

# Petition to protect employees exposed to mercury in dentistry

## Preface

One of the most dangerous metals known to mankind is mercury because it vaporizes into an extremely poisonous volatile gas at room temperature. There are a number of well conducted studies that have found injury to dental employees and dentists exposed to low dose mercury. The injuries were both neurological and physical to dental personnel, especially females.<sup>i ii iii</sup> Certain dental procedures, such as mixing carving and polishing mercury/silver fillings, release so much mercury that they are inherently dangerous, and without vertical standards the employees involved will continue to be harmed.<sup>iv v vi vii viii ix x xi</sup> Many of these procedures release sufficient mercury to exceed the California Maximum Allowable Concentration (MAC) of 100µg/m<sup>3</sup>. This level has been determined to be immediately hazardous to health and is never to be exceeded under any circumstances.

The current scientific data indicates that female dental personnel are severely impacted by occupational exposure to mercury. The Occupational Safety and Health Act (OSHA) has recommended no exposure of fertile women to amounts of mercury greater than 10 micrograms per cubic meter of air, and **pregnant women should be occupationally exposed to no mercury**. These recommendations are not being followed by the dental industry, and there is substantial scientific evidence that even these modest measures would not fully protect dental workers; therefore, the current dental office conditions cry out for a vertical standard to protect employee health. Research has shown that mercury even in extremely small amounts has toxic effects such as neurological pathology, cytotoxicity to nerve tissue.<sup>xii xiii xiv xv xvi xvii xviii xix xx xxi xxii xxiii</sup>

## The Chemistry of Mercury

Mercury is an unusual base metal which is molten at room temperature. It is highly volatile and vaporizes readily. The fumes from elemental mercury are uncharged atoms (Hg<sup>0</sup>) that are easily (75% to 100%) absorbed from lung and nasal tissues.<sup>xxiv xxv</sup> Once absorbed, this uncharged form enters the bloodstream and penetrates cell membranes, the blood-brain barrier, the placental membrane, and fetal tissues.<sup>xxvi</sup> When mercury is combined with other metals to make a dental amalgam it has the unique

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property of forming what could be termed a solid suspension. A mercury/silver filling is actually a mixture. When stimulated or heated, vapor mercury is released. You have each been given the *Smoking Teeth= Poison Gas* DVD depicting this phenomena. Berlin et al. showed that inhalation of mercury vapor selectively increased the uptake in the brain.<sup>xxvii</sup>

Mercury combines readily with many compounds, and it has a particular affinity for sulfur. When it attaches to the sulfur-containing protein molecules, it alters their tertiary structure. This is one way it exerts its poisonous effects. Regardless of the source, once mercury enters the body, the body tries to detoxify the poison. The process of detoxification involves the enzyme catalase and the addition of a positive charge to form mercurous or mercuric ( $Hg^+$  and  $Hg^{++}$ ) which do not easily cross cell membranes.

Neurological tissues have a high sulfur content and it may be for this reason that mercury tends to accumulate in the central nervous system.<sup>xxviii</sup> Less than 1 ppm of mercury absorbed into the bloodstream can transcend the blood-brain barrier within hours, permitting substances from the plasma that would normally be excluded to enter into the cerebral spinal fluid.<sup>xxix xxx</sup> All mercury compounds appear to cause some kind of damage in the brain.<sup>xxxi xxxii xxxiii</sup> Other organs and systems adversely affected by mercury are the immune system, kidneys, liver, cardiovascular and reproductive systems.<sup>xxxiv xxxv</sup> Fetal exposure to elemental mercury vapor is particularly harmful.

### **Why Does Mercury Poison?**

- 1) Neurological
- 2) Immunological
- 3) Endocrine

Because of mercury's effects on the central nervous system, many divergent neurological and psychological symptoms are common findings in mercury poisoning. Stock identified confusion, memory loss, and irritability as associated with inhaling a single 10 ppm dose of mercury vapor and termed these symptoms *micro-mercurialism*.<sup>xxxvi</sup>

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The immune system appears particularly sensitive to mercury as well. It responds to mercury with a classic antigen/antibody reaction in an attempt to remove the foreign substance.

