Mercury Exposure Levels from Amalgam Dental Fillings; Documentation of Mechanisms by Which Mercury Causes over 30 Chronic Health Conditions; Results of Replacement of Amalgam Fillings; and Occupational Effects on Dental Staff

Bernard Windham (Editor)

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Mercury Exposure Levels from Amalgam Dental Fillings; Documentation of Mechanisms by Which Mercury Causes over 30 Chronic Health Conditions; Results of Replacement of Amalgam Fillings; and Occupational Effects on Dental Staff

Bernard Windham, Editor- Chemical Engineer 12164 Whitehouse Road

Tallahassee, FL, 32311 850-878-9024

1.1 Introduction

Toxic metals such as mercury, lead, cadmium, etc. have been documented to be neurotoxic, immunotoxic, reproductive/developmental toxins that according to U.S. Government agencies cause adverse health effects and learning disabilities to millions in the U.S. each year, especially children and the elderly (160, 105, 27d). Exposure of humans and animals to toxic metals such as mercury, cadmium, lead, copper, aluminum, arsenic, chromium, manganese, etc. is widespread and in many areas increasing. A 2009 study found that inorganic mercury levels in people have been increasing rapidly in recent years (543b). It used data from the U.S. Centers for Disease Control and Prevention's National Health Nutrition Examination Survey (NHANES) finding that while inorganic mercury was detected in the blood of 2 percent of women aged 18 to 49 in the 1999-2000 NHANES survey, that level rose to 30 percent of women by 2005-2006. Surveys in all states using hair tests have found dangerous levels of mercury in an average of 22% of the population, with over 30% in some states like Florida and New York (543c).

The U.S. Center for Disease Control (276) ranks toxic metals as the number one environmental health threat to children. According to an EPA/ATSDR assessment, the toxic metals mercury, lead, arsenic, and cadmium are all ranked in the top 7 toxics having the most adverse health effects on the public based on toxicity and current exposure levels in the U.S., with nickel and chromium also highly listed. The U.S. EPA indicates that approximately 25% of U.S. infants are exposed to dangerous levels of mercury (276). A National Academy of Sciences report of July 2000 and other studies (39, 125, 308, 540) found that even small levels of mercury in fish or levels of mercury in the blood of women below 10 micrograms per liter (μg/l) appear to result in developmental effects, and represent unacceptable risks of birth defects and developmental effects in infants. A California clinical study found adverse effects at exposures below 10 μg/l (540). 1 μg/l is the upper level of mercury exposure recommended by the German Commission on Human Biomonitoring in the blood (39). The National Academy of Sciences safety limit is 5 micrograms per liter. But blood level is also documented to not be a reliable indicator of mercury toxicity since mercury vapor passes out of the blood in a very short time. And *mercury amalgam dental fillings have been found to be the largest source of both inorganic and methyl mercury in most who have several amalgam fillings*[1].

The main factors determining whether chronic conditions are induced by metals appear to be exposure and genetic *susceptibility*[2], which determines individuals immune sensitivity and ability to detoxify metals (405, 342). Very low levels of exposure have been found to seriously affect relatively large groups of individuals who are immune sensitive to toxic metals, or have an inability to detoxify metals due to such as deficient sulfoxidation or metallothionein function or other inhibited enzymatic processes related to detoxification or excretion of metals. For those with chronic conditions, fatigue regardless of the underlying disease is primarily associated with hypersensitivity to inorganic and organic mercury, nickel, and gold (342, 369, 375, 382, 595).

While there have been large increases of most neurological and immune conditions among adults over the last 2 decades (574), the incidence of neurotoxic or immune reactive conditions in infants such as autism, schizophrenia, ADD, dyslexia, learning disabilities, etc. have been increasing especially rapidly in recent years (2, 409, 441, 476). A recent report by the National Research Council found that 50% of all pregnancies in the U.S. are now resulting in prenatal or postnatal mortality, significant birth defects, developmental neurological or immune conditions, or otherwise chronically unhealthy babies (441). Exposure to toxic chemicals or environmental factors appear to be a factor in as much as 28 percent of the 4 million children born each year (441, 160), with 1 in 6 having one of the neurological conditions previously listed. EPA estimates that over 3 million of these are related to lead or mercury toxicity (2, 125, 276, 409), with approximately 25% of U.S. infants receiving dangerous levels of mercury exposure (276). A recent study found that prenatal Hg exposure is correlated with lower scores in neurodevelopmental screening, but more so in the linguistic pathway (32c). A study at the U.S. CDC found "statistically significant associations" between certain neurologic developmental disorders such as attention deficit disorder (ADD) and autism with exposure to mercury from thimerosal-containing vaccines before the age of 6 months (476), and a followon study using federal vaccine data bases confirmed that autism, speaking disorders, and heart arrest have increased exponentially with increasing exposures to mercury thimerosal-containing vaccines (476b). Thimerosal has also been found to cause hormonal effects (555, 413). Prenatal exposure to mercury has also been found to predispose animals and infants to seizures and epilepsy (5, 52).

The health effects of toxic metals are synergistic with other toxic exposures such as *pesticides*[3], *endocrine*[4] disrupting substances like organochlorine compounds and PCBs, etc. There are also synergistic effects with the various types of parasites, bacteria, viruses to which people have common exposures and commonly become infected when the immune system is weakened by toxic exposures

[1] **Internet:** "http://www.home.earthlink.net/%7Eberniew1/damspr1.html".
[2] **Internet:** "http://www.home.earthlink.net/%7Eberniew1/suscept.html".
[3] **Internet:** "http://www.flcv.com/pesticid.html".
[4] **Internet:** "http://www.flcv.com/endocrin.html".

(485, 469b, 470) While there is considerable commonality to the health effects commonly caused by these toxic metals, and effects are cumulative and synergistic in many cases, this paper will concentrate on the health effects of elemental mercury from amalgam fillings. Studies have found considerable genetic variability in *susceptibility*[5] to toxic metals as well. The public appears to be generally unaware that considerable scientific evidence supports that mercury is the metal causing the most widespread adverse health effects to the public, and amalgam fillings have been well documented to be the number one source of exposure of mercury to most people, with exposure levels often exceeding Government health guidelines and levels documented to cause adverse health effects.

1.2 Toxicity and health effects of mercury

1. Dental amalgam contains about 50% mercury, as well as other toxic metals such as tin, copper, nickel, palladium, etc. The average filling has 1 gram of mercury and leaks mercury vapor continuously due to mercury's high volatility along with loss due to galvanic action of mercury with dissimilar metals in the mouth (182, 192, 276b, 292, 348, 349, 525), resulting in significant exposure for most with amalgam fillings (see Section III). Mercury vapor is transmitted rapidly throughout the body, easily crosses cell membranes, and like organic methyl mercury has significant toxic effects at much lower levels of exposure than other inorganic mercury forms (38, 281, 287, 304, 329). The OSHA level for mercury vapor in air is 50% lower than for organic mercury in air. According to the U.S. EPA & ATSDR, mercury is among the top 3 toxic substances adversely affecting large numbers of people (217), and amalgam is the number one source of exposure for most people (see III).

A large U.S. Centers for Disease Control epidemiological study, NHANES III, found that those with more amalgam fillings (more mercury exposure) have significantly higher levels of chronic health conditions (543). The conditions in which the number of dental amalgam surfaces were most highly correlated with disease incidence were MS, epilepsy, migraines, mental disorders, diseases of the nervous system, disorders of the thyroid gland, cancer, and infectious diseases (543). Other conditions where incidence was significantly correlated with having more than the average number of amalgam surfaces are: diseases of the male and female genital tracts, Disorders of the peripheral nervous system, Diseases of the respiratory system, and Diseases of the genitourinary system (543). MS clusters in areas with high metals emissions from facilities such as metal smelters have been documented (184).

As far back as 1996 it was shown that the lesions produced in the myelin sheath of axons in cases of multiple sclerosis were related to excitatory receptors on the primary cells involved called oligodendroglia. The loss of myelin sheath on the nerve fibers characteristic of the disease are due to the death of these oligodendroglial cells at the site of the lesions (called plaques). Further, these studies have shown that the death of these important cells is as a result of excessive exposure to excitotoxins at the site of the lesions (576, 585). Most of these excitotoxins are secreted from microglial immune cells in the central nervous system. This not only destroys these myelin-producing cells it also breaks down the blood-brain barrier (BBB), allowing excitotoxins in the blood stream to enter the site of damage. Some common exposures that cause such proliferation of such excitotoxins resulting in MS are mercury and aspartame, with additional effects from MSG and methanol. Mercury and other toxic metals inhibit astrocyte function in the brain and CNS (119), causing increased glutamate and calcium related neurotoxicity (119, 333, 416, 496) which are factors in neural degeneration in MS and ALS. There is evidence that astrocyte damage/malfunction is a major factor in MS (544). Mercury and increased glutamate activate free radical forming processes like xanthine oxidase which produce oxygen radicals and oxidative neurological damage (142, 13). Nitric oxide related toxicty caused by peroxynitrite formed by the reaction of NO with superoxide anions, which results in nitration of tyrosine residues in neurofilaments and manganese Superoxide Dimustase (SOD) has been found to

[5]**Internet:** "http://www.home.earthlink.net/%7Eberniew1/suscept.html".

cause inhibition of the mitochondrial respiratory chain, inhibition of the glutamate transporter, and glutamate-induced neurotoxicity involved in ALS (524, 521).

It is now known the cause for the destruction of the myelin in the lesions is overactivation of the microglia in the region of the myelin (585). An enzyme that converts glutamine to glutamate called glutaminase increases tremendously, thereby greatly increasing excitotoxicity. Any dietary excitotoxin can activate the microglia, thereby greatly aggravating the injury. This includes the aspartate in aspartame and MSG which is in many processed foods. The methanol in diet drinks adds to this toxicity as well. Now, the secret to treatment appears to be calming down inflammation of the microglia.

Mercury and cadmium inhibiting magnesium and zinc levels as well as inhibiting glucose transfer are other mechanisms by which mercury and toxic metals are factors in metabolic syndrome and insulin resistance/diabetes (43, 198, 338, 589). Reduced levels of magnesium and zinc are related to metabolic syndrome, insulin resistance, and brain inflammation and are protective against these conditions (587, 43).

