

AN EVALUATION OF DENTAL AMALGAM MERCURY RELEASE AND CORRESPONDING TOXICOLOGY CONCERNS

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A simple computer search of the literature confirms that mercury and organic mercury are extremely toxic agents and the mere presence of mercury in the body should be proof of toxicity. It has also been clearly shown by many, even the World Health Organization, that amalgams are the major contributor to human body burden. The EPA and National Academy of Sciences (NAS) report that 8 to 10% of American women have such high mercury body burdens that put to elevated risk for neurodevelopmental disorders any child they would give birth to. The Center for Disease Control states that 1 in 6 American children have a neurodevelopmental problem. SO THE PROBLEM OR ISSUE IS NOT WHETHER OR NOT AMALGAMS AND THE MERCURY THEY DELIVER IS A HEALTH RISK, THIS IS AN OBVIOUS FACT ACCORDING TO THE EPA AND NAS. ***THE REAL PROBLEM IS HOW DO WE CONVINCING THE CONTROLLING BUREAUCRATIC AGENCY, THE FDA, TO ADMIT THAT THEY HAVE BEEN WRONG FOR MANY YEARS IN NOT EVALUATING THE MERCURY RELEASE FROM DENTAL AMALGAMS.***

One has to ask the simple question “Why are producers of amalgam products not required to produce data in the packages that describe the amount of mercury vapor that escapes daily from an amalgam of known weight and surface area under conditions that mimic the mouth with regards to temperature, pH and brushing?” In my opinion, the reason they don’t is well known since to do so would quickly establish their amalgam products as dangerous to human health. A recent study on the levels of mercury in autopsy tissues and existing dental amalgams clearly states “Mercury levels were significantly higher in brain tissues compared with thyroid and kidney tissues in subjects with more than 12 occlusal amalgam fillings (all $P < 0.01$) but not in subjects with 3 or less occlusal amalgams (all $P > 0.07$.”³⁶

However, the case against mercury levels produced by amalgams in the human body as being safe is growing. In Alzheimer’s disease the aberrant biochemical events and the pathological hallmarks are well described. So is the research that shows that mercury, and only mercury, will produce the aberrant biochemistry and produce most of the pathological hallmarks in appropriate test systems^{12, 13, 28 and references therein}. Also, a recent study has indicated that the increase in brain amyloid protein is due to an aberrant brain heme level and the heme synthetic pathway is one known to be extremely sensitive to mercury³³.

Mercury exposure to humans comes from various chemical forms such as elemental vapors, inorganic salts and organic-mercurial such as thimerosal and phenylmercury acetate (PMA). All chemical forms of mercury have been proven toxic at very low levels. There is no doubt that mercury and mercury compounds represent the most dangerous form of metal toxicity since research on exposures show them to cause adverse effects in animals and humans at the very lowest levels of any metal. Mercury and mercury containing compounds are listed under California’s Proposition 65 as compounds that need to be evaluated for their level of toxicity to ensure the safety of the

citizens of California. Mercury vapor is one of the most toxic forms of mercury along with some of the organic mercury compounds. This is probably due to the efficient partitioning of vaporous mercury into certain body organs (e.g Central Nervous system (CNS), kidney) and into specific cellular organelles (e.g. the mitochondria) based on mercury vapor's ability to easily penetrate cell membranes and the blood brain barrier. In this manner mercury vapor, Hg^0 , is quite different from ionic Hg^{2+} and Hg^{1+} . For example, air and oral ingestion of mercury vapor (Hg^0) primarily affect the central nervous system whereas the kidney is the major organ affected by the cationic forms of mercury (e.g. Hg^{1+} and Hg^{2+}).