White blood cells are very sensitive to mercury exposure and, as a result, their numbers at first increase, and later, as they die, the numbers will decrease. Release of the migratory inhibitory factor appears reduced. Also the respiratory burst of the white blood cells is inhibited.<sup>xxxvii</sup> Exposure to mercury causes the chromosomes of white blood cells to break and form unusual combinations and genetic aberrations.<sup>xxxviii xxxix xl</sup> White blood cells from mercury-diseased rats show a significant decrease in ability to replicate their own chromosomes, and 90% of the cells develop autoimmune antibodies for their own nuclei, a characteristic of autoimmune disease.<sup>xli xlii</sup> Mercury also suppresses the primary humoral antibody response.<sup>xlili xliiv xlv xlvi xlvii</sup>

In a preliminary study, Dr. David Eggleston demonstrated that both mercury and nickel dental restorations suppress the quantity of circulating T-cells present in humans.<sup>xlvi</sup> Vera Stejfkal, M.D., of Sweden has documented the immunological response to mercury in humans. She found an adverse immune reaction in infants when a mercury preservative (thimerosal) is used with the inoculum. While further research is badly needed in this new area of science, it is clear that mercury plays a very important role in immunosuppression. Its adverse effects on human resistance to diseases and tumors cannot be overlooked.<sup>xlix</sup>

The endocrine system is also affected by the accumulation of mercury in certain critical tissues. Not only does inhalation of this volatile substance allow transport from the lungs into the bloodstream, but also mercury is transported from the nasal mucosa directly to the brain and pituitary. It is here that critical hormone balances can be damaged. (See Reproductive Defects)

## **How Toxic Is Mercury Compared to Other Metallic Compounds?**

Sharma et al. studied the cytotoxic effects of several compounds on chick ganglia. They stated in their conclusions: *Our study showed mercury, cadmium, and lead in decreasing order of toxicity.*<sup>1</sup> Why then does Cal-OSHA have a vertical standard for a substance like lead which is slightly toxic but none for severely toxic mercury?

**SEVERELY TOXIC                      MODERATELY TOXIC                      SLIGHTLY TOXIC**

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MERCURY	THALLIUM	LEAD
CADMIUM	ARSENIC	ARSENIC
ARSENIC	SELENIUM	TIN OXIDE
VANDEX-TIN	COPPER	

## **Industrial Exposure**

In order to protect workers from excessive exposure to toxic materials, the governments of all the developed nations and the World Health Organization (WHO) have adopted adult industrial standards for mercury exposure. In addition to these industrial exposure standards, many governments have also enacted legislation called environmental standards, or simply EPA, to protect the general populace from excessive pollution. The standard for airborne mercury was reduced 300% in 1992 from 1 PPM to 0.3 PPM after an infant became mercury poisoned by sleeping in a bedroom with mercury contamination of just 2 PPM.

Although the exact reasons remain unclear for why an infant or fetus is particularly susceptible to the toxic effects of mercury, the fact remains that numerous incidents of mercury poisoning have found infants are at a much greater risk of injury or death than adults. Both the U.S. EPA and World Health Organization (WHO) have stated that no amount of exposure to mercury can be considered totally harmless. The WHO also noted that "**A specific No-Observed-Effect Level (NOAEL) for mercury cannot be established.**" <sup>ii</sup>

Other groups, including the elderly, pregnant women, women of childbearing age (for possible unsuspected or near-future pregnancy), children, the hypersensitive, immunosuppressed, are also more susceptible to the toxic effects of mercury. Two distinct genetic subsets that are particularly sensitive to mercury have been identified: APOe 4/4 and CPOX positive. <sup>iii iiiii</sup>

It is important to keep in mind that the current OSHA standard a workplace regulation for informed adults was never intended to protect the health of women of childbearing age, the fetus or children. It was based upon a study of male chloralkali workers who were exposed to mercury and chlorine in the workplace. The endpoint

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used was tremor. This is clearly not an appropriate model for exposure of young women to mercury.

Chlorine changes the chemistry of mercury to form a compound used for centuries as a medicine called calomel. Calomel was the key ingredient in the original formula of calamine lotion because it stopped itching by destroying nerves. It is no longer used in medicine because it caused a deadly disease, acrodynia or Pink's Disease, in some children from minute exposure to mercury chloride.

It is the policy of the State of California to dismantle school buildings that are not in compliance with EPA standards. It is unlikely that any dental school teaching students how to mix, pack, carve and manipulate a mercury/silver filling can comply with the current EPA standards.

The biological half-life of mercury in human nervous tissues appears to be over 10,000 days (27 years).<sup>liv lv</sup> Since the brain is sensitive to mercury, many of the first symptoms of mercury poisoning are neurological and psychological in nature. The action of mercury on the brain may occur by blocking the metabolism in nerve tissue which frequently causes irreversible damage and the depolymerization of tubulin which causes neurofibrillary tangles.<sup>lvi lvii</sup> (See Neurodegeneration DVD provided)

Certain areas in the brain tend to collect much more mercury than others. The pituitary gland which regulates the human hormonal system preferentially collects mercury at a rate 10 times greater than the brain as a whole.<sup>lviii</sup> It is also well recognized that mercury has an adverse effect on fetal neurological development.