According to neurologist Dr. RL Blaylock (585), the good news is that there are supplements and nutrients that calm the microglia-the most potent are: silymarin, curcumin and ibuprophen. Phosphatidylcholine helps re-myelinate the nerve sheaths that are damaged, as does B12, B6, B1, vitamin D, folate, vitamin C, natural vitamin E (mixed tocopherols) and L-carnitine (576). DHA plays a major role in repairing the myelin sheath. Vitamin D may even prevent MS, but it acts as an immune modulator, preventing further damage - the dose is 2000 IU a day. Magnesium, as magnesium malate, is needed in a dose of 500 mg 2X a day. They must avoid all excitotoxins, even natural ones in foods-such as soy, red meats, nuts, mushrooms and tomatoes. Avoid all fluoride and especially all vaccinations since these either inhibit antioxidant enzymes or triggers harmful immune reactions.

2. Mercury is the most toxic of the toxic metals. Mercury (vapor) is carried by the blood to cells in all organs of the body where it:

(a) is cytotoxic (kills cells) (2, 21, 27, 36, 56, 147, 148, 150, 160, 210, 259, 295, 333/333).

(b) penetrates and damages the blood brain barrier (311), resulting in accumulation of mercury and other toxic substances in the brain (14, 20, 21b, 25, 85, 99, 175, 273, 301, 305, 149, 262, 274); also accumulates in the motor function areas of the brain and CNS (48, 119, 175, 291, 327, 329).

(c) is neurotoxic (kills brain and nerve cells): damages brain cells and nerve cells (19, 27, 34, 36, 43, 69, 70, 147, 148, 175, 207, 211, 258, 273, 291, 295, 327, 329, 301, 303, 305, 395/39, 262, 274, 303); generates high levels of reactive oxygen species (ROS) and oxidative stress, depletes glutathione and thiols causing increased neurotoxicity from interactions of ROS, glutamate, and dopamine (13, 56, 98, 102, 145, 169, 170, 184, 213, 219, 250, 257, 259, 286, 288, 290, 291, 302, 324, 326, 329, 416, 424, 442, 496, 564, 565); kills or inhibits production of brain tubulin cells (66, 67, 161, 166, 207, 258, 300); inhibits production of neurotransmitters by inhibiting: calcium-dependent neurotransmitter release (372, 432), dihydroteridine reductase (27, 122, 257, 333), nitric oxide synthase (259), blocking neurotransmitter amino acids (412), and effecting phenylalanine, serotonin, tyrosine and tryptophan transport to neurons (34, 122, 126, 257, 285, 288, 333, 372, 374, 412/333).

(d) is immunotoxic (damages and inhibits immune T-cells, B-cells, neutrophil function, etc.) (17, 27, 31, 38, 44, 45, 46, 60, 127, 128, 129, 130, 152, 155, 165, 181, 226, 252, 270, 285, 316, 343, 355, 425, 467/272) and induces ANA antibodies and autoimmune disease (38, 43, 45, 59, 60,

118, 181, 234, 269, 270, 313, 314, 334, 342, 343, 425, 405).

(e) is nepthrotoxic (toxic to kidneys) (14, 20, 203, 209c, 223, 254, 260, 268, 334, 438).

(f) is endocrine system-disrupting chemical (accumulates in pituitary gland and damages or inhibits pituitary glands hormonal functions at very low levels (9, 19, 20, 25, 85, 99, 105, 273, 312, 327, 348, 369, 543b/274), adrenal gland function (84, 369, 381), thyroid gland function (50, 212, 369, 382, 459, 508-511, 35), thymus gland function (513a), and disrupts enzyme production processes at very low levels of exposure (9, 13, 33, 35, 56, 111, 194, 258, 348, 355, 410-412).

(g) exposure to mercury vapor (or methyl mercury) causes rapid transmittal through the placenta to the fetus (20, 22-24, 27, 38, 39, 61, 112, 186, 281, 287, 304, 311, 338, 339, 348, 361, 366, 20/ 4, 22, 37, 39, 41, 42) and significant developmental effects-much more damage to the fetus than for maternal exposure to inorganic mercury and at lower exposure levels than for organic mercury (287, 304, 276e, etc.).

(h) reproductive and developmental toxin (2, 4, 9, 10, 22, 23, 24, 31, 37, 38, 41, 61, 105, 125, 160, 175, 275, 281, 305, 338, 361, 367, 381, 20/4, 39, 55, 149, 162, 255, 308, 339, 357, 540); damages DNA (296, 327, 272, 392, 142, 38, 41, 42, 35) and inhibits DNA & RNA synthesis (114, 175, 35/149); damages sperm, lowers sperm counts and reduces motility. (4, 37, 104.105, 159, 160, 433, 35/4, 55, 162); causes menstrual disturbances (9, 27, 146); reduces bloods ability to transport oxygen to fetus and transport of essential nutrients including amino acids, glucose, magnesium, zinc and Vit B12 (43, 96, 198, 260d, 264, 338, 339, 347, 427); depresses enzyme isocitric dehydrogenase (ICD) in fetus, causes reduced iodine uptake & hypothyroidism (50, 91, 212, 222, 369, 382, 390, 459, 35ab); causes learning disabilities and impairment, and reduction in IQ (1, 3, 38, 110, 160, 285c, 264, 338, 509/39), causes infertility (4, 9, 10, 24, 38, 121, 146, 357, 365, 367, 511 /4, 10, 55, 162), causes birth defects (23, 35ab, 37, 38, 50, 110, 142, 241, 338c, 509, 511/241).

(i) prenatal/early postnatal exposure affects level of nerve growth factor in the brain, impairs astrocyte function, and causes imbalances in development of brain (38, 119, 131, 161, 175, 194, 305, 458/149, 255, 39).

(j) causes cardiovascular damage and disease: including damage to vascular endothelial cells, damage to sarcoplasmic reticula, sarcolemma, and contractile proteins, increased white cell count, decreased oxyhemoglobin level, high blood pressure, tachycardia, inhibits cytochrome P450/heme synthesis (84, 35, 201, 539), and increased risk of acute myocardial infarction (35, 59, 201, 202, 205, 212, 232, 306, 310, 351, 510, 50/201, 308).

(k) causes immune system damage resulting in allergies, asthma, lupus (234, 260e), schleraderma (468), chronic fatigue syndrome (CFS), and multiple sensitivities (MCS) (8, 17, 26, 35, 45, 46, 60, 75, 86, 87, 90, 95, 97, 101, 128, 129, 131, 132, 154, 156, 168, 181, 212, 226, 228, 230, 234, 265, 267, 296, 313, 342, 388, 445, 595, 446/272) and neutrophil functional impairment (285, 404, 467/59, etc.).

(l) causes interruption of the cytochrome C oxidase system/ATP energy function (43, 84, 232, 338c, 35) and blocks enzymes needed to convert porphyrins to adenosine tri phosphate (ATP) causing progressive porphyrinuria, resulting in low energy, digestive problems, and porphyrins in urine (34, 35, 69, 70, 73, 210, 212, 226, 232, 258, 260).

(m) inhibition of immune system facilitates increased damage by bacterial, viral, and fungal infections (17, 45, 59, 129, 131, 251, 296, 350, 40), and increased antibiotic resistance (116, 117, 161, 389, 53, 79).

(n) mercury causes significant destruction of stomach and intestine epithelial cells, resulting in damage to stomach lining which along with mercury's ability to bind to SH hydroxyl radical in cell membranes alters permeability (338, 405, 35, 21c) and adversely alters bacterial populations in the intestines causing leaky gut syndrome with toxic, incompletely digested complexes in the blood (222, 228b, 35) and accumulation of heliobacter pylori, a suspected major factor in stomach ulcers and stomach cancer (256) and candida albicans, as well as poor nutrient absorption.

(o) forming strong bonds with and modification of the-SH groups of proteins causes mitochondrial release of calcium (1, 21, 35, 38, 43, 329, 333, 432), as well as altering molecular function of amino acids and damaging enzymatic process (33, 96, 111, 194, 252, 338, 405, 410-412) resulting in improper cysteine regulation (194), inhibited glucose transfer and uptake (338, 254), damaged sulfur oxidation processes (33, 194, 338), and reduced glutathione availability (necessary for detoxification) (13, 126, 54).

(p) $HgCl_2$ inhibits aquaporin-mediated water transport in red blood cells (479).

3. Mercury has been well documented to be an endocrine system disrupting chemical in animals and people, disrupting function of the pituitary gland, thyroid gland, reproduction processes, and many hormonal functions at very low levels of exposure. Mercury (especially mercury vapor) rapidly crosses the blood brain barrier and is stored preferentially in the pituitary gland, thyroid gland, hypothalamus, and occipital cortex in direct proportion to the number and extent of dental amalgam surfaces (1, 14, 16, 19, 20, 25, 34, 38, 50, 61, 85, 99, 162, 211, 273, 274, 287, 327, 348, 360, 366, 369, 543b) Thus mercury has a greater effect on the functions of these areas. Studies have documented that mercury causes hypothyroidism (50, 390, 35), damage of thyroid RNA (458), autoimmune thyroiditis (369, 382, 91) and impairment of conversion of thyroid T4 hormone to the active T3 form (369, 382, 459, 35, 50d, 91). An overactive thyroid gland, or hyperthyroidism, can trigger restlessness, hyperactivity, insomnia and irritability - symptoms that could be mistaken for mania (560). On the other hand, a thyroid gland that responds sluggishly in a hypothyroid state may result in feelings of coldness, depression, pain, and low energy. Overt autoimmune thyroiditis is preceded by a rise in levels of thyroid peroxidase antibodies. "Collectively, reports show that 30-60% of women positive for TPO antibodies in pregnancy develop postpartum thyroiditis", the researchers point out (561), calling it "a strong association." Without treatment, many of the women with thyroiditis go on to develop overt clinical hypothyroidism as they age and, eventually, associated complications such as cardiovascular disease. About 5% of pregnant women develop thyroiditis after birth.