Attempting to determine a lowest observable affect level (LOAEL) or no observable effect level (NOAEL) regarding mercury vapor exposure is, at best, a complicated procedure as explained by the analysis of published refereed research articles as presented below. The fact is, the relative toxicity of mercury and organic mercury compounds fluctuate dramatically in the same species of animal depending on: (1) delivery route (2) the presence of other synergistic toxic metals (3) different diets³⁴ (4) antibiotic exposure³⁴ (5) genetic type⁷ with 8.7 to 13.4% showing sensitivity to a diagnostic patch test^{5 & references therein}) and gender^{28,35} (6) state of health and (7) age of exposure¹⁹. The end point for measuring toxicity is also critical. That is, if lethality versus loss of neurological function is the end point then different values for a minimum daily acceptable limit of exposure will be arrived at. Also, when lethality and loss of neurological function are compared to suppression of the immune system as the end point an even lower minimum acceptable daily exposure would be expected.

However, we now have a reliable measure of physiological toxicity of mercury exposure that is reflected in the “porphyrin profile”. Porphyrins are small molecular weight organic compounds that are produced in a multi-step pathway and ends in the synthesis of heme. Evidently, different toxic metals and other toxic compounds may inhibit the porphyrin pathway in different manners ending up with a different urinary “porphyrin profile”. Mercury toxicity has a unique “prophyrin profile” that today is not known to be produced by any other toxin. Recent research on dentists and dental technicians has shown that 85% of these subjects have a porphyrin profile that is aberrant from normals and symptomatic of low level mercury toxicity^{23,24}. In addition, 15% of this 85% have a more dramatic aberrancy and this aberrancy corresponds to a polymorphism in the CPOX4 gene²⁵. This data clearly shows both the general toxicity of amalgam mercury vapor and an enhanced sensitivity of a genetic subset of the population. *To date we do not know the effects of amalgam mercury on the porphyrin profiles of children although this work was supposedly done by the group that did the NIDCR children's amalgam trials (see comments on JAMA papers below).* What we do know is that there is a report that the majority of autistic children have an aberrant porphyrin profile and that this aberrancy was reversed by treating these children with a mercury chelator²⁶. This new information will lead to many parents and their children having prophyrin profiles done to establish if they have become mercury toxic. At study concept has been initiated by the IAOMT to test the porphyrin profiles on dental patients with varying amounts of amalgam exposure in a manner similar to the study in references 23-25.

The critical question is the effect of mercury vapor exposure on brain porphyrins profiles since an aberrancy has been reported in brain heme that has been associated with

the inability to remove beta-amyloid protein from brain cells³³. The effect on urinary porphyrins is well known and these porphyrins are primarily from the kidney. It should be noted that porphyrins lead to heme and heme is critical for several biochemical mechanisms. First, heme is the oxygen carrying cofactor for hemoglobin, second, heme is a critical cofactor for the P450 class of enzymes that are responsible for detoxifying organic type of toxins from the body, and, third, heme is a necessary cofactor for one of the complexes in the electron transport system of mitochondria. Therefore, mercury inhibition of heme production could have a multitude of secondary effects that cause human illnesses. It has been pointed out to me that autistic children are usually of very light complexion, indicating a lack of hemoglobin or oxygen carrying capacity, which is consistent with their abnormal porphyrin profiles.

It is obvious that lethality requires a higher level of exposure to mercury vapor than does neurological or developmental damage when considering infants *in utero*. Neurotoxicity or a suppressed immune system in the parent would be considered dangerous for developing and maintaining a pregnancy that leads to birth of a healthy child. Many children may appear normal and have apparently non-toxic levels of blood and urine mercury and still suffer from extreme mercury toxicity. For example, young athletes and others who died from Idiopathic Dilated Cardiomyopathy (IDCM) have been found to have 22,000 times the mercury in their heart tissue whereas the muscular samples did not¹⁸. This level, 178,400ng/g, would have generally been lethal to the kidney and CNS cells. *In my opinion, the unexplained, abnormal partitioning of huge levels of mercury into specific organs in certain individuals essentially renders it impossible to identify a blood or urine level of mercury that is safe for all.* Further, recent research has shown that mercury and ethylmercury have the ability to inhibit the first step (phagocytosis) in the innate and acquired immune response of humans at low nanomolar levels³¹. This clearly shows that mercury exposures quite below the average exposure can cause disruption of the immune system at all ages.