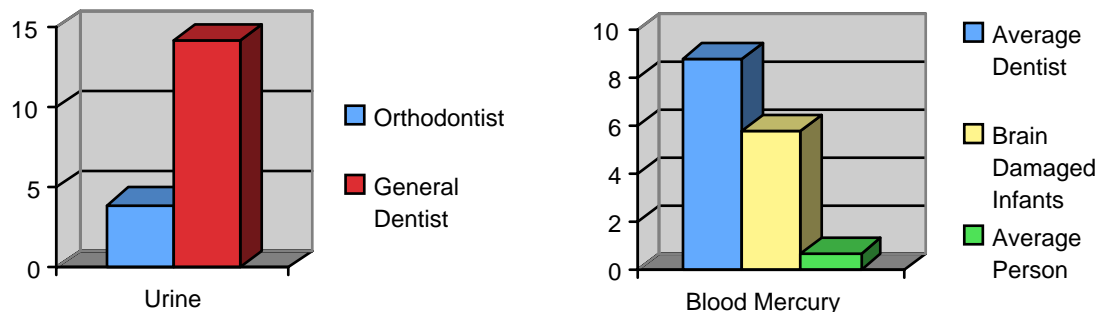
### **Dentists and Personnel Exposure**

I will preface my remarks regarding the urinary excretion of mercury in dental personnel by quoting a short excerpt from Goldwater, et al.: *Urinary mercury levels may give some indication of the degree of exposure. They are of limited value in the diagnosis of poisoning, since high levels can be found in human subjects who are symptom-free, and low levels in those exhibiting marked evidence of mercurialism. It has been suggested that, in some cases, failure to excrete mercury is a factor in the development of poisoning. Those investigators who have studied the subject are in almost unanimous agreement that there is poor correlation between the urinary excretion of mercury and the occurrence of demonstrable evidence of poisoning.*<sup>lix lx</sup>

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Urinary excretion may, however, provide some information on a group basis as to degree of exposure. This has been publicly acknowledged at the National Institute of Dental Research (NIDR) workshop on the biocompatibility of metals in dentistry.<sup>lxi</sup>

During a survey of US dentists 1975 through 1983 the urinary mercury levels of 4,272 U.S. dentists were measured. The mean level was 14.2 micrograms/liter ( $\mu\text{g/l}$ ) with a range from 0 to 556 micrograms/liter. An increase in the mean mercury level was found to correlate with increase in age of the office, the practice, and the dentist. The highest mean was found in general dentists, at 15.3  $\mu\text{g/l}$ , and the lowest was found in orthodontists, at 3.9  $\mu\text{g/l}$ . Blood samples of 1,555 dentists found that the mean for all dentists was 8.2 ng Hg/ml blood, and the mean for general dentists was 8.8 ng Hg/ml.<sup>lxii</sup> That is approximately 12 times greater than the mean blood level of 0.7 ng Hg/ml Abraham found for those with fillings.<sup>lxiii</sup>



Although Mercury levels in the blood, urine or other biomarkers do not reflect the mercury load in critical organs, Trasande et al. estimated brain damage to newborn infants occurred when mother's blood was at or above 4.6  $\mu\text{g/l}$ <sup>lxiv</sup> <sup>lxv</sup> In the U.S. the average urine level for the general population is 0 to 5  $\mu\text{g/l}$ . 4  $\mu\text{g Hg/l}$  is considered excessive in the Federal Republic of Germany.<sup>lxvi</sup> In their report on the Biocompatibility of Metals in Dentistry, the NIDR published the opinion that, "*The distribution of mercury into body tissues is highly variable and appears to be of little correlation between levels in urine, blood, or hair and toxic effects.*" On the other hand, high urinary output on a group basis may indeed indicate high exposure. Recent research has determined that even when exposure to mercury is relatively low, over a period three years or longer the mercury urine level at first rises, then drops as the kidneys lose their ability to remove mercury from the blood, especially in males.<sup>lxvii</sup>

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A 1983 survey of British dental offices found that 10% of those also violated that country's industrial exposure standard of 50 µg/Hg time-weighted average (TWA).<sup>lxxviii</sup> A recent study of a dental school, whose facilities were within the California TWA and ranged from 8 to 48 µg/M<sup>3</sup>, found that student and faculty increases of mercury concentration in the blood and plasma, measured at the beginning and at the end of the academic year, was statistically significant for each group (p<0.001). It rose in the fall, and declined during summer vacation, but also increased in the students with each year of training.<sup>lxxix</sup> Virtually everyone tested had a significant blood mercury level that, if they became pregnant, would damage a fetus.

