

# DENTIST'S ATTITUDE TOWARD MERCURY HYGIENE PRACTICE AND ITS CORRELATION WITH URINARY MERCURY LEVELS AMONG EGYPTIAN DENTISTS

By

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## **Abstract:**

**Background:** Amalgam is the restorative material chosen by many dentists because of its easy manipulation, durability and low cost. It is well known that mercury is highly toxic to the human body. Dentists are exposed in their working environment to mercury vapor and this exposure constitutes a potential risk to them. American Dental Association (ADA) established the recommendations for appropriate mercury hygiene within the dental offices, but they are not practiced properly. **Objective:** the aim of this study is to evaluate mercury hygiene practice among dentists in Cairo University and its reflection on urine mercury level and kidney function.

**Methods:** This study was carried on 30 dentists working in the Operative Dental Clinics in Faculty of Oral and Dental Medicine, Cairo University. Using a specially designed questionnaire to evaluate the attitude of dentists in their following the ADA mercury hygiene recommendations. Urine sample was taken for analysis of mercury concentration and kidney functions from dentists and compared with urine taken from 25 nurses and employers working in Kasr El- Aini Hospital not exposed to mercury after taken their consent who served as control group.

**Results:** Showed that 50% of dentists were aware about mercury hazards to them, while 46.66% of dentists believed that amalgam was hazardous to patients only. Preventive measures taken by the dentists when working with amalgam showed that most of dentists were not following the ADA recommended guidelines.

As regard asking the patient not to swallow the spilled mercury in maxillary cavity, there were 23.34% always asking the patient not to swallow the spilled mercury, where as 13.33% never asking the patient not to swallow the spilled mercury. As regard the disposal of mercury waste, dentists did not know the proper method to dispose the waste mercury, 100% of dentists use waste bag to discard excess amalgam. This study showed a highly significant difference between the level of mercury (ug/creatinine) in dentist's urine ( $19.73 \pm 1.5$ ) and control ( $5.16 \pm 1.47$ ). While as regards urea & creatinine level in urine our results showed a highly significant difference between dentists & control, urea level in dentist's urine ( $21.70 \pm 2.78$ ) while in control ( $16.54 \pm 1.28$ ) creatinine level in dentist's urine ( $1.40 \pm 0.59$ ) & among control ( $0.88 \pm 0.34$ ).

**Conclusion:** This study showed that most dentists do not strictly follow the mercury hygiene and ADA guidelines

**Recommendations:** We recommend increase aware about hazards due to mercury vapor exposure to dentists and patients. ADA recommendations should follow improving occupational hygiene practice and to ensure that all areas of the surgery have mercury levels below the occupational exposure standard.

## Introduction

Dental amalgam is a restorative material used worldwide. It is an alloy composed of mercury, silver, copper and tin, which may also contain palladium, zinc, and other elements to improve handling characteristics and clinical performance (Ferracane & Jack 2001). Dental healthcare workers (DHCWs) are exposed to mercury by two routes, from handling the material while treating patients and/or, from restorations of dental amalgam in their own mouths, like general population. Occupational exposure of DHCWs to mercury may occur during the preparation of the dental amalgam, the insertion and removal of amalgam restorations, storage of mercury and waste amalgam,

autoclaving of instruments contaminated with mercury or particle spread occurring during any surgical procedure (Karahalil et al., 2005). In this respect, it has previously been considered that mercury may vaporize during removal, mixing and polishing of amalgam restorations (Skare & Engqvist, 1994).

Numerous studies report positive correlations between the number of dental amalgam restorations or surfaces remodelling and urine mercury concentrations in non-occupationally exposed individuals. Although of public concern, it is currently unclear what adverse health effects are caused by the levels of mercury vapour (Hg) released from this restoration material. Historically, studies

of occupationally exposed individuals have provided consistent information about the relationship between exposure to Hg and adverse effects reflecting both nervous system and renal dysfunction. (Burke et al., 2001, and Brownawell et al., 2005).