For an accurate determination of a LOEL or NOEL for injury causing mercury exposure it is clear that using data from one strain of a genetically inbred rat or mouse strain could result in a very inaccurate answer. Humans are not genetically inbred and their diets differ dramatically and some are on medications that would enhance the toxicity of all mercury compounds. Further more, it has been established in the literature that different strains of mice and rats give different sensitivities to mercury and that there can be dramatic differences in sensitivity to specific toxicants between species such as rats and humans. Therefore, basing safety on animal data is very misleading. One cannot measure accurately the effects of mercury exposure on the IQ of an individual exposed at birth since we do not know what it would have been without exposure---and a toxicity induced decrease in IQ, if the individual is not severely compromised, is difficult to establish.

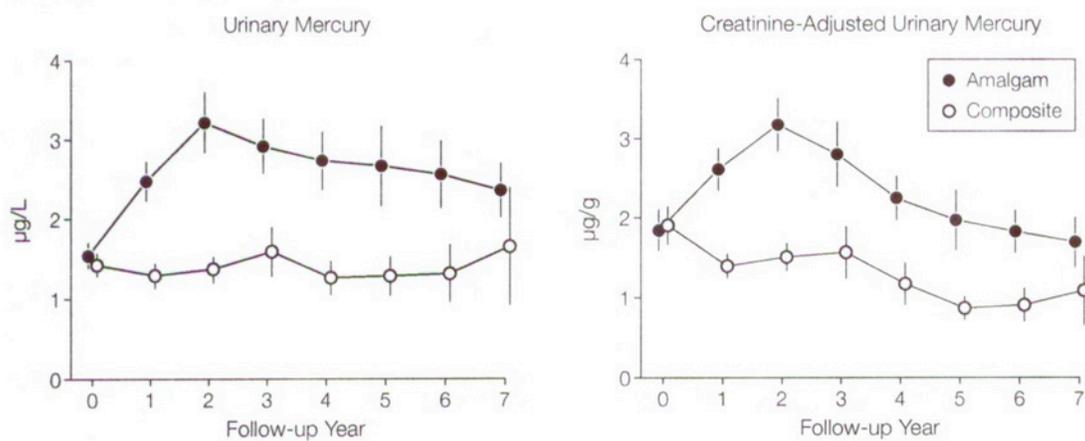
Recent reports in JAMA have come to the conclusion that amalgams are safe for use in children^{29,30}. However, there are numerous flaws with these studies that do not warrant such a conclusion and the papers themselves have been highly criticized both on ethical and scientific grounds by myself and other scientists.(seehttp://web.mac.com/iaomt/iweb/iaomt_news/).

First and foremost, these JAMA reported studies excluded all children with neurological problems (maybe caused by *in utero* mercury exposure from the birth

mother's amalgams²⁰) from the studies, and there are 1 in 6 children in the USA with neurological illnesses according to the CDC. So while a neurological healthy child may not respond to mercury toxic exposures as rapidly as a neurologically unhealthy child it seems untenable to call amalgams safe for general use in children which the authors did inaccurately conclude.

Second, the data presented in these JAMA reported studies regarding urinary excretion of mercury (ref. 27, figure 2, pg 1788, see below) showed clearly that urinary mercury increased in the first two years of amalgam exposure then dropped over 40% in the next five years to where the error bars of amalgam bearers and composite bearers overlapped, indicating no significant difference in urinary mercury excretion between the two groups.

Figure 2. Mean Urinary and Creatinine-Adjusted Urinary Mercury Concentrations by Treatment Group and Follow-up Year



Error bars indicate 95% confidence intervals.

