory-Hygiene Area-B	Area	1115 - 1330	600	62
Operatory-Dentist	Personal	1400 - 1430	600	250*
Operatory-Assistant	Personal	1400 - 1430	600	90
ENVIRONMENTAL CRITERIA				(NIOSH) 25 ppm

1. cc/m = Cubic centimeters of air per minute.
2. Personal = Breathing zone samples.
3. ppm = Parts of vapor per million parts of contaminated air by volume at 25°c and 760 mmHg.
4. Area = Non breathing zone sample.

NOTE: Patient management was difficult.

Table III

Nitrous Oxide Concentrations

Larry Kotlow, D.D.S.
Albany, New York

June 15, 1979

Sample Location	Sample Type	Sampling Time	Sampling Pump Flow Rate (cc/m)[1]	Nitrous Oxide Concentration (ppm)[3]
Operatory-Assistant	Personal	0830 - 0915	600	41
Operatory-Hygiene-A	Area	0830 - 0930	600	40
Operatory-Outer Console	Area	0830 - 1030	600	40
Operatory-Hygiene-A	Area	0930 - 1000	600	87
Operatory-Dentist	Personal	0935 - 1015	600	300*
Operatory-Assistant	Personal	0935 - 1015	600	100
Operatory-Center Console	Area	1000 - 1100	600	87
ENVIRONMENTAL CRITERIA				(NIOSH) 25 ppm

1. cc/m = Cubic centimeters of air per minute.
2. Personal = Breathing zone samples.
3. ppm = Parts of vapor per million parts of contaminated air by volume at 25°c and 760 mmHg.
4. Area = Non breathing zone sample.

NOTE: Patient management was very difficult.

Table IV

Nitrous Oxide Non Operatory and Leak Testing Concentrations

Larry Kotlow, D.D.S.
Albany, New York

June 14-15, 1979

Sample Location	Sample Type	Sampling Time (minutes)	Nitrous Oxide Concentrations (ppm
Consultation Room	Area	5	20
Main Hallway	Area	5	30
Entrance to Operatories (outside door)	Area	10	45
Entrance to Operatories (inside door)	Area	10	60
Receptionist Room	Area	10	30
Closet Floor (O_2 & N_2O)	Area	10	20
Scavenging Exhaust to Drain	Area	5	60
High PSI on O_2O Tank	Area	3	10
High PSI N_2O in Operatory (wall outlet-1)	Area	5	20
High PSI N_2O in Operatory (wall outlet-2)	Area	5	
High PSI on N_2O (anesthesia machine)	Area	5	10
Low PSI on N_2O (at mask)	Area	3	10
ENVIRONMENTAL CRITERIA			(NIOSH) 25 ppm

1. ppm = Parts of vapor per million parts of contaminated air by volume at 25°c and 760 mmHg.

Table V

Results of Charcoal Tube Samples and Monitor Badges for Mercury Vapors

Larry Kotlow, D.D.S.
Albany, New York

June 14-15, 1979

Sample Time	Sample Description	Concentration (mg/M^3)[1]	Detection Limit
0800 - 1615	C/T[2] Personal-Dentist	ND[3]	0.3 ug/sample
0800 - 1615	C/T[2] Personal-Dentist	ND	"
0800 - 1625	C/T[2] Personal-Dental Assistant	ND	"
0800 - 1625	C/T[2] Personal-Dental Assistant	ND	"
0800 - 1630	C/T[2] Area-Dental Hygienist	ND	"
0800 - 1630	C/T[2] Personal-Hygienist Operatory	ND	"
0730 - 1610	M/B[4] Personal-Dentist	.005	N/A[5]
0730 - 1610	M/B[4] Personal-Dental Assistant	.006	N/A
0730 - 1615	M/B[4] Personal-Dental Hygienist	.014	N/A
0730 - 1620	M/B[4] Personal-Dentist	.012	N/A
0730 - 1620	M/B[4] Area-Dental Assistant Operatory	.008	N/A
0730 - 1630	M/B[4] Area-Center Console-1st day	.005	N/A
0730 - 1630	M/B[4] Area-Center Console-2nd day	.009	N/A
ENVIRONMENTAL CRITERIA		(NIOSH) 0.05 mg/M^3	

1. mg/M^3 = Milligrams per cubic meter of air.
2. C/T = Charcoal tube sample.
3. ND = Non Detectable level.
4. M/B = Monitor Badge.
5. N/A = Non Applicable, i.e., detection limit not given on analytical data.

