Determination of mercury concentration in the air of dental clinics and the urines of their personnel with cold vapor atomic absorption spectrometry

Hassan Zavvar Mousavi *[1] *Ahmad Rouhollahi* [2] *Hamid Shirkhanloo*[3]

ABSTRACT

Background: Dental clinics are known to be one of the largest users of Toxic inorganic mercury. It is well documented that dentists and dental assistants who work with amalgam are chronically exposed to mercury vapor. This study investigates exposure to mercury vapor in a dental clinic.

Methods: GBC cold vapor atomic absorption spectrometry (AAS), using sodium borohydride as the reducing agent, was employed to determine mercury concentrations. The determination of mercury in urine and air was carried out using a flow injection system after sample treatment according to the standard procedure.

Result: In this study mercury exposure in some dentist and dental office personnel was examined. We studied 495 persons (280 dentists and 215 dental personnel) occupationally exposed to mercury while working at 58 dental clinics in Tehran. In addition 305 samples from dental office's air were taken and their mercury was measured with HG-AAS.

Conclusion: In this study, mercury levels in dentists urine and dental office atmosphere were lower than occupational safety and health administration (OSHA). Results acquired from this study show that the amount of mercury were in normal range and it is lower than to the potential for adverse exposure to elemental mercury vapor concentration in a dental office.

Key words: Air, Dentists, HG-AAS, Niosh, Toxic of Mercury ,Urine

INTRODUCTION

Dental clinics are known to be one of the largest users of inorganic and metalic mercury (1). Mercury, which vaporizes at room temperature and easily enters the environment, is used in the preparation of amalgam, an alloy that consists chiefly of silver mixed with mercury and variable amounts of other metals and is used as a dental filling. It is well documented that dentists and dental personnel who work with amalgam are chronically exposed to mercury vapors, which can accumulate in their bodies to much more higher levels than for most non-occupationally exposed individuals. Adverse health effects of this exposure including subtle neurological side-effects have also been well documented in most dentists and dental assistants even at the lowest levels of exposure; consequently, measurement of mercury in dental offices seems to be important. A potential source of exposure to metallic mercury for general population is its gradual release from dental amalgam fillings which contains approximately 50% metallic mercury, 35%

[1]Department of Chemistry, College of Science, Semnan University, Semnan, Iran
[2,3]Department of Chemistry, Faculty of Science, K. N. Toosi University of Technology, Tehran, Iran
*Corresponding author: K. N. Toosi University of Technology, Tel / Fax:+98 021 55209332
Email: amidshirkhanloo@yahoo.ca

silver, 9% tin, 6% copper, and trace amounts of zinc. Amalgam is first mixed as a soft paste that can be inserted into the tooth cavity, but within 30 minutes it hardens and the mercury becomes boundeh within the amalgam. During the ensuing years, due to corrosion, chewing, or grinding motions, very small amounts of mercury is slowly released from the surface of the fillings which might vaporize into the air or be dissolved in the saliva. The total amount of mercury released from dental fillings depends on total number of fillings, surface areas of each filling, chewing and eating habits of the person, and chemical milieu of the mouth. Some studies have surveyed dental office exposure levels (2- 6) and found that mercury in the ranged form 0.7 to over 300 micrograms per cubic meter ($\mu g/M^3$) (7). Many dentists have been documented to suffer from mercury poisoning(8,9) presenting with symptoms such as chronic fatigue, muscle pains, stomach upset, tremors, motor effects, immune reactivity, etc of which the most common is chronic fatigue due to immune system overload. Dental workers are mostly exposed through breathing air poluted with mercury vapors released from amalgam fillings, from assembling amalgam in amalgamtor , or to a much lesser extent from direct skin contact with amalgam paste. Family members of these workers may also become exposed to mercury through personnels' clothes contaminated with mercury particles. Ingested metallic mercury enters the body through the stomach or intestines but even in large amounts very little enteres the body. On the other hand, breathing mercury vapors results in direct absorption of most it (about 80%) from the lungs which rapidly travels to other organs, including the brain and kidneys. Once it enters the body, metallic mercury can stay for weeks or months. In the brain, it is readily converted to an inorganic form that is trapped for a long time. Inorganic mercury in the blood of a pregnant woman can cross the placenta gain access to her developing fetus. Most of the mercury accumulates in kidneys and eventually is excreted in the urine and feces, while much smaller amounts leave the body in the exhaled breath. The nervous system and kidneys are most sensitive to mercury and in a number of countries some people who had exposures due to consumption of fish or grains contaminated with methylmercury or other organic mercury compounds, developed permanent damage to the brain and kidneys. Sufficiently high levels of metallic mercury can also permanently damage the brain.