Despite widespread concern about the safety of silver–mercury amalgam dental restorations (Skare & Engqvist, 1994), there is little evidence regarding harm or safety in the general population. Dental amalgams have been used for over 150 years with no overt adverse effects (Sadig & Khairuldean, 1996). Nevertheless, a 1991 American Dental Association survey of 1,000 adults found that 50% thought amalgam restorations might have adverse effect a similar survey of dentists found that although 89% of respondents believed that amalgams posed no risk, 52% reported that they would replace such restorations at a patient's request (Gerbert et al., 1992).

A study was done to examine the health effects of mercury in the UK which compared the urinary mercury excretion level in dentists and in a controlled group which showed that dentists were more likely to have disorder of the kidney and memory disturbances than the general population (Ngim et al., 1992).

### **Aim of work**

The aim of this study was to evaluate mercury hygiene practice among dentists in Operative Dental Clinics, Faculty of Oral and Dental Medicine, Cairo University and its reflection on urine mercury level and kidney functions.

### **Patients and Methods**

This study was conducted on a randomly selected 30 dentists (17 males and 13 females) working with amalgam in an uninterrupted dental practice for 5 consecutive years in the Operative Dental Clinics - Faculty of Oral and Dental Medicine - Cairo University, their age ranged from 26 to 38 years (mean age 32 years). Beside 25 nurses and employers working in Kasr El- Aini Hospital not occupationally exposed to mercury served as a control group after taken their consent. Both participated dentists and control group were matched for age and sex. This study was conducted from July to November 2011. Exclusion criteria were those having dental fillings or kidney dysfunction.

A questionnaire was designed to evaluate the attitude of dentists in following the ADA mercury hygiene recommendations. The questionnaire was focusing on the following

- (1) Awareness of dentists about hazards of mercury exposure to patient and dental personnel (table1)
- (2) Safety measures taken by dentists while dealing with amalgam.
- (3) Measures taken in the clinical setup to control and prevent mercury toxicity(table2).
- (4) Measures taken to discard excess amalgam (table3).

Morning urine sample (25ml) was taken from the dentists and the control groups for analysis of mercury concentration and kidney functions. Freshly collected urine samples were allowed to sit at room temperature for 30 minutes to sediment, and the supernatant was aliquoted and stored at -70 °C until analysis.

All the participants were subjected to:

#### **Urine creatinine test (mmol/L)**

Creatinine assay was carried out according to Cayman Chemical Creatinine Assay (Cayman Chemical Company, UK). The assay relies on Jaffe's reaction, wherein a yellow or orange color is formed when the metabolites are treated with alkaline picrate. The color derived from the creatinine is destroyed at acidic pH. The difference in

color intensity measured at OD495 before and after acidification is proportional to the creatinine concentration. A creatinine standard curve was constructed for urine creatinine concentration determination (Peake & Whiting, 2006).

#### **Urea in urine (mg/dL)**

Quantitative determination of urea was done by using chemical colorimetric method (QuantiChrom™ Urea Assay Kit, Cat. No. DIUR-500), it manufactured by Bioassay Systems Inc., USA. Urine samples should be diluted 50-fold in distilled water prior to assay (n = 50). The intensity of the color, measured at 520nm, is directly proportional to the urea concentration in the sample (Jung et al., 1975).

#### **Mercury in Urine (HgU)**

Levels of mercury in urine were determined using the cold vapor atomic absorption spectrophotometric technique (Lindstedt, 1970). In a special conical flask, one ml urine was digested by concentrated sulfuric acid and potassium-permanganate (5%). The flask was left stopper overnight at room temperature.

After 24 hours, the excess potassium permanganate was reduced by 20%

hydroxylamine hydrochloride solution.

The clear colorless sample was transferred to measurement in the PYE Unicam atomic absorption spectrophotometer SP-90.

The concentration of mercury in urine was referred to its creatinine content (Lindstedt, 1970). According to Rappaport study 50 µg/ g creatinine is the biological limit value for exposure to mercury (Rappaport, 1995).