According to survey tests, 8 to 10% of untreated women were found to have thyroid imbalances so the actual level of hypothyroidism is higher commonly recognized (508). Even larger percentages of

women had elevated levels of antithyroglobulin (anti-TG) or antithyroid peroxidase antibody (anti-TP). Studies indicate that slight imbalances of thyroid hormones in expectant mothers can cause permanent neuropsychiatric damage in the developing fetus (509). Low first trimester levels of free T4 and positive levels of anti-TP antibodies in the mother during pregnancy have been found to result significantly reduces IQs (509). Hypothyroidism is a well documented cause of mental retardation (509). Women with the highest levels of thyroid-stimulating-hormone (TSH) and lowest free levels of thyroxine 17 weeks into their pregnancies were significantly more likely to have children who tested at least one standard deviation below normal on an IQ test taken at age 8. Based on study findings, maternal hypothyroidism appears to play a role in at least 15% of children whose IQs are more than 1 standard deviation below the mean, millions of children. Studies have also established a "clear association" between the presence of thyroid antibodies and spontaneous abortions (511), as well as a connection between maternal thyroid disease and babies born with heart, brain, and kidney defects (509c). Levels of recurrent abortions in a population with positive levels of thyroid antibodies in one study were 40%, 5 times the normal rate (511). Hypothyroidism is a well documented risk factor in spontaneous abortions and infertility (9). Another study of pregnant women who suffer from hypothyroidism (underactive thyroid) found a four-times greater risk for miscarriage during the second trimester than those who don't, and women with untreated thyroid deficiency were four-times more likely to have a child with a developmental disabilities and lower I.Q. (509). The American Assoc. of Clinical Endocrinologists advises that all women considering becoming pregnant should get a serum thyrotropin test so that hypothyroidism can be diagnosed and treated early (558).

Mercury blocks thyroid hormone production by occupying iodine binding sites and inhibiting hormone action even when the measured thyroid level appears to be in proper range (390, 35ab). The thyroid and hypothalamus regulate body temperature and many metabolic processes including enzymatic processes that when inhibited result in higher dental decay (35). Mercury damage thus commonly results in poor bodily temperature control, in addition to many problems caused by hormonal imbalances such as depression. Such hormonal secretions are affected at levels of mercury exposure much lower than the acute toxicity effects normally tested (390, 50, 84, 595), as previously confirmed by hormonal/reproductive problems in animal populations (104, 381c, 50d). Mercury also damages the blood brain barrier and facilitates penetration of the brain by other toxic metals and substances (311). Thyroid imbalances, which are documented to be commonly caused by mercury (369, 382, 459, 35, 50, 91), have been found to play a major role in chronic heart conditions such as clogged arteries, mycardial infarction, and chronic heart failure (510).

Mercury can have significant effects on thyroid function even though the main hormone levels remain in the normal range, so the usual thyroid tests are not adequate in such cases. Prenatal methylmercury exposure severely affects the activity of selenoenzymes, including glutathione peroxidase (GPx) and 5-iodothyronine deiodinases (5-Di and 5'-DI) in the fetal brain, even though thyroxine (T4) levels are normal (390e). Gpx activity is severely inhibited, while 5-DI levels are decreased and 5'-DI increased in the fetal brain, similar to hypothyroidism. Thus normal thyroid tests will not pick up this condition.

The pituitary gland controls many of the body's endocrine system functions and secretes hormones that control most bodily processes, including the immune system and reproductive systems. One study found mercury levels in the pituitary gland ranged from 6.3 to 77 ppb (85), while another (348) found the mean level to be 30ppb - levels found to be neurotoxic and cytotoxic in animal studies. Some of the effect on depression is related to mercury's effect of reducing the level of posterior pituitary hormone (oxytocin). Low levels of pituitary function are associated with depression and suicidal thoughts, and appear to be a major factor in suicide of teenagers and other vulnerable groups. A study by a neuroscience researcher found a connection between the levels of pituitary hormone lutropin and chronic mercury exposure (543b). The authors indicated that inorganic mercury binding to luteinizing hormone can impair gonadotrophin regulation affecting fertility and reproductive function, as well as immune function and has been found to accumulate in the brain and stay

there for years, which may help explain mercury's link to neurodegenerative disease.

The pituitary glands of a group of dentists had 800 times more mercury than controls (99). This may explain why dentists have much higher levels of emotional problems, depression, suicide, etc (Section VIII.). Amalgam fillings, nickel and gold crowns are major factors in reducing pituitary function (35, 50, 369, etc.). Supplementary oxytocin extract has been found to alleviate many of these mood problems (35), along with replacement of metals in the mouth (Section VI.). The normalization of pituitary function also often normalizes menstrual cycle problems, endometriosis, and increases fertility (9, 35).

The thymus gland plays a significant part in the establishment of the immune system and lymphatic system from the 12^{th} week of gestation until puberty. Inhibition of thymus function can thus affect proper development of the immune and lymphatic systems. Lymphocyte differentiation, maturation and peripheral functions are affected by the thymic protein hormone thymulin. Mercury at very low concentrations has been seen to impair some lymphocytic functions causing subclinical manifestations in exposed workers. Animal studies have shown mercury significantly inhibits thymulin production at very low micromolar levels of exposure (513a). The metal allergens mercuric chloride and nickel sulfate were found to stimulate DNA synthesis of both immature and mature thymocytes at low levels of exposure, so chronic exposure can have long term effects (513b). Also, micromolar levels of mercuric ions specifically blocked synthesis of ribosomal RNA, causing fibrillarin relocation from the nucleolus to the nucleoplasm in epithelial cells as a consequence of the blockade of ribosomal RNA synthesis. This appears to be a factor in deregulation of basic cellular events and in autoimmunity caused by mercury. There were specific immunotoxic and biochemical alterations in lymphoid organs of mice treated at the lower doses of mercury. The immunological defects were consistent with altered T-cell function as evidenced by decreases in both T-cell mitogen and mixed leukocyte responses. There was a particular association between the T-cell defects and inhibition of thymic pyruvate kinase, the rate-limiting enzyme for glycolysis (513c). Pyruvate and glycolysis problems are often seen in mercury toxic children being treated for autism (409). L-arginine restored thymulin activity, TEC proliferation, NKT cytotoxicity, cytokine profiles and nitrite and nitrate plasma levels both in vivo and in vitro (513a).

4. Mercury's biochemical damage at the cellular level include DNA damage, inhibition of DNA and RNA synthesis (4, 38, 41, 42, 114, 142, 175, 197, 272, 296, 305, 392/149); alteration of protein structure (33, 111, 114, 194, 252/114); alteration of the transport of calcium (333, 43, 96, 254, 329, 432); inhibition of glucose transport (338, 254), and of enzyme function and other essential nutrient transport (96, 198, 254, 258, 263, 264, 338, 339, 347, 410-412); induction of free radical formation (13, 54, 496), depletion of cellular glutathione (necessary for detoxification processes) (111, 126), inhibition of glutathione peroxidase enzyme (13, 258, 496), endothelial cell damage (202), abnormal migration of neurons in the cerebral cortex (149), and immune system damage (34, 38, 111, 194, 226, 252, 272, 316, 325, 355).

Part of the toxic effects of mercury, cadmium, lead, etc. are through their replacing essential minerals such as zinc at their sites in enzymes, disabling the necessary enzymatic processes.

There has been a huge increase in the incidence of degenerative neurological conditions in virtually all Western countries over the last 2 decades (574). The increase in Alzheimer's has been over 300% while the increase in Parkinson's and other motor neuron disease has been over 50%. The primary cause appears to be increased exposures to toxic pollutants (574).

Oxidative stress and reactive oxygen species (ROS) have been implicated as major factors in neurological disorders including stroke, PD, MS, Alzheimer's, ALS, MND, FM, CFS, etc. (13, 35c, 56, 84, 98, 145, 169, 207b, 258, 424, 442-444, 453, 462, 496). Mercury induced lipid peroxidation has been found to be a major factor in mercury's neurotoxicity, along with leading to decreased levels of glutathione peroxidation and superoxide dismustase (SOD) (13, 254, 489, 494-496, 577). Metalloprotein (MT) are involved in metals transport and detoxification (442, 464). Mercury inhibits

sulfur ligands in MT and in the case of intestinal cell membranes inactivates MT that normally bind cuprous ions (477), thus allowing buildup of copper to toxic levels in many and malfunction of the Zn/Cu SOD function. Exposure to mercury results in changes in metalloprotein compounds that have genetic effects, having both structural and catalytic effects on gene expression (114, 241, 296, 442, 464, 477, 495). Some of the processes affected by such MT control of genes include cellular respiration, metabolism, enzymatic processes, metal-specific homeostasis, and adrenal stress response systems. Significant physiological changes occur when metal ion concentrations exceed threshold levels. Such MT formation also appears to have a relation to autoimmune reactions in significant numbers of people (114, 60, 313, 342, 369, 442, 464). Of a population of over 3000 tested by the immune lymphocyte reactivity test (MELISA, 60, 342), 22% tested positive for inorganic mercury and 8% for methyl mercury.

Programmed cell death (apoptosis) is documented to the a major factor in degenerative neurological conditions like ALS, Alzheimer's, MS, Parkinson's, etc. Some of the factors documented to be involved in apoptosis of neurons and immune cells include inducement of the inflamatory cytokine Tumor Necrosis Factor-alpha (TNFa) (126), reactive oxygen species and oxidative stress (13, 43b, 56a, 296b), reduced glutathione levels (56, 126a, 111a), inhibition of protein kinase C (43), nitric oxide and peroxynitrite toxicity (43a), excitotoxicity and idation (490, 496, 521, 524), excess free cysteine levels (56d, 111a), excess glutamate toxicity (13b, 416e), excess dopamine toxicity (56d, 13a), beta-amyloid generation (462), increased calcium influx toxicity (416e, 296b, 333, 432, 462c, 507) and DNA fragmentation (296) and mitochondrial membrane dysfunction (56d, 416e, 51a).