Dentists' exposure to mercury is associated with many health problems, most notably birth defects and neurological disorders.<sup>lxx</sup> <sup>lxxi</sup> <sup>lxxii</sup> <sup>lxxiii</sup> <sup>lxxiv</sup> A 1987 study by Sikorski identified a significant positive correlation between mercury levels in the hair of occupationally exposed women and the occurrence of reproductive failures and menstrual cycle disorders.<sup>lxxv</sup> Recently reported in the literature is the case of a young dentist, professionally exposed to mercury for 35 weeks during her pregnancy, who delivered a severely brain-damaged mercury-poisoned infant.<sup>lxxvi</sup> This tragic outcome can only be prevented if a vertical standard is adopted.

The textbook Occupational Hazards in the Health Professions cautions against comprehensive amalgam work during pregnancy.<sup>lxxvii</sup> Koos and Lango stated as early as 1970 that their research indicated that fertile women should be exposed to no more than 10 Hg µg/m<sup>3</sup>, and pregnant women should be exposed to no mercury at all.<sup>lxxviii</sup> It is likely that the use of mercury in dentistry makes exposure inevitable.<sup>lxxix</sup>

Clearly, women in dentistry are not only at the greatest risk from exposure to mercury, but they are not being adequately protected by the present standards. An assistant's death was reported in 1969 from kidney failure.<sup>lxxx</sup> The United States Environmental Protection Agency states that, "*Women chronically exposed to mercury vapor experience increased frequency of menstrual disturbances and spontaneous abortions; also a high mortality rate was observed among infants born to women who displayed symptoms of mercury poisoning.*"<sup>lxxxi</sup>

### **Dental Personnel Health Risks**

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The kidney filters the blood and, as a result, chronic exposure to chemicals might eventually induce kidney damage. A 1988 study by Verschoor, et al. evaluated the kidney function of 68 dentists (63 men, 5 women) and 64 female assistants who were apparently healthy, not pregnant, and taking no drugs. They compared the results of their kidney function analysis to 250 workers known to be exposed through the workplace to lead, cadmium, or chromium. Their conclusion was that, *“Dentists and dental assistants appear to have a higher potential risk of kidney function disturbances than the workers in these industries. Although this study did not present evidence for changes of renal function parameters in dental practice in relation to Hg-urine levels below 20 µg/l, it certainly suggests that dental practice may carry a risk of renal dysfunction. There is a need to assess the renal hazard of the potential nephrotoxic chemicals used in dental practice.”*<sup>lxxxii</sup>

Kuntz followed 57 prenatal patients with no known exposure to mercury for changes in whole blood from initial prenatal examination to delivery and postpartum hospitalization. The mothers' whole blood total mercury increased during pregnancy from .79 ppb at initial examination to 1.16 ppb at delivery. This represents a 46% increase during pregnancy. Mercury has previously been recognized for its particular ease of crossing the placental membrane. The umbilical cord blood was also sampled at birth and found to have even higher levels of mercury at 1.5 ppb.<sup>lxxxiii</sup> After careful analysis of the data, Kuntz concluded: *“Previous stillbirths, as well as history of birth defects, exhibited significant positive correlation with background mercury levels.”* He further stated that patients with large numbers of dental fillings exhibited a tendency to higher maternal blood levels, which agrees with both Ott and Abraham.<sup>lxxxiv</sup>

Vimy has confirmed the transport of mercury from fillings to the fetus in experimental animals (sheep and monkey), and the additional exposure through mothers milk.<sup>lxxxv</sup> Berlin has shown the fetal blood content of mercury was raised dramatically at the end of pregnancy exceeding that of the mother at delivery by a factor of at least five. Early abortion, premature birth, low birth weight with a perinatal death, have been observed in monkeys.<sup>lxxxvi</sup>

### **Women Exposed to Mercury Vapor Have a Higher Incidence of Menstrual Disturbances**

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Mikhailova, et al. found that 26.8% of women working in a mercury polluted atmosphere suffered from menstrual disturbances. Marinova, et al. found that 29% had hypermenorrhea.<sup>lxxxvii</sup> The controls found only 0.3% with the same condition. Hypomenorrhea occurred in 15.3% of the exposed group and only 0.6% of the nonexposed group. This could mean that more than 44% of female dental personnel working under these conditions will suffer from reproductive disorders due to mercury in the dental office. This hypothesis is corroborated by two other studies of women occupationally exposed to mercury, which found that 36% to 45% will develop these types of disorders within 6 months of employment, a proportion that increases to 67% within 3 years of employment.<sup>lxxxviii lxxxix</sup>

