

## HAZARDOUS EFFECTS OF METALLIC MERCURY

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*SUMMARY: Over the past two or three decades, there has been an increasing awareness of the hazards inherent in the use of mercury in dentistry. All aspects of handling the mercury should be given attention. Many potential sources of mercury exposure exist in a dental office. Sources include: accidental spills, poor mercury hygiene, manual mulling to excess mercury from freshly mixed amalgam, mechanical amalgamators, ultrasonic amalgam condensers, failure to use high-vacuum suction while removing old amalgam restorations, and improper dry heat sterilization of amalgam contaminated instruments. Atmospheric mercury vapor resulting from a spill of free mercury is a major cause of contamination in the dental office environment. Occupational exposure to mercury is known to have toxic effects on a wide variety of systems. Inhalation of mercury is a major cause of mercury toxication and will cause severe pulmonary damage and renal injury, and central nervous system disturbances. Many nonspecific signs and symptoms also may occur, including weakness fatigue, anorexia, insomnia and gastrointestinal disturbances. Every dental clinic should follow the proper procedures for handling of mercury to reduce the hazard of contamination.*

*Key Words: Amalgam, Mercury, Mercury toxicity.*

### INTRODUCTION

In dental practice, amalgam is used widely approximately in three fourth of the fillings. An amalgam is an alloy in which one of the constituents is mercury. In the United States, more than 100 tons of mercury are used by the dental profession annually (40). The hazardous effects of mercury exposure is known and attracted scientific interest from earliest times. Careless handling of mercury in the preparation of amalgam is usually the most important factor in contaminated dental offices (34). Some dentists and dental assistants have taken the risk of mercury contamination and exercise no precautions. They unconsciously allow contaminated workbenches, rugs and equipment to become potentially hazardous sources of mercury vapor. Accidental spills, poor mercury hygiene, manual mulling to eliminate excess mercury from freshly mixed amalgam, mechanical amalgamators, failure to use high-vacuum suction while removing old amalgam restorations are the sources of mercury exposure in a dental office.

Over the past two or three decades, there has been an increasing awareness of the hazards inherent in the use of

mercury in dentistry (12,25,35,37,39,41,46,50,51). Several studies have been made to determine urinary and blood mercury levels of dental staff and mercury vapor levels in dental offices (5,21,22,23,34,38,39,42,46,49).

Cases of dentists who had symptoms of mercury toxicity have been documented (6,44,47). Atmospheric mercury vapor resulting from a spill of free mercury is a major cause of contamination in the dental office environment. Chronic and low level exposure to vapors of metallic mercury often go undetected in dentist and dental personnel.

Cook and Yates (11), reported a fatality due to chronic mercury intoxication. A 42 -year- old dental surgery assistant with at least a 20-year history of exposure to mercury developed a rapidly fatal nephrotic syndrome. The high levels of mercury in the kidney, estimated by neutron activation analysis and demonstrated histologically, indicate that this was the result of mercury intoxication. 520 ppm of mercury was found in the kidney against a maximum of 9 ppm in one of three control cadavers.

This paper represents the hazardous effects of metallic mercury to human health in way of inhalation, dermal exposure or in case of ingested or injected accidentally and gives hints in therapy of intoxication and cautions should be taken during handling mercury, especially in dentistry.

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Mercury toxication is encountered by dentists and employed personnel primarily from two sources: direct absorption into the tissues through contact or handling of mercury - containing compounds or inhalation of vapors that are emitted through a volatilization of mercury and mercury containing substances. Absorption by the skin should not be a problem of these days, as hand mulling is no longer an acceptable procedure in preparing amalgam. The use of spherical alloys and low mercury alloy ratios permits the practising of non-squeeze technique which also limits the possibility of skin contact. Inhalation hazards are more difficult problems, environmental monitoring has shown that levels of mercury vapor are higher in surgeries with inadequate ventilation (20). Other factors altering the concentration of mercury vapor in the air are changes in temperature, good hygienic clinical practice, inadvertent spillage of mercury and the number of persons present.

#### TOXIC EFFECTS

##### INHALATION

a. ACUTE: Metallic mercury is non-toxic unless air oxidation or heating has occurred. Under these conditions mercuric oxide is formed, producing inorganic mercury poisoning. Being odorless mercury vapor may be inhaled unwittingly in high concentrations. Acute mercury poisoning most frequently occurs from inhalation of high concentrations of mercury vapor. Symptoms include chest pain and shortness of breath, metallic taste and nausea and vomiting. Acute damage to the kidney occurs next. If the patient survives, severe gingivitis and gastroenteritis occur on the third to fourth days. In the most severe cases, severe muscle tremor and psychopathology develop. Mercury vapor can produce alterations in personality when exposure is prolonged in a closed area. Vapors resulting from heating of metallic mercury contain mercuric oxide which is corrosive to the skin and mucous membranes of the eye mouth and airways. Inhalation of mercury vapor will also cause severe pulmonary damage (1, 2, 15, 19, 30, 32, 36).

b. CHRONIC: Breathing and atmosphere of mercury vapor in lower concentrations over a longer period may fail to provoke any acute reactions but as percutaneous exposure, it may bring about chronic mercurial poisoning. Chronic respiratory disease may occur as a sequelae to aspiration of metallic mercury. Chest radiographs frequently show mercury droplets at both lung bases (28). Early signs of chronic poisoning by mercury vapors are mild central nervous system dysfunction, including increased irritability, loss of memory, reduced self confidence, insomnia, anorexia and slight tremor (15,19,20, 30,32,47).