TNFa (tumor necrosis factor-alpha) is a cytokine that controls a wide range of immune cell response in mammals, including cell death (apoptosis). This process is involved in inflamatory and degenerative neurological conditions like ALS, MS, Parkinson's, rheumatoid arthritis, etc. Cell signaling mechanisms like sphingolipids are part of the control mechansim for the TNFa apoptosis mechanism (126a). Gluthathione is an amino acid that is a normal cellular mechanism for controlling apoptosis. When glutathione is depleted in the brain, reactive oxidative species increased, and CNS and cell signaling mechinsisms are disrupted by toxic exposures such as mercury, neuronal cell apoptosis results and neurological damage. **Mercury has been shown to induce TNFa and deplete glutathione, causing inflamatory effects and cellular apoptosis in neuronal and immune cells** (126b, 126c).

Another neurological effect of mercury that occurs at very low levels is inhibition of nerve growth factors, for which deficiencies result in nerve degeneration. Mercury vapor is lipid soluble and has an affinity for red blood cells and CNS cells (21a). Only a few micrograms of mercury severely disturb cellular function and inhibits nerve growth (175, 147, 226, 255, 305, 149). Prenatal or neonatal exposures have been found to have life long effects on nerve function and susceptibility to toxic effects. Prenatal mercury vapor exposure that results in levels of only 4 parts per billion in newborn rat brains was found to cause decreases in nerve growth factor and other effects (305). This is a level that is common in the population with several amalgam fillings or other exposures (500). Insulin-like-growth factor I (IGF-I) are positively correlated with growth hormone levels and have been found to be the best easily measured marker for levels of growth hormone, but males have been found more responsive to this factor than women (497). IGF-I controls the survival of spinal motor neurons affected in ALS during development as well as later in life (497, 498). IGF-I and insulin levels have been found to be reduced in ALS patients with evidence this is a factor in ALS (497, 498). Several clinical trials have found IGF-I treatment is effective at reducing the damage and slowing the progression of ALS and Alzheimer's with no medically important adverse effects (498). It has also been found that in chronically ill patients the levels of pituitary and thyroid hormones that control many bodily processes are low, and that supplementing both thyrotropin-releasing hormone and growth control hormone is more effective at increasing all of these hormone levels in the patient (499).

(11) A direct mechanism involving mercury's inhibition of cellular enzymatic processes by binding

with the hydroxyl radical (SH) in amino acids appears to be a major part of the connection to allergic/immune reactive conditions such as autism (408-414, 439, 464, 468, 476, 33, 160, 251c), schizophrenia (409, 410), lupus (234, 330, 331, 468, 260e), Scleroderma (468), eczema and psoriasis (323, 342, 385, 419, 455, 33), and allergies (26, 46, 60, 95, 132, 152, 156, 271, 313, 330, 331, 445, 446, 468). For example mercury has been found to strongly inhibit the activity of dipeptyl peptidase (DPP IV) which is required in the digestion of the milk protein casein (411, 412) as well as of xanthine oxidase (439). Studies involving a large sample of *autistic and schizophrenic*[6] patients found that over 90% of those tested had high levels of the milk protein beta-casomorphin-7 in their blood and urine and defective enzymatic processes for digesting milk protein (410). Elimination of milk products from the diet has been found to improve the condition. Such populations have also been found to have high levels of mercury and to recover after mercury detox (413, 60, 313). As mercury levels are reduced the protein binding is reduced and improvement in the enzymatic process occurs. Additional cellular level enzymatic effects of mercury's binding with proteins include blockage of sulfur oxidation processes (33, 114, 194, 412), enzymatic processes involving vitamins B6 and B12 (418), effects on the cytochrome-C energy processes (43, 84, 232, 338c, 35), along with mercury's adverse effects on cellular mineral levels of calcium, magnesium, zinc, and lithium (43, 96, 119, 198, 333, 386, 427, 432, 38). And along with these blockages of cellular enzymatic processes, mercury has been found to cause additional neurological and immune system effects in many through immune/autoimmune reactions (60, 203d, 313, 314, 21). Most doctors treating such conditions also usually recommend supplementing the deficient essential minerals previously noted that mercury affects, often obtaining a hair element test to determine imbalances and needs (386, 484).

But the effect on the immune system of exposure to various toxic substances such as toxic metals and environmental pollutants has also been found to have additive or synergistic effects and to be a factor in increasing eczema, allergies, asthma, and sensitivity to other lesser allergens. Most of the children tested for toxic exposures have found high or reactive levels of other toxic metals, and organochlorine compounds (413, 313, 415). Much mercury in saliva and the brain is also organic (220, 272, 506), since mouth bacteria and other organisms in the body methylate inorganic mercury to organic mercury (51, 81, 225, 503b, 506, 512). Studies and clinical tests have found amalgam to be the largest source of methyl mercury in most people (506, 220, 79, 386, etc.). Bacteria also oxidize mercury vapor to the water soluble, ionic form Hg (II) (431). A clinical study found that methyl mercury in saliva is significantly higher in those with amalgam fillings than those without, and correlated with the number of amalgam fillings (506). The average level of methyl mercury in the blood of a group with amalgam was more than 4 times that of groups without amalgam or that had amalgam replced. Total mercury in those with amalgams was over 10 times that of those without amalgam. Other studies have found similar results (512, 79, etc.).

5. Because of the extreme toxicity of mercury, only $^1/_2$ gram is required to contaminate a 10 acre lake to the extent that a health warning would be issued by the government to not eat the fish (151, 160). Over half the rivers and lakes in Florida have such health warnings banning or limiting eating of fish, and most other states and 4 Canadian provinces have similar health warnings (2). Wisconsin has fish consumption warnings for over 250 lakes and rivers and Minnesota even more, as part of the total of over 50,000 such lakes with warnings (2).

Over 30% of all U.S. lakes have mercury health warnings and 15% of all U.S. river miles. All Great Lakes as well as many coastal bays and estuaries and large numbers of salt water fish carry similar health warnings. Some wading birds and Florida panthers that eat birds and animals that eat fish containing very low levels of mercury (about 1part per million) have died from chronic mercury poisoning (104, 160, 2). Since mercury is an estrogenic chemical and reproductive toxin, themajority of the rest cannot reproduce. The average male Florida panther has higher estrogen levels than females, due to the estrogenic properties of mercury (105, 160). Similar is true of some other animals

[6]**Internet:** "http://www.flcv.com/autismgc.html".

at the top of the food chain like alligators, polar bears, minks, seals, beluga and orca whales, etc., which are affected by mercury and other hormone disrupting chemicals (105, 533).

6. Mercury accumulates in the pituitary glands, ovaries, testes, and prostate gland (35, 99, 9 19, 20, 25, 85, 273, 543b). In addition to having estrogenic effects, mercury has other documented hormonal effects including effects on the reproductive system resulting in lowered sperm counts, defective sperm cells, damaged DNA, aberrant chromosome numbers rather than the normal 46, chromosome breaks, and lowered testosterone levels in males and menstrual disturbances and infertility in women (4, 9, 10, 23, 31, 37, 105, 146, 159, 395, 433, 27, 35, 38); and increased neurological problems related to lowered levels of neurotransmitters dopamine, serotonin, noreprenephrine, and acetylcholinesterase (35, 38, 104, 107, 125, 140, 141, 175, 251, 254, 275, 288, 290, 296, 305, 365, 367, 372, 381, 432, 451, 465, 412). The reduced neurotransmitter levels in those with amalgam appear to be a factor encouraging smoking since nicotine increases these neurotransmitter levels and a much higher percentage of those with amalgam smoke than in those without amalgam (141).

7. An average amalgam filling contains over $^1/_2$ gram of mercury, and the average adult had at least 5 grams of mercury in fillings (unless most has vaporized). Mercury in solid form is not stable, having low pressure and being subject to galvanic action with other metals in an oral environment (182, 192, 292, 348, 349, 525), so that within 10 years up to half has been found to have been transferred to the body of the host (18, 34, 35, 182, 86c, & section III). In patients with galvanic cell in their oral cavity we found decreased levels of antiinflamatory markers, such as secretory IgA, IgA 1, IgA 2, and lysozyme, and increased levels of the proinflammatory marker albumin (192i).

The amount of mercury released by a gold alloy bridge over amalgam over a 10 year period was measured to be approximately 101 milligrams (mg) (60% of total) or 30 micrograms (μg) per day (18).

8. Elemental mercury vapor is more rapidly transmitted throughout the body than most other forms of mercury and has more much toxic effects on the CNS and other parts of the body than inorganic mercury due to its much greater capacity to cross cell membranes, according to the World Health Organization and other studies (38, 82, 183, 287, 360, 376e, 21a, section III). Mercury vapor rapidly crosses the blood-brain barrier (14, 85, 311) and placenta of pregnant women (20, 22-24, 27, 38, 105, 162, 186, 231, 281, 287, 304, 308, 311, 361) Developmental, learning, and behavioral effects have been found from mercury vapor at much lower levels than for exposure to methyl mercury (287, 304). Similarly for inhibition of some essential cellular processes (333, 338, 329).

9. Running shoes with $^1/_2$ gram of mercury in the heels were banned by several states, because the amount of mercury was considered dangerous to public health and created a serious disposal problem. Mercury from dental offices and human waste from people with amalgam fillings has much higher levels and is a major source of mercury in Florida and U.S. waters. Nationwide the dental industry is the third largest user of mercury, using over 45 tons of mercury per year (548, 549), and most of this mercury eventually ends up in the environment. Amalgam from dental offices is by far the largest contributor of mercury into sewers and sewer plants (548, 549), with mercury from replaced amalgam fillings and crown bases the largest source. One study found dental offices discharge into waste water between 65 and 842 milligrams per dentist per day (231), amounting to several hundred grams per year per office. This is in addition to air emissions. In Canada the annual amount discharged is about 2 tons per year (28), with portions ending up in waters/fish, some in landfills and cropland, and in air emissions. When amalgam fillings are removed by standard practice methods using primary and secondary solids collectors, approximately 60% of the amalgam metals by weight end up in sewer effluent (547b). As much as 10% of prepared new amalgam becomes waste. This mercury also accumulates in building sewer pipes and septic tanks or drain fields where used, creating toxic liabilities. The recently enacted regulations on dental office waste in Canada are expected to reduce emissions by at least 63% by 2005, compared to 2000 (547). Mercury excreted into sewers by those with amalgam fillings was found by government agencies to be the second largest

source of mercury in sewers (548, 549, 553). In a Finnish study, over 20% of those with amalgam excrete so much to home sewers that the EEU standard for mercury in sewers (50 μg/L) is exceeded (553). The percentage exceeding the standard doubled for each additional 10 amalgam surfaces.