### Statistical analysis

Statistical analysis was performed using computer statistical software package SPSS 9.02. Descriptive statistics was presented as mean  $\pm$  standard deviation. One-way frequency tables were generated to summarize the responses. Comparative analysis between different groups applied using student T test for parametric data and Wilcox on sum of rank for skewed data. P-value was considered significant if  $<0.05$ .

### Results

**Table 1: Measures taken by dentist when working with amalgam**

Preventive measures taken by dentists in%	Always	Sometimes	Rarely	Never
Wearing gloves	96.67	3.33	0	0
Wearing face masks	100	0	0	0
Eye protection	0	0	0	100
Change of clothing	0	0	0	100
Drinking and eating in clinics	0	0	36.67	63.33
Rubber dam placement	0	0	46.66	53.34
High volume suction	0	0	0	100
Pre-amalgamated capsuled alloys	63.34	36.66	0	0
Asking not to swallow spilled mercury in maxillary cavity.	23.34	30	33.33	13.33

**Table 2: Measures taken by dentists in the clinical up set to control mercury contamination**

<b>Clinical set up</b>	<b>Yes (%)</b>	<b>No (%)</b>
Awareness of dentists about mercury hazards to them	50	50
Awareness of dentists about mercury hazards to patients	46.66	53.34
Change AC filter	0	100
Protective lid in amalgamator	100	0
Reusable amalgam capsule	0	100
Sleek flooring	100	0
Coarse Flooring	0	100
Periodic monitoring of Mercury vapor	0	100
Efficient ventilation	100	0
Steam heat sterilizer	60.66	39.34
Dry heat sterilizer	39.34	60.66

**Table 3: Measures taken to discard excess amalgam**

Discarded amalgam in excess	Yes %	No %
Use of vacuum cleaner	0	100
Use of household product containing ammonia and chlorine	0	100
Walk around with contaminated shoes	100	0
Amalgam spills is cleaned using broom & dust pan	100	0
Excess amalgam is discarded in waste bag	100	0

**Table 4: Kidney functions and mercury analysis in urine**

	Dentists	Control	t	P
Mercury in urine (ug/g creatinine)	19.73±1.57	5.16±1.47	33.87	<0.001
Urea (mg/dL)	21.70±2.78	16.54±1.28	8.42	<0.001
Creatinine (mmol/L)	1.40±0.59	0.88±0.34	3.81	<0.05

More than half of dentists (63.34%) prefer the use of pre-amalgamated capsule alloys, while 36.66% sometimes use it.

As regard asking the patient not to swallow the spilled mercury in maxillary cavity there are 23.34% always asking the patient not to swallow the spilled mercury. While 13.33 % of dentists did not asking the patient for not to swallow the spilled mercury (Table 1).

Regarding the precautionary measures and knowledge in safely dealing with amalgam restorations, the results showed that 50% of dentists were aware about mercury hazards to them, while 46.66% of dentists believed that amalgam was hazardous to patients. While the preventive measures taken by the dentists during working with amalgam showed that, dentists were not following the ADA recommended guidelines, especially wearing eye protector, changing eye clothes after each patient, placement of rubber dam, and high volume suction. In contrast, 96.67% of dentists followed the universal recommendations of wearing gloves, 100% wearing face masks, most dentists did not prefer eating and drinking in the operative clinic(63.33%).

Table 2 showed the measures taken by dentists in the clinical up set to control mercury contamination, there were efficient ventilation (100%), protective lid in amalgamator (100%), disposable capsule (100%), also the results showed deficient periodic mercury vapor monitoring (100%), 60.66% of dentists use steam sterilizer where as 39.34% of dentists use dry heat sterilizer. Also sleek flooring is found in Operative Dental Clinic(100%).

Responses about the methods of discarding excess amalgam waste the results showed that dentists did not know the proper method to dispose the waste mercury, 100% of dentists used waste bag to discard excess amalgam. While regarding cleaning methods of accidental amalgam spills 100% used broomstick and dustpan for picking up the spill (Table 3).