Chronic mercury poisoning may be difficult to diagnose. Complaints of mouth and gastrointestinal disorders may be reported, and signs of renal insufficiency may be present. Stomatitis, gingivitis with sometimes a blue pigmented line at the gum margins, discoloured gums and loosening of the teeth are common. The salivary glands may be enlarged, salivation increases. Tiredness, tremor involving the fingers, arms and legs is often present. Chronic mercury poisoning may also simulate drug intoxication, cerebellar dysfunction or Wilson's disease. An alteration of handwriting is frequently observed. Ocular changes, including deposition of mercury in the lens are reported. Personality changes with unusual fearfulness, inability to concentrate, and irritability have been described (1,2,30).

Elevated urine mercury levels have been seen in children of thermometer workers, perhaps because of contamination of workers' clothing with metallic mercury which was brought home (27).

Brodsky *et al.* (7) mailed questionnaire to dentists and dental assistants requesting information about work, health and reproductive history. Statistical analysis of the data indicated, there were no increased rates of spontaneous absorptions or congenital abnormalities in the children of men and women who were exposed to low and high levels of mercury in dental environment.

##### TOPICAL:

Skin contact with mercury should be avoided as it can be absorbed by the skin. Cutaneous absorption of metallic mercury and its salts applied for antimicrobial, antipsoriatic or cosmetic purposes have resulted in reports of erythema, elevated urinary mercury elimination (30,48).

##### ASPIRATION:

Aspiration of metallic mercury may cause both acute and chronic effects and result in local and systemic toxicity. Hemoptysis, tachycardia, cyanosis, hypotension, blood diarrhea, hematuria, respiratory distress and pneumonitis have been reported (15,19,52).

##### ORAL INGESTION:

Elemental mercury if swallowed has no action on the body, because it is excreted from intestines without having any systemic effects, unless there is a fistula present in gastrointestinal system (27,19). Years ago it was used among Mexica-Americans for gastroenteritis (17).

##### INJECTION:

Several cases of deliberate subcutaneous injection of elemental mercury have been reported (26,31,33,45). In

all cases, the mercury caused inflammation, abscesses granuloma formation and when measured elevated blood and urine mercury concentrations. Cases of intravenous injection of elemental mercury have been reported, resulting in mercury pulmonary emboli (43). In addition to the formation of abscesses and granulomas which developed at the injection sites, hemoptysis and hematuria have occurred. Systemic absorption has been documented by elevated blood mercury levels.

#### LABORATORY METHODS FOR MERCURY LEVELS

Blood, urine, hair and nails can be analyzed for mercury content.

##### Serum / Blood Levels:

5-10 ng Hg/ml is considered normal for blood mercury levels, toxicity has been observed at 100-200 ng Hg/ml (4). In acute situations, elevation of blood-mercury level elevates to ranges of 250-500 ng Hg/ml. The studies with the blood mercury levels of the dentists was considerably below the toxicity levels (4,5).

##### Urine Levels

Normal mercury level in urine is 0-0.02 mg/l and allowable maximum limit in urine is 0.15 mg/l. Normal urine excretion rarely exceeds 0.15 mg/l in exposed individuals. Chronic cases of poisoning may be associated with extravagant elevations in urine excretion of mercury without significant elevations of blood mercury levels.

Urine 24-hour delta ALA levels are invariably elevated to the ranges of 3-10 mg/l in chronic poisoning cases. Although urinary levels as high as 20 mg/l have been seen without symptoms, levels greater than 10mg/l may need careful behavioral and neurological evaluation (1). Saliva and urine normal levels are equal (14). Urine analysis is the best means of detecting any unusual mercury absorption (41). Urinary mercury levels of the dental staff was found to be higher than the allowable limits in many studies (20,29,40).

Analysis of mercury levels in hair have not shown good general correlation with exposure and absorption of mercury as measured by other methods. Hefferen indicated that analysis of mercury levels in hair should be used only as an indicator of mercury absorbed by dental personnel (24).

##### Mercury vapor concentrations in the atmosphere:

For studies of ambient mercury vapor, dental investigators have adopted the threshold limit value (TLV) of 0.05 mg Hg/m<sup>3</sup> of air. The TLV is the maximum safe environmental concentration of mercury vapor in air (14). The literature revealed that most dental office mercury vapor

levels lie below 0.05 mg/m<sup>3</sup>, with levels of fewer offices in the range of 0.06-0.10 mg/m<sup>3</sup>. As many as 10% of dental offices have been shown to have mercury vapor concentrations in excess of 0.1 mg/m<sup>3</sup> of air (20).