Additionally cremation of those with amalgam fillings adds to air emissions and deposition onto land and lakes. A study in Switzerland found that in that small country, cremation released over 65 kilograms of mercury per year as emissions, often exceeding site air mercury standards (420), while another Swiss study found mercury levels during cremation of a person with amalgam fillings as high as 200 micrograms per cubic meter (considerably higher than U.S. mercury standards). The amount of mercury in the mouth of a person with fillings was on average 2.5 grams, enough to contaminate 5 ten acre lakes to the extent there would be dangerous levels in fish (151). A Japanese study estimated mercury emissions from a small crematorium there as 26 grams per day (421). A study in Sweden found significant occupational and *environmental*[7] exposures at crematoria, and since the requirement to install selenium filters mercury emission levels in crematoria have been reduced 85%(422).

10. Studies have found that levels of exposure to the toxic metals mercury, cadmium, and lead have major effects on classroom behavior, learning ability, and also in mental patients and criminals behavior (3, 160).

Studies have found that both genetic susceptibility and environmental exposures are a factor in xenobiotic related effects and disease propagation (21d, 7e, 11a, 230b, etc.). Large numbers of animal studies have documented that genetically susceptible strains are more affected by xenobiotic exposures than less susceptible strains (234, 336, 425, 526, etc.). Some genetic types are susceptible to mercury induced autoimmunity and some are resistant and thus much less affected (234, 336, 425, 383, 21d). Studies found that mercury causes or accelerates various systemic conditions in a strain dependent manner, and that lower levels of exposure adversely affect some strains but not others, including inducing of autoimmunity. Also when a condition has been initiated and exposure levels decline, autoimmune antibodies also decline in animals or humans (342, 369, 405, 233, 234d). One genetic factor in Hg induced autoimmunity is major histocompatibility complex (MHC) linked. Both immune cell type Th1 and Th2 cytokine responses are involved in autoimmunity (425c). Mercury has been found to affect both Th1 and Th2 cytokines causing an increase in inflammatory Th2 cytokines (152, 181, 285, 404b). In the pancreas, the cells responsible for insulin production can be damaged or destroyed by the chronic high levels of cytokines, with the potential of inducing type II diabetes - even in otherwise healthy individuals with no other risk factors for diabetes (501). Mercury inhibits production of insulin and is a factor in diabetes and hypoglycemia, with significant reductions in insulin need after replacement of amalgam filings and normalizing of blood sugar (35). Diabetes incidence is increasing drastically. For individuals born in 2000, the lifetime risk of diabetes in the U.S. is 33% and over 16 million currently have diabetes (501d). Several studies have documented that lipoic acid (an antioxidant and chelator) resulted in improvement in the majority of diabetes cases it was used for, by improving glucose metabolism, increasing insulin sensitivity, and reducing nerve damage (including in diabetic neuropathy) (501e).

Another genetic difference found in animals and humans is cellular retention differences for metals related to the ability to excrete mercury (426). For example it has been found that individuals with genetic blood factor type APOE-4 do not excrete mercury readily and bioaccumulate mercury, resulting in susceptibility to chronic autoimmune conditions such as Alzheimer's, Parkinson's, etc. as early as age 40 (437cd, 577, 35), whereas those with type APOE-2, which contains 2 cysteine molocules, readily excrete mercury and are less susceptible. Those with type APOE-3 are intermediate to the other 2 types. The incidence of autoimmune conditions have increased to the extent this is now one of the leading causes of death among women (450).

11. Long term occupational exposure to low levels of mercury can induce slight cognitive deficits,

[7] **Internet:** "http://www.flcv.com/damspr2f.html".

lability, fatigue, decreased stress tolerance, etc. Higher levels have been found to cause more serious neurological problems (119, 128, 160, 285, 457, etc.). Occupational exposure studies have found mercury impairs the body's ability to kill Candida albicans by impairment of the lytic activity of neutrophils and myeloperoxidase in workers whose mercury excretion levels are within current safety limits (285, 404, 467). Such levels of mercury exposure were also found to inhibit cellular respiratory burst. A population of plant workers with average mercury excretion of 20 μg/ g creatinine was found to have long lasting impairment of neutrophil function (285, 404). Another study (59) found such impairment of neutrophils decreases the body's ability to combat viruses such as those that cause heart damage, resulting in more inflammatory damage. Another group of workers with average excretion rates of 24.7 μg/ g creatinine had long lasting increases in humoral immunological stimulation of IgG, IgA, and IgM levels. Other studies (285b,g, 395, 250c) found that workers exposed at high levels at least 20 years previous (urine peak levels above 600 μg/L demonstrated significantly decreased strength, decreased coordination, increased tremor, paresthesia, decreased sensation, polyneuropathy, etc. Significant correlations between increasing urine mercury concentrations and prolonged motor and sensory distal latencies were established (285g, 119e). Elemental mercury can affect both motor and sensory peripheral nerve conduction and the degree of involvement is related to time-integrated urine mercury concentrations. Thirty percent of dentists with more than average exposure were found to have neuropathies and visuographic dysfunction compared to none in the control group (395d). Other studies have also found a connection between mercury with peripheral neuropathy and paresthesia (190, 449, 502, 71bd, 395c) as well as with hearing loss (102b). Mercury exposure has been found to commonly cause tremor, ataxia, and balance problems (250c). Several doctors have found thiamin (B3), Vit B6, inositol, and folic acid supplementation to alleviate peripheral neuropathies, pain, tinnitus, and other neurological conditions (502).

Another study found that many of the symptoms and signs of chronic candidiasis, multiple chemical sensitivity and chronic fatigue syndromes are identical to those of chronic mercurialism and remit after removal of amalgam combined with appropriate supplementation and gave evidence to implicate amalgam as the only underlying etiologic factor that is common to all (404).

Other studies (285c) found that mercury at levels below the current occupational safety limit causes adverse effects on mood, personality, and memory - with effects on memory at very low exposure levels. More studies found that long term exposure causes increased micro nuclei in lymphocytes and significantly increased IgE levels at exposures below current safety levels (128), as well as maternal exposure being linked to mental retardation (110) and birth defects (23, 35, 37, 38, 50, 142, 241, 361, 338c/241).

1.3 Systemic mercury intake level from amalgam fillings

1. The tolerable daily exposure level for mercury developed in a report for Health Canada is .014 micrograms/kilogram body weight (μg/kg) or approximately 1 μg/day for average adult (209). The U.S. EPA Health Standard for elemental mercury exposure (vapor) is 0.3 micrograms per cubic meter of air (2). The U.S. ATSDR health standard (MRL) for mercury vapor is 0.2 μg/ M 3 of air, and the MRL for methyl mercury is 0.3 μg/kg body weight/day (217). For the average adult breathing 20 M 3 of air per day, this amounts to an exposure of 4 or 6 μg/day for the 2 elemental mercury standards. The EPA health guideline for methyl mercury is 0.1 μg/kg body weight per day or 7 μg for the average adult (2), or approximately 14 μg for the ATSDR acute oral toxicicity standard. Since mercury is methylized in the body, some of both types are present in the body. The older World Health Organization (183) mercury health guideline (PTWI) is 300 μg per week total exposure or approximately 42 μg/day. The EPA drinking water standard for mercury is 2ppb (125). The upper level of mercury exposure recommended by the German Commission on Human Biomonitoring is 1 micrograms per liter in the blood (39), since adverse effects such as increases in blood pressure and cognitive effects have been documented as low as 1 μg/L cord blood, with

impacts higher in low birth weight babies (308) and commonly in adults with levels below 10 μg/l (540). The FDA limit for mercury in seafood is 1 ppm, with a warning at $^1/_2$ ppm (125). The Japanese government's limit for mercury contamination, 0.4 micrograms per gram (533) and studies have found adverse health effects eating fish at levels below 0.5 ppm (20, 540). EPA and several medical labs suggest health safety guideline of 1 ppm (438). The EPA safety standard for mercury in blood is 5.8 ppb (218b) and EPA has found that since the fetus normally has mercury levels 70% above that of the mother's blood, large numbers of infants are at risk of neurological damage.

2. Mercury in the presence of other metals in the oral environment undergoes galvanic action, causing movement out of amalgam and into the oral mucosa and saliva (174, 182, 192, 436, 525, 179, 199, 86c). Mercury in solid form is not stable due to high volatility and evaporates continuously from amalgam fillings in the mouth, being transferred over a period of time to the host (15-19, 26, 31, 36, 79, 83, 211, 182, 183, 199, 276b, 298, 299, 303, 332, 335, 371). Mercury has a relatively high vapor pressure and vaporizes at room temperature. The rate of mercury volatilization is directly related to temperature so in the body it is even more volatile. The vapor saturation concentration in air of 20 milligrams of mercury per cubic meter of air is much higher than the safety limit. The ATSDR safety standard (MRL) for mercury is 0.2 micrograms of mercury per cubic meter of air. Thus mercury readily vaporizes to above the MRL level. The daily total exposure of mercury from fillings is from 3 to 1000 micrograms per day, with the average exposure being above 10 micrograms per day and the average uptake over 5 μg/day (183, 199, 209, 18, 19, 77, 83, 85, 100, 335, 352, 371, etc.). (see further details continued).