The rationale for this amazing data was not discussed in the published manuscripts as the authors appeared to consider urinary mercury as a “measure of exposure” and were content with a decreased excretion as being explained by a decreased release of mercury from the amalgams as they aged. However, mercury does not stop emitting from amalgams after two years and these children also received new amalgams after year two through year six. **What the authors did not consider was that the decreased urinary mercury levels were a measure of “a decreased ability to excrete mercury” via the kidney. The most straight-forward explanation for this data is that after two years exposure to mercury vapor from amalgams the children are losing their ability to excrete mercury through the kidneys.** This explanation is consistent with amalgam exposure affecting the kidney porphyrin synthetic pathway and causing additional metabolic problems. This data, data from the articles that conclude dental amalgams are safe for all children, actually proves that basing any safety of dental amalgams on single day a year urinary mercury levels is totally invalid.

Thirdly, according to most reports that have directly studied the issue, a very high percentage of mercury is excreted not by the urinary route but by the fecal route. One study found that the ratio was 12 to 1 with the fecal excretion being over 90% of the total.³⁷ Therefore, using a single, yearly spot urine analysis to account for mercury

exposure appears to be a scientifically unacceptable procedure to evaluate the mercury exposure of these children based on the fact that urine most likely is a minor excretory route.

Fourthly, why weren't the porphyrin profiles of these study children evaluated rapidly and reported? One would be surprised if they remained normal in light of the reported effects on the porphyrin profiles of dentists and dental hygienist exposed to mercury vapor that has been in the literature for some time now.²³⁻²⁵ In fact, the behavior of the authors of these papers is symptomatic of developing a study that will show no significant differences while avoiding any experiments that have been shown to react more rapidly and more sensitively to mercury toxicity.

Mercury based LOELs and NOELs from non-human data have another short-coming. For example, it has been known for some time that the relative toxicity of mercury containing compounds appears to be dramatically affected by the presence of other compounds and heavy metals that synergistically enhance the toxicity of mercury. For example, mixing of an LD1 dose of mercury with a 1/20 dilution of an LD1 of lead produces a mixture with an LD100, not an LD2 or less that would be expected with additive toxicities¹. Since there is considerable concern about the lead levels in the drinking water in our nation's capital it seems the citizens there would be under more toxic stress than in locations with little or no lead exposure. This data strongly implies that synergistic toxicity of mercury with other readily available toxic metals would dramatically enhance the toxicity and lower the LOEL and NOEL values.

What we do know from a study entitled "Mercury in Brain Tissue of Infants" is that the mercury levels in the brain stem of infants from California had a mean of over 55ng Hg/g wet weight of tissue. This is roughly 55 micrograms/kg. Assuming a kg of tissue is about 1 liter then the mercury concentration is about 275 nanomolar. It has been clearly shown that neurons in culture are destroyed by levels of mercury much less than 50 nanomolar with no synergistic compounds, such as lead, aluminum or cadmium, present to enhance mercury toxicity²⁸. This level of mercury is especially toxic in the presence of testosterone whereas estradiol affords protection. Given the findings of elevated testosterone in the amniotic fluid of mothers who gave birth to autism spectrum children this has to be a concern.

Consider also that mercury from different exposures are at the least additive in their toxicity effects. A report from the National Center for Health Statistics, Center for Disease Control and Health in 2003 stated that approximately 8% of women of child-bearing age had concentrations of mercury higher than the USA EPA's recommended reference dose, below which exposures are considered to be without adverse effects³. This blood level in women caused more recent concern with data showing that cord blood was 1.7 times the level of maternal blood indicating that more than 8% of children being born are being exposed to toxic levels of mercury from their mother's blood. These individuals would definitely be more at risk during transient mercury exposures than would the general population and are certainly not comparable to animals in a pristine environment being exposed to only one mercury toxicant. Therefore, a 10-fold reduction for mercury in medicaments, as is common in converting a LOEL into a NOEL, most likely does not provide the protection factor as it would for exposures to most non-mercury toxicants that have less defined synergistic partners.