#### TREATMENT OF MERCURY POISONING

a. Acute Exposure: Treatment of acute mercury poisoning consists of removal from exposure and chelation treatment with dimercaprol, usually in dosage of 3-5 mg/kg intramuscularly every 4 hours for 48 hours and then every 12 hours for 10 days. If renal damage occurs, hemodialysis will be required. Oral charcoal therapy is probably not useful in binding mercury in the gastrointestinal tract (11,15,19,30,32).

b. Chronic Exposure: With chronic mercury poisoning, oral penicillamine or N-acetylpenicillamine (250-500 mg orally 4 times a day for 10 days) is usually required. Urinary mercury levels should be monitored to observe enhanced removal (3,30). Dimercaprol and penicillamine promote excretion of mercury into the urine (14).

#### PROCEDURE FOR CLEANING UP SMALL MERCURY SPILLS

Spills from household thermometers, and during dental use can be removed by finely divided granular zinc (obtainable from scientific supply houses) or powdered sulphur (used for acidifying soils obtainable from some garden supply houses and pharmacies). Granular zinc may stain carpets a grey color which can not be removed with certain commercial cleaning agents (37). It is also advisable to sprinkle powdered sulphur or granular zinc on the working area and remove it with a damp cloth, which removes the mercury spills (18). It is recommended that waste from amalgam be collected regularly, and placed in sealed containers ready for disposal (51).

In areas where amalgam is used, it is recommended that floor covering should be vinyl based and continuous, with the few joints that are necessary hermetically sealed (29,37,51). Flooring materials in some parts of the hospitals and offices can be deteriorated considerably producing cracks and gaps where dust, spilt mercury and amalgam could lie undetected creating a potential hazard. Carpets are not preferred for operatory rooms (9,44), occasional spills will occur, and mercury will accumulate in the deep recesses of the rugs and become continuous sources of mercury vapor.

Naleway *et al.* (40) found an increased urine mercury level in those dentists who had office heating-cooling systems that produced minimal air turnover. Gronka *et al.* (20) found that urinary mercury levels paralleled mercury vapor

exposure. They also reported that 63% of air conditioners examined return air to the room 20% higher in mercury content than the general room air conditioners. The non-circulating type of air conditioning/heating system is desirable because it eliminates mercury laden air from the internal environment by maximizing air turnover.

Any excess mercury should not be allowed to get into sinks, as it can react with some of the alloys used in plumbing.

The toxicity of mercury is known, it is logical to ask if there are any likely toxic effects for the patient who has amalgam restorations. It is known that mercury penetrates into the tooth structure and can discolor the tooth, traces may even reach the pulp. It is believed however that there are no systemic toxic effects. Dental patients rarely experience allergic reactions to mercury, usually as dermatitis, stomatitis or urticaria (10,13,16).

The removal of old amalgam during cavity preparation was measured (8), removal of amalgam by a high speed bur not water cooled and with no aspiration produces a large amount of mercury containing vapor which was measured 0.19 mg/m<sup>3</sup>, more than three times the permitted exposure.

#### RECOMMENDATIONS FOR MERCURY HYGIENE

1. Mercury must be stored in unbreakable, tightly sealed containers and tightly closed capsules must be used during amalgamation. Ultrasonic condensers should not be used.

2. During handling the amalgam, it must not be touched. The handling of mercury should be at a special work area, which is covered with a washable or disposable plastic. Spilled mercury should be gathered up at once and residual droplets must be dusted with powdered sulphur.

3. If amalgam fillings are removed with high speed rotary instruments, a water spray and a high volume evacuator should also be used to minimize the dispersion of fine particles. When grinding amalgam water spray and suction must be used, waste amalgam should be kept under water in sealed containers.

4. Dental surgeries should be adequately ventilated and the filters of air conditioners replaced at regular intervals.

5. Floor coverings should be seamless and impervious carpeting should not be used in a dental surgery.

#### DISCUSSION

During the past 20 years, there has been an increasing interest in the potential health hazards of exposure to mercury. For dental personnel mercury is absorbed directly into the body through handling and by inhalation of mer-

cury vapors (37,40). The National Institute for Occupational Safety and Health (NIOSH) recommendation for time-weighted average concentration of mercury in the breathing zone is 0.05 mg Hg/m<sup>3</sup> for 8 hours a day, 40 hours a week. This is the upper limit of what is considered to be safe exposure.

Occupational exposure to mercury is known to have toxic effects on a wide variety of systems particularly the central nervous system, the kidneys and the skin. Many nonspecific signs and symptoms may also occur, including weakness, fatigue, anorexia, insomnia and gastrointestinal disturbances (30,47).

Ideally, a well ventilated office with central air conditioning should provide a safe environment if the dentist and his staff exercise reasonable precautions in handling mercury. However, if he has worked in the same location for a long period time and has not always been cautious in the handling of mercury, then mercury vapor may reach unacceptable levels.

Available evidence does not suggest that the insertion of amalgam restorations constitutes a significant hazard to the patient. However, the risks to dental personnel engaged in the constant use of mercury are recognized and these must neither be exaggerated nor ignored. An observance of the precautions as indicated in this memorandum should be sufficient.

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