MATERIAL AND METHODS:

Reagents: Deionized water, hydrochloric acid conc., nitric acid (HNO_3), potassium permanganate, %20 w/v stannous chloride ($SnCl_2$) in 1ml hydrochloric acid solution and calibration stock solution, Hg^{2+}, 1000 µg/mL were used. The artificial urine (5.08 g NaCl, 2.86 g KCl, 0.31 g CaO and 0.42 g $MgCl_2$,$2H_2O$, 0.67 ml H_2SO_4, 8.7 ml HCl, 3.09 g $NH_4H_2PO_4$) for blank sample was employed. Personal pump and BOD buttle were used for collection of air in the dental clinics. Amalgamator model smedent (YDM-PRO) were used in dental clinics .

Equipments: GBC cold vapor atomic absorption spectrometry (AAS), using sodium borohydride as the reducing agent, was employed to determine mercury concentrations. Personal pump and BOD buttle were used for collection of air in the dental clinics.

Urine sampling: 24-hour urine samples were obtained from dentists and their colleagues who had several months of steady exposure, at the end of a working week in 2.5 lit. polypropylene sampling vessels and after the addition of conc. HCL to yield a final acid concentration of 1-3% v/v were stored at -20°C prior to analysis.

Air sampling: All samples were collected in an employee's breathing zone according to OSHA analytical method. Each personal sampling pump was calibrate with a representative sampler and the end of sampler was broken immediately prior to sampling. Samplers were attached to the pumps with flexible tubings and air was colleted at a rate of 0.15 to 0.25 L/min.

Samplers were capped and pack securely for shipment. Hopcalite sorbent and the front glass wool plug from each sampler was placed in separate 50-ml volumetric flasks and 2.5 ml conc. HNO 3 followed by 2.5 mL conc. HCl was added. Hopcalite sorbent was dissolved then it was diluted to 50 mL with deionized water and mercury concentration was determined with AAS- HG.

RESULTS

Mercury levels found in blood, urine, breast milk, or hair may be used to determine if adverse health effects are likely to occur. Mercury in urine is used to test for exposure to metallic mercury vapor and to inorganic forms of mercury. A person's exposure to mercury vapor should not exceed OSHA's PEL for mercury vapor of 0.1 mg/m^3 of air. In addition NIOSH has established a recommended exposure limit for mercury vapor of 0.05 mg/m^3 TWA for up to a 8-hour workday and a 40-hour workweek. ACGIH has assigned mercury vapor a threshold limit value of 0.025 mg/m^3 TWA for a normal eight-hour workday and a 40-hour work week (10). Mercury levels in urine can be used to help diagnose recent mercury exposure and to evaluate patient response to chelation therapy. Normal mercury concentration in urine is less than 20 ug/L in NIOSH. In this study mercury exposure in some dentist and dental office personnel was examined. We studied 495 persons (280 dentists and 215 dental personnel) occupationally exposed to mercury while working at 58 dental clinics in Tehran. These groups were The median mercury concentration (58 clinic) in the urine samples were 3.6 ± 0.1 µg/ L and workplace air was 0.011 ± 0.002 mg/m^3 for dental offices. This results have normal range as compared to OSHA and ACGIH.

Table1:Number of dental clincs and personnels at 20-50 age

N Dentist (M)/(F)	N assistant (M)/(F)	N Gov Clinic	N Non GovClinic
145/135	73/142	32	26

Table2: Median of mercury concentration in dental urines(µg/l) and dental office(mg/m^3)

	Dentist	Dental assistant	Gov Clinic	Non-Gov Clinic
Num	280	215	32	26
Urines	3.4	3.8	3.05	4.16
Offices	0.01	0.012	0.009	0.014

Table3:Effect of number of patients in increasing mercury vapor concentration in around of amalgamator system

N-Patient (20-50age)	(Time-h)(Flow rate-ml/min) (Con.mercury- mg/m^3)
5	(4) (200)(0.011)
13	(4) (200)(0.021)
20	(4) (200)(0.026)
27	(4) (200)(0.031)
32	(4) (200)(0.045)
43	(4) (200)(0.076)
55	(4) (200)(0.104)

Table4-Effect of number of patients in increasing of mercury vapor in urine and dental office

N- patient	Urine (µg/L)	Dental office (mg/m^3)
5	1	0.002
13	3	0.005
20	4.5	0.008
27	5.2	0.009
32	7.8	0.011
43	9	0.014
55	13.4	0.022

Table5Effect of increase volume of dental office(m^2) in decreasing of mercury vapor con.

