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 NO. 77-21-381

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LITTLESTOWN, PENNSYLVANIA 17340

APRIL 1977

I. TOXICITY DETERMINATION

A Health Hazard Evaluation was conducted by the National Institute for Occupational Safety and Health (NIOSH) in the clinic of H.O. Strickler, D.D.S., Littlestown, Pennsylvania on January 7, 1977. The intent of the survey was to determine whether exposures to mercury vapor were posing a health hazard to Dr. Strickler and his employees. On the basis of air sample results, urine mercury levels, employee interviews, and available toxicity information, it is concluded that exposures to mercury vapors did not present a health hazard to the employees at the time of the survey. Measurements with a direct reading instrument did indicate that a small amount of mercury contamination was present in various places in the clinic. Recommendations for mercury control in dental offices are given in the text of this report. Several of these recommendations were discussed with Dr. Strickler at the time of the survey.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this report are available 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 from the National Technical Information Service, (NTIS), Springfield, Virginia. Information regarding its availability through NTIS can be obtained from the NIOSH Publications Office at the Cincinnati address.

Copies of this report have been sent to:

1. Dr. H.O. Strickler, Littlestown, Pennsylvania
2. U.S. Department of Labor - Region III
3. NIOSH - Region III

To "inform" the 3 affected employees, copies of the report shall be provided to these employees or the report shall be posted in a place prominent to the employees for a period of 30 days.

III. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669 (a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by 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.

NIOSH received such a request from Dr. Strickler to evaluate the potential of hazardous exposure to mercury in his dental clinic. Dr. Strickler had "heard and read of dangers of mercury contamination in dental offices during trituration of alloy with mercury and due to spillage" and wanted to ascertain as to whether or not a hazard existed in his clinic.

IV. HEALTH HAZARD EVALUATION

A. Facility and Process Description

The clinic occupies approximately 800 square feet, which provides for a waiting room, a receptionist area, 3 operatories, a laboratory, an x-ray room, an office, and a rest room. The clinic is of typical construction having linoleum flooring in the operatories, laboratories and office. The waiting room and hallway are carpeted. The clinic is steam heated during the colder season and has a central air conditioner for cooling pruposes in the hotter months. The current staff at the clinic includes Dr. Strickler, his assistant, a dental hygienist, and his receptionist, all of whom work about an 8-hour day. On the day of the survey, the dental hygienist was not working.

The mercury handling procedure is similar to that found in many dental offices. The mercury is purchased in 1 pound bottles. The amalgam preparation process consists of putting a 6 gram alloy tablet into a plastic capsule and adding a drop of mercury. The capsule is agitated on an amalgamator after which the amalgam is removed from the capsule and used for tooth filling pruposes. During this process, it is possible for mercury contamination to occur. It is necessary that certain precautions be taken in order that the dentists, assistants, and even patients not be needlessly exposed to mercury vapor. About four pounds of mercury are used per year at this clinic.

B. Evaluation Methods

1. Environmental

Four 3M mercury monitor badges were used as personal samplers to determine employee exposures to mercury vapor. These badges were analyzed by the 3M Company, St. Paul, Minnesota.

Ten fixed location samples for mercury vapor were collected using iodine-impregnated activated charcoal tubes and personal sampling pumps operating at air flows of about 50 cubic centimeters of air per minute (50 cc/min). These tubes were analyzed by atomic absorption spectrophotometry (Utah Biomedical Test Laboratory, Salt Lake City, Utah).

A number of mercury vapor determinations were made with a direct reading Bacharach Model MV2 Mercury Sniffer. The prime value of the Mercury Sniffer is to point out areas of contamination rather than to provide an accurate estimate of employee exposures.

2. Medical

The employees of the clinic were interviewed via a non-directed questionnaire to determine whether there were health effects implied by signs or symptoms and associated with exposure to mercury vapor.