A large study was carried out at the Univ. Of Tubingen Health Clinic in which the level of mercury in saliva of 20,000 persons with amalgam fillings was measured (199). The level of mercury in unstimulated saliva was found to average 11.6 μg Hg/L, with the average after chewing being 3 times this level. Several were found to have mercury levels over 1100 μg/L, 1% had unstimulated levels over 200 μg/L, and 10% had unstimulated mercury saliva levels of over 100 μg/L. The level of mercury in saliva has been found to be proportional to the number of amalgam fillings, and generally was higher for those with more fillings, increasing by approximately 1.5 μg/L for each additional amalgam filling. The following table gives the average daily mercury exposure from saliva alone for those tested, based on the average levels found per number of fillings and using daily saliva volumes of 890 ml for unstimulated saliva flow and 80 ml for stimulated flow (estimated from measurements made in the study and comparisons to other studies). It also gives the 84^{th} percentile mercury exposure from saliva for the 20,000 tested by number of fillings. Note that 16% of all of those tested with 4 amalgam fillings had daily exposure from their amalgam fillings of over 17 μg per day, and even more so for those with more than 4 fillings.

Average daily mercury exposure in saliva by number of amalgam fillings (199)

Number of fillings:	4	5	6	7	8	9	10	11	12	13	14	15	16
Av. Daily Hg (μg)	6.5	8	9.5	11	12.4	14	15.4	16.9	18.3	19.8	21.3	22.8	24.3
84^{th} percentile (μg)	17	23.5	26	30.5	35	41.5	43.8	48.6	50.3	46.7	56.6	61.4	64.5

Saliva tests for mercury are commonly performed in Europe, and many other studies have been carried out with generally comparable results (292, 315, 79, 9b, 335, 179, 317, 352). Another large German study (352) found significantly higher levels than the study summarized here, with some with exposure levels over 1000 μg/day. These studies found that the amount of **mercury in saliva increased about 1.5 to 2.5 micrograms for each additional amalgam filling** (199, 352). Some of the variability in these studies might be due to the fact that a more accurate measure of exposure such as amalgam surfaces augmented by also counting the number of metal crowns over amalgam. Metal crowns over amalgam have been found to produce as much exposure as an amalgam filling, due to galvanic currents in mixed metals. Three studies that looked at a population with more than 12 fillings found generally higher levels than this study, with average mercury level in

unstimulated saliva of 29 μg/L (18), 32.7 μg/L (292c), and 175 μg/day (352). The average for those with 4 or less fillings was 8 μg/L (18). While it will be seen that there is a significant correlation between exposure levels and number of amalgam surfaces and exposure generally increases as number of fillings increases, there is considerable variability for a given number of fillings. Some of the factors that will be seen to influence this variability include composition of the amalgam, whether person chews gum or drinks hot liquids, bruxism, oral environmental factors such as acidity, type of tooth paste used, etc. Chewing gum or drinking hot liquids or use of bleaching products to whiten teeth can result in 10 to 100 times normal levels of mercury exposure from amalgams during that period (15, 35, 136, 258).

The Tubingen study did not assess the significant exposure route of intraoral air and lungs. One study that looked at this estimated a daily average burden of 20 μg from ionized mercury from amalgam fillings absorbed through the lungs (191), while a Norwegian study found the average level in oral air to be 0.8 μg/m^3(176). Another study at a Swedish University (335) measured intraoral air mercury levels from fillings of from 20 to 125 μg per day, for persons with from 18 to 82 filling surfaces. Other studies found similar results (83, 95), and some individuals have been found to have intraoral air mercury levels above 400 μg/ m^3 (319). Most of those whose intraoral air mercury levels were measured exceeded U.S. Gov't health guidelines for workplace exposure (2). The German workplace mercury limit is even lower than the U.S. guideline, at 1 μg/m^3 (258).

The studies also determined that the number of fillings is the most important factor related to mercury level, with age of filling being much less significant (319b). Different filling composition/manufacturer can also make a difference in exposure levels (as will be further discussed). The authors of the Tubingen study calculated that based on the test results with estimates of mercury from food and oral air included, over 40% of those tested in the study received daily mercury exposure higher than the WHO standard (PTWI). As can be seen most people with several fillings have daily exposure exceeding the Health Canada TDE and the U.S. EPA and ATSDR health guideline for mercury (2, 209, 217, 199, etc.), and many tested in past studies have exceeded the older and higher WHO guideline for mercury (183), without consideration of exposure from food, vaccinations, etc. The WHO guideline for mercury in air, like the OSHA standard, assumes exposure for a 40 day work week rather than continuous exposure, and also assume no other mercury exposures. This produces large differences compared to guidelines or standards assuming continuous exposure.

3. The main exposure paths for mercury from amalgam fillings are absorption by the lungs from intraoral air; vapor absorbed by saliva or swallowed; amalgam particles swallowed; and membrane, olfactory, sublingual venal, and neural path transfer of mercury absorbed by oral mucosa, gums, etc. (6, 17, 18, 31, 34, 77, 79, 83, 94, 133, 174, 182, 209, 211, 216, 222, 319, 335, 348, 364, 436) The sublingual venal, olfactory, and neural pathways are direct pathways to the brain and CNS bypassing the liver's detox system and appear to represent major pathways of exposure (34) based on the high levels of mercury vapor and methyl mercury found in saliva and oral cavity of those with amalgam. A study at Stockholm Univ. (335) made an effort to determine the respective parts in exposure made by these paths. It found that the majority of excretion is through feces, and that the majority of mercury exposure was from elemental vapor. Daily exposure from intraoral air ranged from 20 to 125 μg of mercury vapor, for subjects with number of filling surfaces ranging from 18 to 82. Daily excretion through feces amounted to from 30 to 190 μg of mercury, being more variable than other paths. Other studies had similar findings (6, 15, 16, 18, 19, 25, 31, 36, 77, 79, 80, 83, 115, 196, 386.) Most with several amalgams had daily fecal excretion levels over 50 μg/day. The reference average level of mercury in feces (dry weight) for those tested at Doctors Data Lab with amalgam fillings is .26 mg/kg, compared to the reference average level for those without amalgam fillings of .02 mg/kg (528). (13 times that of the population w/o amalgam). Other labs found similar results (386). This level of mercury gives a daily excretion of over 30 micrograms per day.

The feces mercury was essentially all inorganic with particles making up at most 25%, and the majority being mercury sulfuhydryl compounds-likely originating as vapor. Their study and others

reviewed found that at least 80% of mercury vapor reaching the lungs is absorbed and enters the blood from which it is taken to all other parts of the body (335, 348, 349, 363). Elemental mercury swallowed in saliva can be absorbed in the digestive tract by the blood or bound in sulfhydryl compounds and excreted through the feces. A review determined that approximately 20% of swallowed mercury sulfhydryl compounds are absorbed in the digestive tract, but approx 60% of swallowed mercury vapor is absorbed (292, 335, 348). At least 80% of particle mercury is excreted. Approx. 80% of swallowed methyl mercury is absorbed (335, 199, etc.), with most of the rest being converted to inorganic forms apparently. The primary detoxification/excretion pathway for mercury absorbed by the body is as mercury-glutathione compounds through the liver/bile loop to feces (111, 252, 538), but some mercury is also excreted though the kidneys in urine and in sweat. A high fiber diet has been shown to be helpful in mercury detoxification (538). The range of mercury excreted in urine per day by those with amalgams is usually less than 15 μg (6, 49, 83, 138, 174, 335, etc.), but some patients are much higher (93). A large NIDH study of the U.S. military population (49) with an average of 19.9 amalgam surfaces and range of 0 to 60 surfaces found the average urine level was 3.1 μg/L, with 93% being inorganic mercury. The average in those with amalgam was 4.5 times that of controls and more than the U.S. EPA maximum limit for mercury in drinking water (218). The average level of those with over 49 surfaces was over 8 times that of controls. The same study found that the average blood level was 2.55 μg/L, with 79% being organic mercury. The total mercury level had a significant correlation to the number of amalgam fillings, with fillings appearing to be responsible for over 75% of total mercury. From the study results it was found that **each 10 amalgam surfaces increased urine mercury by approximately 1 μg/L**. A study of mercury species found blood mercury was 89% organic and urine mercury was 87% inorganic (349b), while another study (363) found on average 77% of the mercury in the occipital cortex was inorganic. In a population of women tested In the Middle East (254, 223e), the number of fillings was highly correlated with the mercury level in urine, mean= 7 μg/L. Amalgam has also been found to be the largest source of organic mercury in most people (506, 79, 386, 220, etc.). Nutrient transport and renal function were also found to be adversely affected by higher levels of mercury in the urine.

As is known from autopsy studies for those with chronic exposure such as amalgam fillings (1, 14, 17, 20, 31, 34, 85, 94), mercury also bioaccumulates in the kidneys (85, 273, 14), liver, brain/CNS (301, 273, 274, 327, 329, 348, 18, 19, 85), heart (59, 205, 348)), hormonal glands (85, 99, 348), and oral mucosa (174, 192, 436, etc.) with the half life in the brain being over 20 years. Studies have found dental amalgam, chewing on amalgam, and fish consumption were positively associated with Urinary-HgC (85d). In men, including workers occupationally exposed to mercury, U-HgC was positively associated with the kidney markers, especially with NAG, but to some extent also with A1M and albumin.

Elemental mercury vapor is transmitted throughout the body via the blood and readily enters cells and crosses the blood-brain barrier, and the placenta of pregnant women (38, 61, 287, 311, 361), at much higher levels than inorganic mercury and also higher levels than organic mercury. Significant levels are able to cross the blood brain barrier, placenta, and also cellular membranes into major organs such as the heart since the oxidation rate of Hg0 though relatively fast is slower than the time required by pumped blood to reach these organs (290, 370). Thus the level in the brain and heart is higher after exposure to Hg vapor than for other forms (360, 370). While mercury vapor and methyl Hg readily cross cell membranes and the blood-brain barrier, once in cells they are rapidly oxidized to Hg+ inorganic mercury form that does not readily cross cell membranes or the blood brain barrier readily and is responsible for the majority of toxicity effects. Thus inorganic mercury in the brain has a very long half life (85, 273, 274, 503b, etc.).