office m^2	mercury vapour mg/m^3
15	0.018
40	0.01
50	0.009
65	0.008
75	0.006
90	0.004
110	0.002

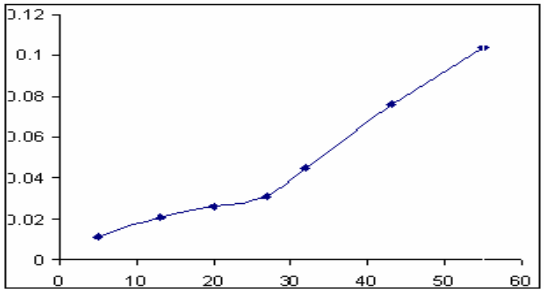

Figure1- Effect of number of patients in increasing mercury vapor concentration in around amalgamator system

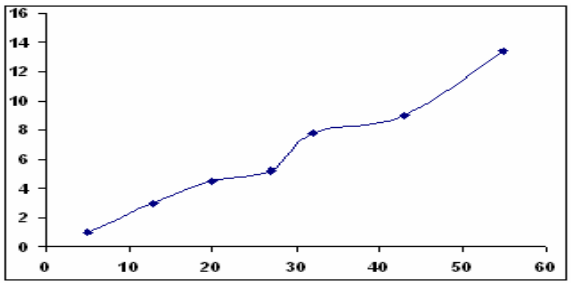

Figure 2-Effect of number of patients in increasing of mercury vapor con. in dental urine

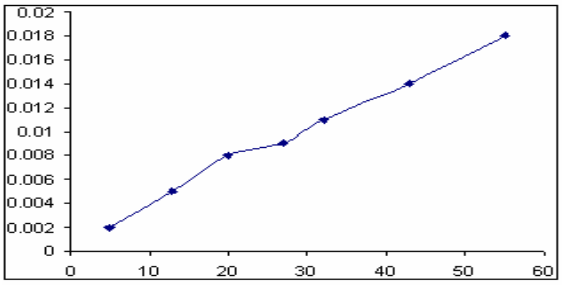

Figure 3-Effect of number of patients in increasing of mercury vapor con. in dental office

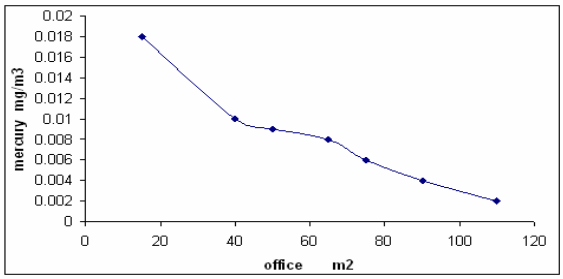

Figure 4-Effect of increase volume of dental office in decreasing of mercury vapor con.

DISSCUSSION

The results show us mercury concentration (Hg) in urine and office of dental personnel in 58 dental clinics of Tehran. Two groups of dental clinics selected for investigation from 32 government clinics with 215 dental personnels and 26 nongovernment clinics with 280 personnels. Volume sample was 50ml for urine and 50 Li air vacuumed by personnel pump. Statistical methods such as relative standard division (RSD) and median was used for precision and accuracy. Table(1 ,2) shows us the situation of sex, age , number of dentists and their assistants, different clinics and median mercury concentration.

For showing effect of increasing number of patients on mercury vapor concentration, we selected randomly seven clinics with different number of patients and determined mercury in dental office and urine. Table 3 and figure1 shows , the effect of number of patients in increasing of mercury vapor concentration in air around of amalgamator system. Amalgamator model smedent (YDM-PRO) were used in dental clinics .

Table4 and Figure(2 ,3) shows us the effect of number of patients in increasing of mercury concentration in dental urine and office. Finally, table 5 and diagram 4 show us, the effect of volume of dental office on mercury vapor concentration.

CONCLUSIONS

Mercury is a toxic substance. For high exposures, observed mostly in occupational settings, the severity of response correlates with the duration and intensity of the

exposure. Urine mercury levels of dental personnel in the study were similar to OSHA. Results of this study also showed no increase in the prevalence of these symptoms in relation to concentrations of mercury in urine. In addition, subtle signs and symptoms of chronic mercury intoxication may not be found through routine physical examinations. but many number of patients can be little increase mercury in dental urine and air office so increase mercury depend on time of working , number of patients and volume of dental office. Available data are not sufficient to indicate that health hazards can be identified in occupationally exposed persons. Health hazards, however, cannot be dismissed. Results acquired from this study show that the amount of mercury were in normal range and it is lower than to the potential for adverse exposure to elemental mercury vapor concentration in a dental office.

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