In the morning, spot urine samples were solicited from the clinic employees in order to determine whether there was evidence of occupational exposure to mercury. These samples were put into 125 cc bottles to which a few crystals of "Thymol" (3-p-cymeno) had been added as a preservative. The samples were analyzed by atomic absorption spectroscopy (Utah Biomedical Test Laboratory, Salt Lake City, Utah).

C. Evaluation Criteria

1. Physiological Effects

Mercury is a general protoplasmic poison that can be absorbed by inhalation or in the case of soluble mercury salts by ingestion. Mercury and its organic compounds may also cause dermatitis, vision disorders, and chronic gingivitis and pharyngitis. Occupational exposure to mercury or its organic compounds is usually chronic in form. However, acute poisoning may occur due to massive inhalation of mercury vapor. Acute conditions are limited to the buccopharyngeal area. Cases of mercury intoxication with neurological symptoms have been reported. The classical symptoms of chronic intoxication of mercury (mercurialism) consists of excessive salivation and gingivitis, a metallic taste in the mouth, erethism, and a tremor of the upper and/or lower extremity. Erethism is a syndrome that consists of the following symptoms: nervousness, irritability, hyperexcitability and easy loss of temper. However, mercurialism has been associated with other signs and/or symptoms which include: depression, headache, fatigue, insomnia, impaired memory, anorexia, weight loss, loose teeth, bleeding gums, sore throat, black line on gums (mercury line), various gastrointestinal disturbances, dermatitis, stomatitis, tingling sensation of the tongue, "shakey" legs, intention tremor of lips, hands or feet, loss of muscle strength in arms and legs, disturbances of gait, and nephrotic syndrome with edema, proteinuria and casts in the urinary sediment[1,2,3].

2. Environmental Criteria

The NIOSH recommended standard for exposure to mercury is 0.05 milligrams of mercury per cubic meter of air (mg/M^3) for an 8-hour time-weighted average daily exposure.[2] The current U.S. Department of Labor[4] legally enforceable standard is 0.1 mg/M^3 as a ceiling concentration.[3] These occupational exposure standards (recommended and legal) are designed to protect the average worker over a normal worklife consisting of 8-hours per day, 40 hours per week exposure. It is felt that the NIOSH recommended standard is the most appropriate criteria for this investigation.

3. Medical Criteria (Urine mercury levels)

The complexities of renal excretory mechanisms for mercury makes it difficult to correlate urine mercury levels with either environmental exposures or signs and symptoms of mercury "intoxication". Such difficulties are particularly evident in the case of "spot" urine samples as compared with 24-hour samples, since the rate of excretion of mercury fluctuates considerably resulting in day-to-day and diurnal variations. The normal urine mercury levels for non-occupationally exposed persons can be considered to be less than 10 micrograms of mercury per liter of urine (ug/l). A suggested guide for the interpretation of urine mercury levels is as follows:[5]

Guide for Workers Exposed to Inorganic Mercury	Level of Mercury in Urine Micrograms/Liter
Normal Limits	Less than 30
Increased Absorption	above 50
Warning	above 100
Hazardous Level - remove from further exposure	above 200
Symptoms of Mercury Poisoning may occur	above 300

While there are many variables, the average urinary mercury level for a group of workers may be indicative of environmental exposure. Group average urine mercury levels greater than 50 ug/liter should arouse suspicion and levels greater than 100 ug/liter should lead to corrective measures which will reduce environmental exposures.

D. Discussion of Results - Recommendations

The results of this study are not remarkable - they neither portray this clinic to be significantly contaminated nor do they portray the clinic to be free of contamination. The monitor badge personal sampling results (Table 1) indicate exposures to clinic personnel which ranged from 2% to 10% of the NIOSH recommended standard for occupational exposure. The

charcoal tube air sample results (Table 2) indicated general air concentrations which were also well below 0.05 mg/M^3. The one charcoal tube sample indicating an air concentration greater than 0.05 mg/M^3 was collected inside the mercury storage cabinet. Although this sample was taken primarily for academic interest, it may give substance for recommending that the mercury be stored in unused areas or within air tight containers. The monitor badge and charcoal tube air sample results may be summarized by saying that they indicate air concentrations of mercury which should not cause adverse health effects.