It is well known that diet plays a major role in the ability of mammals to excrete mercury². Studies have shown that three different diets fed to adult female mice (high protein synthetic diet; standard rat chow diet; milk diet) dramatically changed the rate of fecal excretion of mercury. Mercury was introduced orally as methyl-mercury (MeHg) and diet caused differential rates of whole body mercury elimination. The results showed that mice fed a synthetic, high protein diet had the lowest tissues levels of mercury whereas those fed the milk diet retained the highest mercury levels. *This was confirmed by the total percentage of mercury excreted in the feces after 6 days of 43%, 29% and 11% in the high protein, rat chow and milk diets, respectively* Therefore, diet plays a major role in the fecal excretion rates of mercury from an organic mercury compound. As expected, diet also affected the excretion rate of mercury from body tissues. The retention of mercury in the body of a child on a milk diet would be much higher than for a child not on a milk diet. Twenty-year-old studies report that suckling animals absorb about 50% of Hg²⁺ versus 5% in non-suckling animals¹¹. Since the level of toxicity would likely increase with retention time, especially if the exposure rate to mercury were consistent over any significant period of time, then the diet can have a major affect on the calculated NOELs and minimum acceptable daily levels.

Toxicity is also known to vary with the chemical species of mercury that exists in the body's tissues. Diets can change this as it was observed that foods ingested played a major role in the mercury chemical species that existed in the mice given oral doses of MeHg. Hg²⁺ was the species found at the highest level in test animals on a synthetic protein diet (35.3%) and was the lowest in test animals on a milk diet (6.6%). It is reasonable to predict that diet changes the conversion of MeHg to Hg²⁺ and would likely do so for other organic mercury compounds, such as ethyl-mercury (Et-Hg), which is released from thimerosal. Since the toxicity of organic mercury compounds (e.g. MeHg versus EtHg) which partition similar to mercury vapor has been suggested to be greater than Hg²⁺ (inorganic mercury) and toxicity is partially determined by the rate that the compound is converted to Hg²⁺ after the chemical nature of the mercury source has allowed effective partitioning across the blood brain barrier.

Other studies confirm that the renal uptake and toxicity of circulating mercury is significantly enhanced in rats by the co-ingestion of the essential amino acid L-cysteine⁸ and disease marker homocysteine⁹. Elevated blood homocysteine level is a major risk factor for cardiovascular disease. Therefore, humans with risk for cardiovascular disease would be more at risk for low level mercury exposure than others. This would also be true for Alzheimer's disease where elevated homocysteine has also been reported.³²

Medical status is of concern when considering mercury compound toxicity, especially when bacterial infections are being treated. Treatment of adult female mice with widely used antibiotics 7 days prior to MeHg exposure dramatically influenced mercury retention of tissues from mice receiving similar organic mercury exposures². The calculated whole body mercury elimination half-times from day 1 to day 6 varied from 34, 10 and 5 days for mice fed a milk diet, mice chow or high protein diet respectively. *A remarkable 6.8 fold increase in retention half-life existed between a milk diet and high protein diet that was caused by antibiotic treatment that also changed the gut microflora.* Antibiotic treatment dropped the fecal mercury excretion to near zero in the high protein and milk diets and to less than 8% with the mouse chow diet. Therefore,

it can be concluded that the relative toxicity of mercury and mercury compounds would be dramatically increased if the test subject were on antibiotics.

The toxicity of mercury vapor is dependent on retention and excretion and these vectors are dramatically affected by diet and antibiotic treatment as well as other factors. This makes it nearly impossible to define a safe level of exposure for mothers and their infants *in utero*. Being exposed minute by minute to mercury vapor for years has never been established as safe, but ~~it has~~ reasonable concerns have been effectively nullified by the dental organizations giving their opinions regarding perceived safety. It is incredible that the responsible US government agencies and the organizations and companies using dental amalgam have not felt the need to produce such research. Especially with the obvious severe toxic nature of mercury vapor and the ease with which the amount of mercury vapor that would escape from a dental amalgam could be measured. The quality data is just not available in the literature to evaluate and determine the level at which mercury vapor is emitted from the various types of dental amalgam. However, it is my opinion that the reason is not because it would be difficult to do, but to do so would place the manufacturers and users of dental amalgam at risk for major lawsuits and they would lose their businesses.