Table 4 showed a statistically significant higher level of mercury in urine(ug/g

creatinine) among dentist ( $19.73 \pm 1.5$ ) compared to control ( $5.16 \pm 1.47$ ). Similarly urea mean level among dentist showed a statistically significant higher level ( $21.70 \pm 2.78$ ) compared to control( $16.54 \pm 1.28$ ).Also creatinine mean level in dentist ( $1.40 \pm 0.59$ ) showed a statistically significant higher level compared to control ( $0.88 \pm 0.34$ ).



## Discussion

Elemental mercury readily vaporizes at room temperature. When inhaled, elemental mercury vapor easily passes through pulmonary alveolar membranes and enters the blood, it distributes primarily to the red blood cells, central nervous system (CNS) and kidneys (Clarkson, 1997).

Dental offices are known to be one of the largest users of inorganic mercury (Jasindki & Bureau, 1994). It is well documented that dentists and dental personnel who work with amalgam are chronically exposed to mercury vapor, that accumulates in their bodies more than non-occupationally exposed. Urinary mercury levels of exposed dental personnel average at least 2 times that of controls (Campbell & Godfrey, 1994).

The results of this study indicated that dentists are satisfactorily adopting universal standard precautions for infection control, such as wearing gloves, face masks and to a lesser extent an eye wear. However, rubber dam application was 0% of the dentist was applied. This result is in agreement with a survey study in Saudi Arabia which indicated that dentists were satisfactorily adopting universal standard barrier techniques, such as wearing gloves, face masks and to a lesser extent an eye

wear. However, rubber dam application is markedly deficient in this study as only 10.6% of the respondents claimed that it was always applied (Sadig, 2007).

Dentists are occupationally exposed to mercury vapor in their working environment and this exposure represents a risk for them, mainly from the inhalation of Hg vapor and fine particles of amalgam. These results were in accordance with a study showed that normal handling of mercury in practice did not present a threat to patients but could present a threat to dental personnel if precautions were not taken (Brownawell et al., 2005).

Most of the signs and symptoms of mercury toxicity have been associated with long term occupational exposure to air concentration of mercury more than 50 fg/m<sup>3</sup> which is reflected by urinary mercury concentration more than 100 ng/ml while clinical significance have not been reported below the air concentration of 100 fg/m<sup>3</sup> (National Institute of Dental Research, 1995). The threshold limit value (TLV) for occupational exposure to metallic mercury vapor 0.05 mg/m<sup>3</sup> (OSHA 1998).

The results of this study showed that there was proper ventilation and fresh air exchange at the clinics, but it reported that

air conditioning filters were not replaced periodically. Such conditions lead to increased possibility of indirect mercury exposure, this result was in agreement with Kulkarni et al,2008 study which revealed that about 96.4% of the dentists take care of proper ventilation and fresh air exchange at their clinics, but it is reported that air conditioning filters were not replaced periodically .

In our study, there was no checking for the dental operatory atmosphere for mercury vapor which was in agreement with Sadig ,2007 study, which showed that none of the clinics was periodically checking the dental operatory atmosphere for mercury vapor .

About 60.66% of the dentists' studied group used steam heat sterilizer while 39.34% use dry heat sterilizer; this was in agreement with Sadig ,2007study which showed that 85.11% of the respondents used steam heat sterilizer in their clinic . Heating amalgam-contaminated instruments often occurs when incompletely cleansed instruments are sterilized. Scrap amalgam frequently clings to the lumen of amalgam carriers. Amalgam adheres to crosshatched surfaces of amalgam condensers and carving and finishing instruments. Residual

waste amalgam subjected to high autoclave temperature will generate exceptionally high levels of mercury vapour. When venting autoclaves or any potential source of mercury vapour, proper air exchange is advised to protect employees (ADA, 2001).

In our study dentists used single used capsules and protective lid amalgamator.

This is in agreement with Martin et al ,1995 study which showed that nearly three quarters (72.6%) of the students and half (46.6%) of the dentists never used pre-amalgamated capsules.