This hypothesis has been further confirmed in a recent study of 418 women working in dentistry who became pregnant during the previous four years. Detailed information was collected on mercury-handling practices and the number of non-contracepting menstrual cycles it took the women to become pregnant. Dental assistants not working with amalgam served as unexposed controls. Women working in offices with poor mercury hygiene factors took longer to become pregnant. The fecundability (probability of conceiving in any given menstrual cycle) of this high exposure group was only 50% of that for unexposed women after controlling for age, smoking, race, frequency of intercourse, history of pelvic inflammatory disease, year the attempt began, and occupational exposure to cold sterilants, x-rays, and unscavenged nitrous oxide.<sup>xc</sup>

The most common symptoms were dysmenorrhea (painful menstruation), hypermenorrhea, anovulation (infertility >40%), and hypomenorrhea. These symptoms are known to increase in populations additionally exposed to lead.<sup>xcii</sup> The relationship between spontaneous abortion, stillborn infants, and mercury has also been confirmed.<sup>xciii</sup>

Problems that may develop in the fetus from maternal exposure are not always evident at birth. Prenatal exposure to mercury vapor has been shown to have an effect on brain development.<sup>xciv</sup> Such delayed problems include diminished learning capacity, muscle spasms, and altered electroencephalograms.<sup>xcv</sup> Exposure continues to increase if the infant is nursed, since mercury concentrates 8 fold in breast milk.<sup>xcvi</sup>

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## **Neurological Damage**

In a study of 298 dentists, Shapiro measured their mercury levels by X-ray fluorescence. Of those dentists with greater than 20 µg Hg/liter tissue levels, 30% had polyneuropathies, while those dentists with no detectable mercury levels had no polyneuropathies. Shapiro concluded that these findings suggest that the use of mercury as a restorative material is a health risk for dentists.<sup>xcvii</sup>

Dr. Magnus Nylander in a series of experiments utilizing neutron activation analysis (NAA) to study the mercury content of brain tissues of amalgam bearers, non-amalgam bearers, and dentists, found in the cases of 7 dentists and 1 dental nurse that all had a surprisingly high pituitary mercury content, totally out of proportion to the content found in other parts of the brain. Values ranged from 135 to 4,000 nanograms Hg per gram tissue.<sup>xcviii xcix</sup> He also found in a related study of dentists and dental assistants in Sweden that they have twice the incidence of brain tumors as nondental personnel.<sup>c</sup>

	Pituitary	Occipital	Ratio
1) Dentist	4,040	300	14:1
2) Dentist	3,650	84	43:1
3) Dentist	2,700	16	169:1
4) Dentist	350	40	9:1
5) Dentist	350	5	70:1
6) Dentist	350	17	18:1
7) Dentist	135	19	7:1
8) Assistant	1300	18	72:1
Amalgam bearers	7-77	3-23	
Cases 9-23	28	11	2.5:1
Mean			
24)	10	6	2:1
25)	5	6	1:1

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The evidence is clear that dentists and dental personnel are exposed to substantial amounts of mercury in the routine practice of dentistry.

### **Who is responsible?**

The California OSHSB was established to address exactly these issues. Where general controls of a toxic substance are not sufficient to protect the health of employees, this Board has the power and authority, and indeed the responsibility, to enact vertical standards that will protect all employees exposed to mercury in dentistry. It is our fervent desire that such protections be enacted immediately as this is an ongoing problem where harm and injury is occurring in many of the 10,000 dental offices and 5 dental schools everyday.

In 1985 the International Academy of Oral Medicine and Toxicology developed a scientifically-established patient, staff, dentist protection guideline that this board is welcome to adopt. A video of this procedure being performed is included at the end of the Smoking Teeth DVD.

I wish to express my sincere thanks to the International Academy of Oral Medicine and Toxicology for the knowledge gathered by this excellent organization of physicians and dentists and to Drs. Murray Vimy and the late Michael Ziff for expanding my knowledge of the science of dentistry. A special thanks to Jeff Green of Jeff Green and Associates in the preparation of this petition.

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#### Audiovisuals DVDs:

*Smoking Teeth = Poison Gas* run time 40 min.

*How Mercury Causes Brain Neuron Degeneration* run time 20 min.

*The Mercury – mystery* run time 59 min.

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## Printed Documents:

Dispersalloy MSDS Sheet

Rowland's Case Controlled study of CA dental assistants

Tezel Blood mercury levels of dental students and dentists at a dental school

Mutter Amalgam studies: Disregarding basic principles of mercury toxicity

IAOMT Safe Removal of Amalgam Fillings

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