The process of placing or removing dental amalgam's in a pregnant mother has to increase the exposure of the *in utero* infant to elevated mercury vapors as it would dramatically increase the mother's blood mercury levels. It is well known that mercury vapor can cross the placenta, and is even concentrated in the cord blood versus the mother's blood. Other studies have shown that mercury increases in the birth hair of normal children in response to increasing dental amalgams in the birth mother²⁰. Other similar studies point to aberrant mercury hair levels in children with neurological problems^{20,21}. There can be little doubt that the exposure of a pregnant mother to mercury vapor by aggressive dental amalgam treatment could cause harm to her infant *in utero*.

Finally, based on the exacerbation of mercury toxicity by variation in human sex hormone presence, dietary factors, other toxic metals, antibiotic usage, and genetic susceptibility factors there is no intelligent way that anyone can say they know that a specific exposure to mercury to an infant in utero or an aged ill person would not cause a significant affect on their health.

CONCLUSIONS:

We know that alcohol is a toxic material and mere presence in the blood stream or oral air can lead to a conviction. However, the presence of the more toxic mercury, known to have adverse effects of a more permanent nature in humans, is not judged by the FDA based on its mere presence, it is required that studies be done to prove it has toxic effects in humans---if it comes from dental amalgam. Yet the cost of such studies are such that only the USA government agencies such as the FDA or CDC could afford to do such studies or have the power to insist that the manufacturers of amalgams do so. However, this is something the FDA and CDC have steadfastly refused to require. No other compound, drug, etc. seems to have this special consideration, which is amazing in light of the known, potent neurotoxicity of mercury vapor.

When agencies such as the EPA and National Academy of Sciences report that a large percentage of American women have mercury levels which render susceptibility to neurological damage to any child they would give birth to, and when the CDC states that

1 in 6 American children have neurodevelopmental disorders, and when solid laboratory research shows that the major contributor to human mercury body burden comes from dental amalgam it seems as if the FDA and CDC are being remiss in performing their assigned task of protecting the American public from toxic damage by not eliminating or phasing out the use of dental amalgam.

The above is especially true when studies on dentists themselves show that 85% have aberrant porphyrin metabolism caused by mercury exposure and 15% of this group have a more severe response that is correlated to a genetic susceptibility. This genetic susceptibility also seems to apply to children in the autism spectrum disorders group which has led to the recent epidemic of neurological problems in children. French researchers have also shown that a high percentage of autistic children have the same aberrant porphyrin profile as the dentists exposed to amalgam mercury vapors, and that this aberrancy can be reversed by chelation of the mercury from their bodies.

No other material has near the number of close mimicking abilities of mercury with regards to producing the aberrant biochemistry and producing the known diagnostic hallmarks of Alzheimer's disease (AD) than mercury. Many Americans have grams of mercury vapor releasing amalgams within two inches of their brains and it is inarguable that this minute by minute exposure for 20 to 50 plus years would not push those condemned to die with AD into dementia earlier, and at a great cost to their families and our medical system. Yet, in spite of all of this knowledge American Dentistry and Medicine remains silent and in active denial that these modern man diseases, which first occurred after the dental and medical introduction of the use of mercury, may be caused or even exacerbate these awful neurological illnesses for which medicine has no explanation for.

First do no harm, this is one of the major mantras of medicine. It seems as if the FDA has chosen to ignore this advice in the past as certainly there can be no doubt about amalgam's contribution to human mercury body burden and the opinion of the EPA and NAS that this mercury body burden is not healthy and most likely is quite damaging.

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