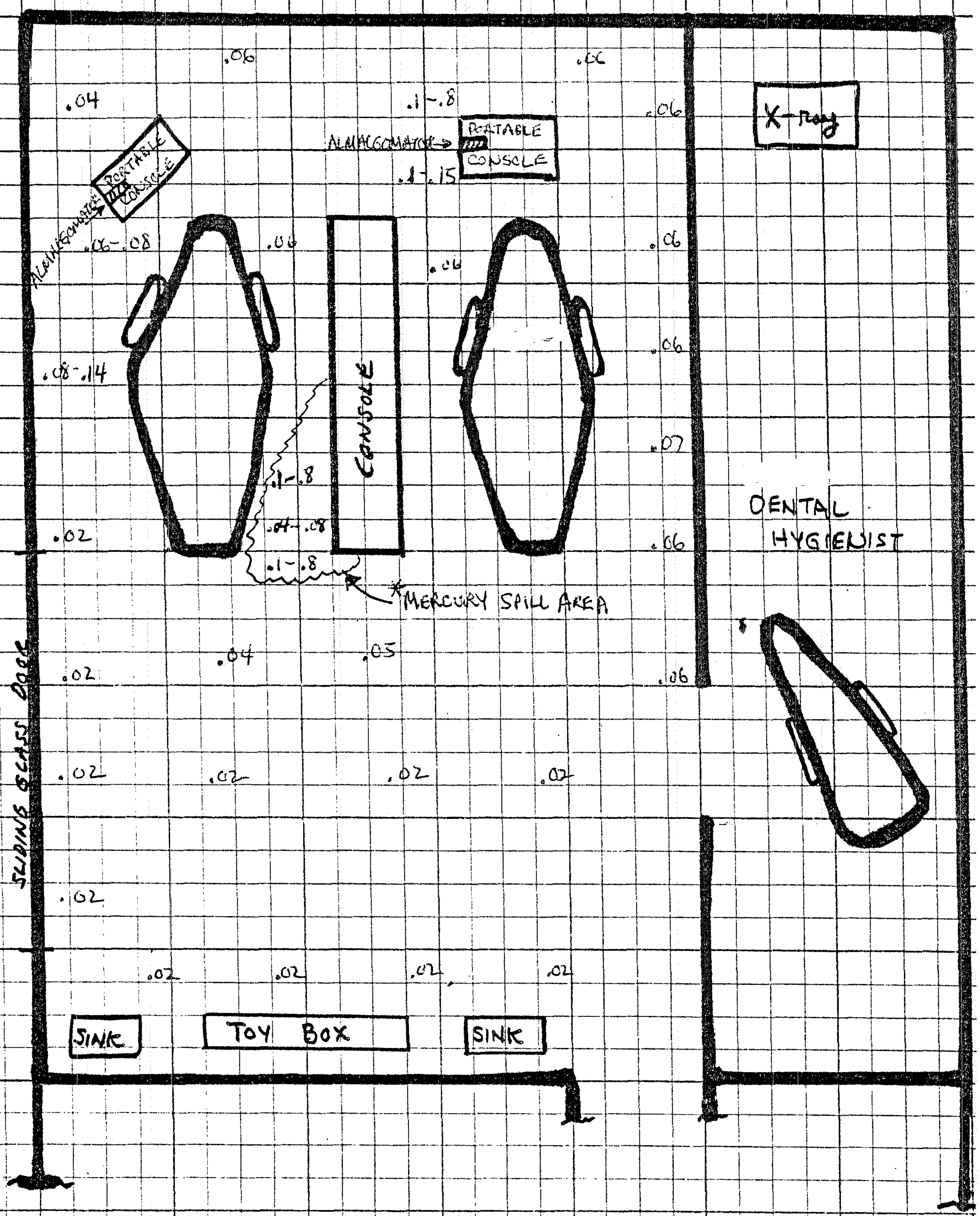
X-ray
DENTAL HYGIENIST
PORTABLE CONSOLE
ALMAGOMATOR
PORTABLE CONSOLE
ALMAGOMATOR
CONSOLE
MERCURY SPILL AREA
SINK
TOY BOX
SINK