Thyroid imbalances, which are documented to be commonly caused by mercury (369, 382, 459, 35, 50, 91), have been found to play a major role in chronic heart conditions such as clogged arteries, mycardial infarction, and chronic heart failure (510). In a recent study, published in the Annals of Internal Medicine, researchers reported that *subclinical hypothyroidism is highly preva-*

lent in elderly women and is strongly and independently associated with cardiac atherosclerosis and myocardial infarction (510c). People who tested hypothyroid usually have significantly higher levels of homocysteine and cholesterol, which are documented factors in heart disease. 50% of those testing hypothyroid, also had high levels of homocysteine (hyperhomocysteinenic) and 90% were either hyperhomocystemic or hypercholesterolemic (510a). These are also known factors in developing arteriosclerotic vascular disease. Homocysteine levels are significantly increased in hypothtyroid patients and normalize with treatment (510efg, 597).

4. The average amalgam filling has approximately 0.5 grams (500,000 μg) of mercury. As much as 50% of mercury in fillings has been found to have vaporized after 5 years and 80% by 20 years (182, 204). Mercury vapor from amalgam is the single largest source of systemic mercury intake for persons with amalgam fillings, ranging from 50 to 90% of total exposure. (14, 16, 17, 19, 36, 57, 61, 77-83, 94, 129, 130, 138, 161, 167, 183, 191, 196, 211, 216, 273, 292, 303, 332,), averaging about 80% of total systemic intake. After filling replacement levels of mercury in the blood, urine, and feces typically temporarily are increased for a few days, but levels usually decline in blood and urine within 6 months to from 60 to 85% of the original levels (57, 79, 82, 89, 196, 303). Mercury levels in saliva and feces usually decline between 80 to 95% (79, 196, 335, 386).

5. Having dissimilar metals in the teeth (e.g.-gold and mercury) causes galvanic action, electrical currents, and much higher mercury vapor levels and levels in tissues. (182, 192, 292, 348, 349, 390, 525, 19, 25, 27, 29, 30, 35, 47, 48, 100) Average mercury levels in gum tissue near amalgam fillings are about 200 ppm, and are the result of flow of mercury into the mucous membrane because of galvanic currents with the mucous membrane serving as cathode and amalgam as cathode (192). Average mercury levels are often 1000 ppm near a gold cap on an amalgam filling due to higher currents when gold is in contact with amalgam (30, 25, 35, 48). These levels are among the highest levels ever measured in tissues of living organisms, exceeding the highest levels found in chronically exposed chloralkali workers, those who died in Minamata, or animals that died from mercury poisoning. German oral surgeons have found levels in the jaw bone under large amalgam fillings or gold crowns over amalgam as high as 5760 ppm with an average of 800 ppm (436). These levels are much higher than the FDA/EPA action level for prohibiting use of food with over 1 ppm mercury. Likewise the level is tremendously over the U.S. Dept. Of Health/EPA drinking water limit for mercury which is 2 parts per billion (218). Amalgam manufacturers, Government health agencies such as Health Canada, dental school texts, and dental materials researchers advise against having amalgam in the mouth with other metals such as gold (446, 35), but many dentists ignore the warnings.

Concentrations of mercury in oral mucosa for a population of patients with 6 or more amalgam fillings taken during oral surgery were 20 times the level of controls (174). Studies have shown mercury travels from amalgam into dentin, root tips, and the gums, with levels in roots tips as high as 41 ppm (192, 47). Studies have shown that mercury in the gums such as from root caps for root canaled teeth or amalgam tattoos result in chronic inflammation, in addition to migration to other parts of the body (200, 47, 86c, 35). Mercury and silver from fillings can be seen in the tissues as amalgam "tattoos", which have been found to accumulate in the oral mucosa as granules along collagen bundles, blood vessels, nerve sheaths, elastic fibers, membranes, striated muscle fibers, and acini of minor salivary glands. Dark granules are also present intracellularly within macrophages, multinucleated giant cells, endothelial cells, and fibroblasts. There is in most cases chronic inflammatory response or macrophagic reaction to the metals (47), usually in the form of a foreign body granuloma with multinucleated giant cells of the foreign body and Langhans types (192). Most dentists are not aware of the main source of amalgam tattoos, oral galvanism where electric currents caused by mixed metals in the mouth take the metals into the gums and oral mucosa, accumulating at the base of teeth with large fillings or metal crowns over amalgam base (192). Such metals are documented to cause local and systemic lesions and health effects, which usually recover after removal of the amalgam tattoo by surgery (47fghi). The high levels of accumulated mercury also are dispersed to other parts of the body. It is well documented that amalgam fillings are a major factor in gingivitis, oral gum

tissue inflamation, bleeding, and bone loss (29, 21ab, 47, 7d etc.). Mercury also accumulates in the trigeminal ganglia (325, 329ab) and can cause trigeminal neuralgia from which patients recover after amalgam replacement (525a, 192a, 35d, 222). Cavitations from improperly healed tooth extractions also commonly cause trigeminal neuralgia and most such recover after cavitation surgery (437b, 35a).

The periodontal ligament of extracted teeth is often not fully removed and results in incomplete jawbone regrowth resulting in a pocket where mouth bacteria in anaerobic conditions along with similar conditions in the dead tooth produce extreme toxins similar to botulism which like mercury are extremely toxic and disruptive to necessary body enzymatic processes at the cellular level, comparable to the similar enzymatic disruptions caused by mercury and previously discussed (35, 437ab).

The component mix in amalgams has also been found to be an important factor in mercury vapor emissions. The level of mercury and copper released from high copper amalgam is as much as 50 times that of low copper amalgams (191). Studies have consistently found modern high copper non gamma-two amalgams have a high negative current and much greater release of mercury vapor than conventional silver amalgams and are more cytotoxic (35, 258, 298, 299). Clinics have found the increased toxicity and higher exposures to be factors in increased incidence of chronic degenerative diseases (35, etc). While the non gamma-two amalgams were developed to be less corrosive and less prone to marginal fractures than conventional silver amalgams, they have been found to be unstable in a different mechanism when subjected to wear/polishing/ chewing/ brushing: they form droplets of mercury on the surface of the amalgams (182, 297). This has also been found to be a factor in the much higher release of mercury vapor by the modern non gamma-two amalgams. Recent studies have concluded that "because the high mercury release levels of modern amalgams, mercury poisoning from amalgam fillings is widespread throughout the population" (95, 199, 238, 258). Numerous other studies also support this finding (Section IV).

Amalgam also releases significant amounts of silver, tin, and copper which also have toxic effects, with organic tin compounds formed in the body being even more neurotoxic than mercury (51, 222, 262). Alloys containing tin such as amalgam were found to have the highest galvanic corrosion rates, while alloys containing copper or iron were very corrosive in acid environments (297). Metals tend to cause cellular acidic conditions which lead to disease and measuring urine acidity is useful in this regard. Normal acidity is PH of about 6.8 (228a).

6. The number of amalgam surfaces has a statistically significant correlation to :

(a) blood plasma mercury level (13d, 17, 22, 23, 49, 79, 89, 133, 211) (usually not as strong as other measures)

(b) urine mercury level (38, 49, 57, 76, 77, 79, 82, 83, 134, 138, 167, 176, 254, 303, 332, 335)

(c) oral air (16, 18, 100, 176, 335)

(d) saliva and oral mucosa (18, 30, 77, 79, 117, 179, 174, 199, 211, 222, 292, 315, 317)

(e) feces mercury (25, 79, 80, 83, 115, 117, 182, 335, 386)

(f) pituitary gland (19, 20, 25, 85, 99, 273, 543b, 572c/274)

(g) brain occipital cortex (14, 16, 19, 25, 34, 85, 211, 273, 348, 366/274) and frontal lobe (572c)

(h) renal (kidney) cortex (14, 16, 19, 20, 85, 254, 273, 348, 366)

(i) liver (14, 19, 85, 366)

(j) motor function areas of the brain & CNS: brain stem, cerebellum, rhombencephalon, dorsal root ganglia, and anterior horn motor neurons (48, 291, 327, 329, 442, 35)

(k) fetal and infant liver/brain levels (61, 112, 186, 231, 22) related to maternal fillings.

7. A person with amalgam fillings has daily systemic intake from mercury vapor of between 3 and 70 micrograms of mercury, with the average being at least 7 micrograms (μg) per day (18, 77, 83, 85, 93, 138, 183, 199, 211, 292, 315, 335). In a large German study, the median daily exposure for those with fillings through saliva was approximately 10 μg/day, 4% of those with fillings had daily exposure through saliva of over 80 μg/day, and 1% had over 160 μg/day (199). The methods and results of the Tubingen study (199) were similar to those of other German studies (292, 315, 9, 138, 317, 335). Total intake is proportional to the number and extent of amalgam surfaces, but other factors such as chewing gum, drinking hot liquids, brushing or polishing or bleaching, and using fluoride toothpaste significantly increase the intake (15, 18, 28, 31, 100, 134-137, 182, 183, 199, 209, 211, 292, 317, 319, 348, 349, 350). Vapor emissions range up to 200 $\mu g/m^3$ (35) and are much higher after chewing (15, 137, 319). After chewing, those with amalgams had levels over 50 times higher than those without, and the average level of exposure was 29 μg/day for those with at least 12 occlusal surfaces (18). At least 30% of those having amalgam fillings tested in a large German study had ingested mercury levels exceeding the WHO PTWI mercury standard of 43 μg/day (199, 183), and over 50% of those with 6 or more fillings had daily exposures more than the U.S. EPA health guideline level (199) of 0.1 μg/kg body weight/day (199). The median daily exposure through saliva for those with 10 or more fillings was over 10 times that of those with no fillings (199, 292, 315, 318). Mercury level in saliva has been found to give much better indication of body levels than blood or urine levels (36). Most people with fillings have daily exposure levels exceeding the U.S. ATSDR and EPA health guideline levels (2, 36, 83, 89, 183, 199, 209, 217, 261, 292, 335, 93). Note that the WHO standard assumes exposure for a 40 hour week with no other exposure, which gives large differences with standards or guidelines based on assuming continuous exposure.