Regarding amalgam safety, our results showed that 50% of dentists believed that amalgam is hazardous to dentists while 46.66% of dentists believed it to be unsafe for patients. This is in agree with Sadig & Khairuldean,1996 study which stated that 88% of the dentists indicated that mercury amalgam is hazardous to the dentist if not properly handled . Also in accordance with our study Suhas et al,2008 showed that more than 80% of dentists believed that mercury is hazardous to both dentist and patients .

Regarding the different preventive measures taken by the dentists when working with amalgam, the results of this study showed that dentists were not

strictly following the recommended guidelines, especially placement of rubber dam, clothes changing and eye protection. Concerning the types of amalgam used in the clinics, 63.34% of the respondents were using preamalgamated capsule alloys, while 36.66% sometimes using the preamalgamated capsules alloys. As regard rubber dam our study showed a decreased in rubber dam application as only 46.66% of the dentists said it was rarely applied. These results were in accordance with The survey study in Saudi Arabia indicating that dentists are satisfactorily adopting universal standard barrier techniques, such as wearing gloves, face masks and to a lesser extent, an eye wear. However, rubber dam application is markedly deficient in this study as only 10.6 % of the respondents claimed it was always applied (Sadig, 2007).

According to our results amalgam spill is cleaned using broom & dust pan excess amalgam is discarded in waste bag this is in accordance with Suhas et al ,2008 study that showed that that only a few dentists were using proper work area designed to facilitate spill contamination and clean up .

This study showed a highly significant higher level of mercury (ug/g creatinine) in

urine among dentists compared to control group, also our results showed a highly significant higher level between dentists & control as regard urea & creatinine in urine. These results were in accordance with Ritchie et al,1995 study which showed a highly significant difference between urinary mercury levels of dentists and controls, with the geometric mean urinary mercury for dentists being 4.17 times that for the control group .Dentists were significantly more likely than control subjects to report that they had suffered from and received treatment for a kidney disorder . Another study in Turkey found that dental staff had higher whole blood (B-Hg) and urine (U-Hg) Hg levels than the control . The mean B-Hg value was( 2.18 nmol/L) and U-Hg was( 1.17 nmol/mmol) creatinine (Aydin, et al 2003).

A study examining the health effects of mercury in the United Kingdom compared urinary mercury excretion level in dentists and in a control group showed that dentists were significantly more likely than control subjects to have had disorders of the kidney or memory disturbance (Langworth et al., 1992).

Also a survey of over 60,000 U.S. dentists and dental assistants with chronic

exposure to mercury vapor and anesthetics found increased health problems compared to controls, including significantly higher liver, kidney, and neurological diseases (Nylander, 1989). Roels et al, 1985 study showed that mercury exposure at levels around 0.05 mg/m<sup>3</sup> or lower have been of concern and may include minor renal tubular damage .

On the contrast to our results Weiner et al ,1990 study stated that although dental amalgams are a source of mercury exposure and are associated with slightly higher urinary mercury excretion there is no scientific evidence of any measurable clinical toxic effects other than rare hypersensitivity reactions .

### **Conclusion**

In conclusion, this study showed that although there appears to be an awareness of exposure to occupational hazards among dentists, the practical steps to prevent occupational hazards among them need to be reinforced. Increased awareness needs to be created to the danger of chronic mercury poisoning and its prevention and also regular monitoring of blood and urine levels for mercury and air level of their clinic for mercury vapour. Enforcement of

the WHO recommendations regarding the use of rubber dam, high volume suction and water-cooling to avoid heating and mercury contamination when removing or polishing amalgam restorations .

### **Recommendations**

Air conditioning filters should be periodically checked ,cleaned or replaced .

Monitoring for the dental operatory atmosphere for mercury vapor.

Increase awareness about hazards due to mercury vapor exposure to dentists and patients by posters, workshops or training courses.

ADA (American dental association) recommendations should followed especially the use of rubber dam and measures taken to discard excess amalgam.

Further efforts should be made to improve occupational hygiene practice and to ensure that all areas of the surgery have mercury levels below the occupational exposure standard.

Periodic health surveillance, including urinary mercury monitoring, of dental personnel should be conducted to identify possible effects of practicing dentistry.

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