SLIDING GLASS DOOR
OUTSIDE
.04
.06
.1-.8
.1-.15
.06-.08
.08-.14
.02
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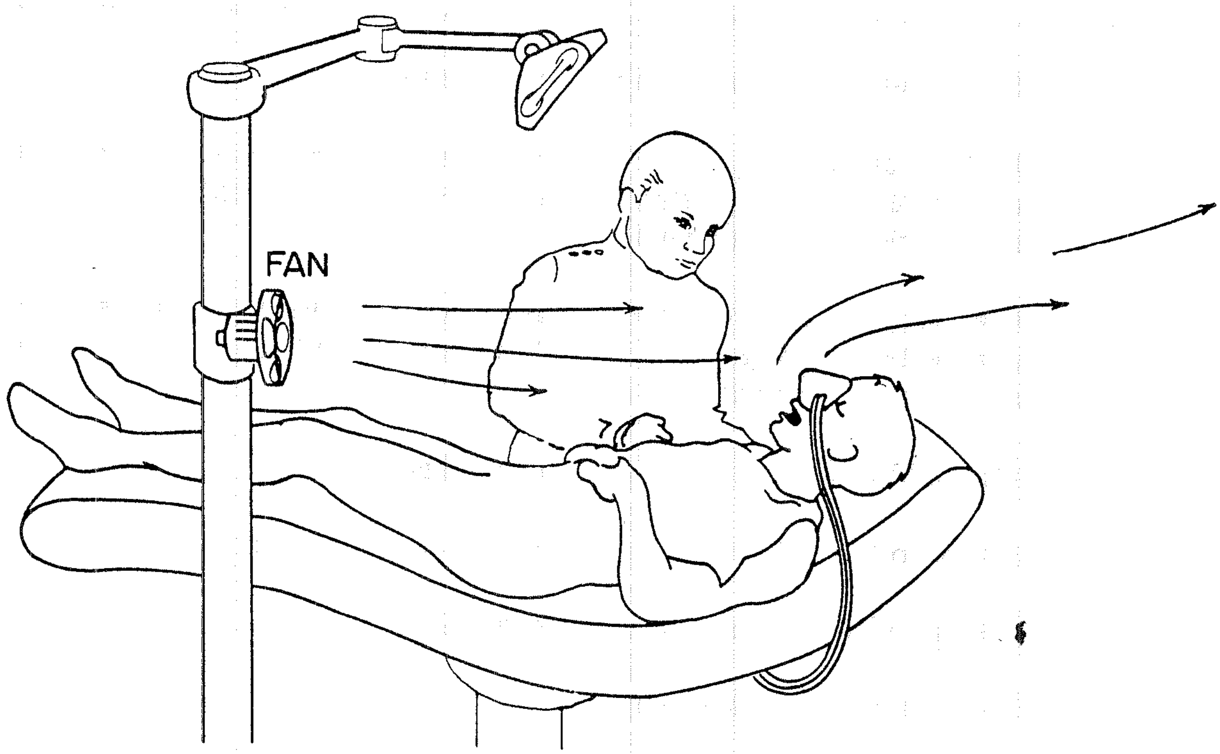
Figure II