The three urine mercury analyses on clinic personnel averaged 40 ug/liter. While this group average of 40 ug/liter is based on a small number of samples (n=3), it may be taken to be indicative of a certain amount of environmental exposure. It is interesting that Joselow, et. al.[5] for "spot" urine sampling of 50 dentists, also found the average urine mercury level to be 40 ug/liter. A "control" sample from the NIOSH investigator of this hazard evaluation showed a urine mercury level of less than 10 ug/liter. The urine mercury levels may be summarized by saying that they suggest non-serious environmental exposures.

The results of the direct reading instrument measurements (Table 3) indicate that a typical amount of mercury contamination is present within this clinic. Not surprisingly, the carpet in the hallway was the most contaminated feature of the clinic. Once again, the often quoted recommendation of avoiding carpeting in dental clinics is validated.

On the basis of this investigation, it is concluded that exposures to mercury vapor in this clinic are such that they should not present a health hazard to clinic personnel. Even so, the recommendations in mercury hygiene as set forth by the American Dental Association (see attachment) should be consulted as they represent methods of reducing employee exposure to mercury vapor.

V. REFERENCES

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TABLE 1

Results of Monitor Badge Personal Sampling for Mercury Vapor

H.O. Strickler, D.D.S.
Littlestown, Pennsylvania

January 7, 1977

Time	Sample Location	Mercury Concentration (mg/M^3)*
0818-1435	Receptionist	0.005
0816-1438	Dental Assistant	0.001
0817-1500	Dentist	0.002
0819-1440	NIOSH Industrial Hygienist	0.000

The NIOSH recommended standard for exposure to inorganic mercury is 0.05 mg/M^3 for an 8-hour time weighted average daily exposure.

*Milligrams of mercury per cubic meter of air

TABLE 2

Results of Fixed Location Charcoal Tube Air Sampling for Mercury Vapor

H.O. Strickler, D.D.S.
Littlestown, Pennsylvania

January 7, 1977

Time	Sample Location	Mercury Concentration (mg/M^3)*
0831-1412	Receptionist's desk	0.01
0848-1417	Operatory 1 - by amalgamator	0.02
0845-1419	Operatory 1 - cabinet by x-ray	0.02
0847-1417	Lab - counter top	0.02
0830-1413	Lab - inside mercury storage cabinet	0.07
0850-1430	Operatory 2 - by amalgamator	0.01
0836-1418	Office - by desk top	0.01
0838-1410	Storage room shelf	none detected
0834-1408	Operatory 3 - tool stand	less than 0.01
0849-1424	Rest room - towel cabinet	none detected

*Milligrams of mercury per cubic meter of air

TABLE 3

Results of Mercury Vapor Sampling with Bacharach Direct Reading Sniffer

H.O. Strickler, D.D.S.
Littlestown, Pennsylvania

January 7, 1977

Location	Concentration (mg/M^3)
Waiting room - ambient	.005
- carpet	.005
- chairs	.005
- table	.005
Receptionist - ambient	.01
- floor	.01
- counter top	.01
- desk top	.01
- carpet	.01
Operatory 1 - ambient	.01-.02
- counter top by amalgomator	.04
- under floor mat	.02
- carpet in hallway, just outside door	.04
Laboratory - ambient	.01
- wastebaskets	.01
- floor	.01
- counter tops	.01
- sink drains	.01
- scrub pail	.01
- carpet mat	.01
- inside Hg. storage cabinet	.02
Operatory 2 - ambient	.02
- sinks	.02
- floor	.02
- counter top	.02
- mat too	.02
- carpet in hallway, just outside door	.04
Office - ambient	.005
- carpet	.005
- desk top	.005
- chair seat	.005
X-ray Room - ambient	.01
- counter tops	.01
- floor	.01
- mop	.01
- mop (after mopping)	.04
Operatory 3 - ambient	.005
- sink drain	.005
- cuspidor	.005
- cabinet tops	.005
- carpet in hallway, just outside door	.02

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.

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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