Air Sweep System



NOTE: The apparatus consist of a quietly operating fan located to take in relatively fresh air.

RECOMMENDATIONS IN MERCURY HYGIENE, FEBRUARY 1974

1. Store mercury in unbreakable, tightly sealed containers.
2. Perform all operations involving mercury over areas that have impervious and suitably lipped surfaces so as to confine and facilitate recovery of spilled mercury or amalgam.
3. Clean up any spilled mercury immediately. Droplets may be picked up with narrow bore tubing connected (via a wash-bottle trap) to the low-volume aspirator of the dental unit.
4. Use tightly closed capsules during amalgamation.
5. Use a no-touch technique for handling the amalgam.
6. Salvage all amalgam scrap and store it under water.
7. Work in well-ventilated spaces.
8. Avoid carpeting dental operatories as decontamination is not possible.
9. Eliminate the use of mercury-containing solutions.
10. Avoid heating mercury or amalgam.
11. Use water spray and suction when grinding dental amalgam.
12. Use conventional dental amalgam compacting procedures, manual and mechanical, but do not use ultrasonic amalgam condensors.
13. Perform yearly mercury determinations on all personnel regularly employed in dental offices.
14. Have periodic mercury vapor level determinations made in operatories.
15. Alert all personnel involved in handling of mercury, especially during training or indoctrination periods, of the potential hazard of mercury vapor and the necessity for observing good mercury hygiene practices.

Attachment II

Recommendations in mercury hygiene

Council on Dental Materials and Devices

The Association, through its Council on Dental Materials and Devices, is publishing a series of recommendations concerning safety or proper practices in the dental office. The Council, in cooperation with the Council on Dental Research, sponsored and published an article titled "Significance to Health of Mercury Used in Dental Practice: A Review" in the June 1971 issue of THE JOURNAL (JADA 82:1401 June 1971).

Since mercury as a potential health hazard in dental practice cannot be dismissed or casually treated, the Council has continued to follow reports in this area. Reports of surveys in the US,[1-3] Canada,[4] and England[5] all show that at least 10% of dental offices have air levels of mercury vapor in excess of the threshold limit value (TLV) of 0.05 mg/m^3. A summary of surveys made in the United States will be the subject of a subsequent report. Even though neither a dentist nor a dental assistant has been reported as suffering from chronic mercurialism, many exposures are sufficient to cause concern. This is especially true since the *British Dental Journal*[6] reported one fatality of a dental assistant that was attributed to acute mercury poisoning. This case was inadequately investigated so nothing is known concerning her medical history or the mercury hygiene of her work spaces. Consequently, the mercury hygiene observed in the office where she worked cannot be identified as the direct source of her mercury poisoning.

Much has been made over the materials and methods used in dental office construction to reduce the potential of mercury contamination. Impervious and seamless work and floor areas with edges lipped to confine spills have been universally recommended. Even so, many decorators continue to install rugs on the floors of dental operatories. Carpeting is not recommended, as decontamination in the event of spills is not possible. The mercury levels in these offices, however, are often lower than the mercury levels in offices decorated as recommended. The determining factor influencing vapor levels is the mercury hygiene observed by the dental personnel in the offices. Consequently, efforts to establish guidelines for proper mercury hygiene must center on the few minutes during proportioning of the mercury and alloy and mixing of the amalgam mechanically. Capsules fitted with friction grip caps and some preproportioned disposable capsules disperse free mercury during high-speed mechanical trituration.[7,8] This loss of mercury during trituration can be detected by wrapping adhesive tape around the capsule prior to the mechanical mixing. If the capsules are tight and no mercury is thrown out, the adhesive side of the tape will be clean after trituration. Drops of mercury, 0.1 mm in diameter and weighing approximately 0.01 mg, can be seen on the tape with the naked eye.[8] This test should be made on new capsules, as well as occasionally during the use of the capsule.

Von Nossek and Seidel[9] and Chandler and coworkers[10] observed a spray of mercury-rich particles during condensation with an ultrasonic instrument. Although no significant mercury vapor was detected, the dispersal of small particles, which can be inhaled by dental personnel and patients, is not considered to be good mercury hygiene.

These foregoing reports, along with Stewart and Stradling's[11] code of mercury hygiene for dental operatories, form the basis for the Council's recommendations of criteria for good mercury hygiene.

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