8. The blood and urine mercury load of a person with amalgam fillings is often 5 times that of a similar person without (14, 16, 17, 79, 80, 82, 93, 136, 138, 303, 315, 317, 318). The average blood level for one large population was 5 μg/l (176). Normal blood levels are less than 20 ppb, but health effects have been observed in patients in the upper part of this range. A Swedish study estimated the total amount mercury swallowed per day from intra-oral vapor was 10 micrograms per day (177), and a large German study (199) found median exposure through saliva alone for those with fillings to be about 10 μg/day, with many having several fillings with over 10 times that level. Other studies have found similar amounts (18, 83, 211, 183, 209).

9. Teeth are living tissue and have massive communication with the rest of the body via blood, lymph, and nerves. Mercury vapor (and bacteria in teeth) have paths to the rest of the body. (34, etc.) German studies of mercury loss from vapor in unstimulated saliva found the saliva of those with amalgams had at least 5 times as much mercury as for controls (138, 199, 292, 315).

10. Mercury (especially mercury vapor) rapidly crosses the blood brain barrier and is stored preferentially in the pituitary gland (14, 85, 327, 543b), hypothalamus (348c), thyroid gland (99), adrenal gland (84, 369, 381), and occipital cortex in direct proportion to the number and extent of amalgam surfaces (14, 19, 20, 25, 34, 38, 85, 99, 273, 274, 287, 348, 366) Thus mercury has a

greater effect on the functions of these areas. The range in one study was 2.4 to 28.7 ppb (85), and one study found on average that 77% of the mercury in the occipital cortex was inorganic (363). Autopsy studies have found higher levels of mercury in the brain of infants than of adults from the same population, and much higher levels in adults who have amalgam fillings (14d). Infants of mothers who had dental work involving amalgam during pregnancy had significantly higher levels of mercury in hair tests (541a).

11. Some mercury entering nasal passages is absorbed directly into the olfactory lobe and brain without coming from blood (34, 35, 182, 222, 348, 364). Mercury also is transported along the axons of nerve fibers (5, 25, 34, 35, 327, 329).

12. Mercury has a long half life in the body and over 20 years in the brain, and chronic low level intake results in a slow accumulation in body tissues. (20, 34, 35, 38, 85, etc.)

13. Methyl mercury is more toxic to some body processes than inorganic mercury. Mercury from amalgam is methylated by bacteria, galvanic electric currents (35), and candida albicans in the mouth and intestines (51, 81, 98, 182, 225, 503b, 506). The level of organic mercury in saliva is significantly related to the number of amalgam fillings (506). Oral bacteria streptococommus mitior, S.mutans, and S.sanguis were all found to methylate mercury (81). High levels of Vit B12 in the system also have been found to result in increased methyl mercury concentrations in the liver and brain (51). Methyl mercury is 10 times more potent in causing genetic damage than any other known chemical (Ramel, in (35)), and also crosses the blood-brain barrier readily. Once mercury vapor or methyl mercury are converted to inorganic mercury in cells or the brain, the mercury does not readily cross cell membranes or the blood-brain barrier. Thus mercury has a very long half life in the brain. N-acetylcysteine (NAC) has been found to be effective at increasing glutathione levels and chelating methyl mercury (54, 126).

14. The level of mercury in the tissue of the fetus, new born, and young children is directly proportional to the number of amalgam surfaces in the mother's mouth. (20, 23, 61, 112, 210, 361) The level of mercury in umbilical cord blood, meconium, and placenta was higher than that in mother's blood (22, 23b, 186), with meconium level the most reliable indicator of mercury exposure levels. The saliva and feces of children with amalgams have approximately 10 times the level of mercury as children without (25, 315, 386, 528), and much higher levels in saliva after chewing. A group of German children with amalgam fillings had urine mercury level 4 times that of a control group without amalgams (76), while a Canadian study found 3.2 times as much exposure in those with amalgam with adverse health effects (low weight and height) (76c), and in a Norwegian group with average age 12 there was a significant correlation between urine mercury level and number of amalgam fillings (167). The level of mercury in maternal hair was significantly correlated to level of mercury in nursing infants (541). One study found a 60% increase in average cord blood mercury level between 1980 and 1990 in Japan (186). Amalgam use in dentistry in Europe has been declining rapidly. The routine use of amalgam in pediatric dentistry in the UK, previously 80%, had declined to 35% in favour of glass ionomer cements (23d). A recent study found that glass ionomer cement fillings (ART) were more effective than amalgam in children's teeth (23e).

16. The fetal mercury content after maternal inhalation of mercury vapor was found to be higher than in the mother (4, etc.) Mercury from amalgam in the blood of pregnant women crosses the placenta and appears in amniotic fluid and fetal blood, liver, and pituitary gland soon after placement (20, 22, 23, 31, 36, 61, 162, 186, 281, 348, 366). Dental amalgams are the main source of mercury in breast milk (112, 186, 304, 339, 20). Milk increases the bioavailability of mercury (112, 304, 391) and mercury is often stored in breast milk and the fetus at much higher levels than that in the mother's tissues (19, 20, 22, 23, 61, 112, 186, 210, 287, 304). Mercury is transferred mainly by binding to amino acids like albumin (339). The level of mercury in breast milk was found to be significantly correlated with the number of amalgam fillings (61, 339), with milk from mothers with 7 or more fillings having levels in milk approximately 10 times that of amalgam-free mothers. The milk

sampled ranged from 0.2 to 6.9 μg/L. Several authors suggest use of early mother's milk as a screen for potential problems since it is correlated both to maternal and infant mercury levels. The highest level is in the pituitary gland of the fetus which affects development of the endocrine system. Levels for exposure to mercury vapor has been found to be approx 10 times that for maternal exposure to an equivalent dose of inorganic mercury (281, 287), and developmental behavioral effects from vapor have been found at levels considerably below that required for similar effects by methyl mercury (20, 49, 119c, 264, 287, 304, 338). The level of total mercury in nursing infants was significantly correlated to total mercury level in maternal hair (22, 541).

17. There is a significant correlation between number of amalgam fillings of the mother and the level of the fetus and older infants (20, 22, 23, 61, 304), and also with the level in mother's milk (19, 20, 38, 112, 304, 339). Fertile women should not be exposed to vapor levels above government health guidelines (38, 61, 182, 282); or have amalgams placed or removed during pregnancy (20, 182, 231, 304, 339). The U.S. ATSDR mercury health MRL of 0.2 mcg/m^3 (2, 217).

1.4 Immune system effects and autoimmune disease

1. Many thousands of people with symptoms of mercury toxicity have been found in tests to have high levels of mercury, and many thousands who have had amalgam fillings removed (most) have had health problems and symptoms alleviated or greatly improved (see Section VI). From clinical experience some of the symptoms of mercury sensitivity/mercury poisoning include chronic fatigue, dizziness, frequent urination, insomnia (199d), amnesia (119d), headaches, irritability, chronic skin problems, metallic taste, gastrointestinal problems (21c), asthma (8, 97), stuffy nose, dry crusts in nose, rhinitis, plugged ears, ringing ears, chest pain, hyperventilation, diabetes (35, 501, 369), spacy feeling, chills, chronic skin problems, immune and autoimmune diseases, cardiovascular problems, muscle weakness, and many types of neurological problems (21, 26, 34, 35, 36, 38, 45, 59, 60, 69, 70, 71, 75, 91, 109, 148, 165, 199, 204, 212, 246, 255, 268-270, 290, 291, 294, 313, 343, 503, 504, 508-510, 539, 595). Amalgam results in chronic exposure rather than acute exposure and accumulation in body organs over time, so most health effects are of the chronic rather than acute in nature, but serious health problems have been documented to be related to amalgam and researchers have attributed some deaths as due to amalgam (356, 32, 245).

2. Mercury vapor exposure at very low levels adversely affects the immune system (17, 27, 31, 38, 45, 60, 84, 118, 129, 131, 165, 226, 270, 285, 296, 313, 314, 355, 342, 369). From animal studies it has been determined that mercury damages T-cells by generating reactive oxygen species (ROS); depleting the thiol reserves of cells; binding with mitochondria, damaging and decreasing the dimension of mitochondria, impairing cellular respiration and cellular energy; causing destruction of cytoplasmic organelles with loss of cell membrane integrity, inhibiting ability to secrete interleukin IL-1 and IL-2R, causing activation of glial cells to produce superoxide and nitric oxide, and inactivating or inhibiting enzyme or coenzyme systems or hormones involving the sulfhydryl protein (SH) groups (181, 226, 338, 405, 424, 442), along with OH, NH2, and Cl groups in proteins. $HgCl_2$ also inhibits aquaporin-mediated water transport in red blood cells (479) as well as oxygen transport by hemoglobin (232). Thus some of the main mechanisms of toxic effects of metals include cytotoxicity; changes in cellular membrane permeability; inhibition of enzymes, coenzymes, and hormones; and generation of lipid peroxides or free radicals - which result in neurotoxicity, immuno toxicity, impaired cellular respiration, gastrointestinal/metabolic effects, hormonal effects, and immune reactivity or autoimmunity. Occupational studies have found that the number of suppressor-inducer immune cells and natural killer cells are significantly negatively correlated with urine mercury level (270ad).

Mercury caused adverse effects on both neutrophil and macrophage function and after depletion of thiol reserves, T-cells were susceptible to Hg induced cellular death (apoptosis) (226, 272,

355). Interferon syntheses was reduced in a concentration dependent manner with either mercury or methyl mercury as well as other immune functions (131), and low doses also induce aggregation of cell surface proteins and dramatic tyrosine phosporlation of cellular proteins related to asthma, allergic diseases such as eczema and lupus (234, 260e, 323, 35), and autoimmunity (181, 314, 405). Porphyrins are precursors to heme, the oxygen carrying component of blood. Mercury inhibits the conversion of specific porphyrins to heme. (84, 35, 201, 260, 539) Mercury and other toxic metals block coproporphyrin and uroporphyrin which is a marker in using the porphyrin test for lupus diagnosis and treatment (260e). One study found that insertion of amalgam fillings or nickel dental materials causes a suppression of the number of T-lymphocytes (270), and impairs the T-4/T-8 ratio. Low T4/T8 ratio has been found to be a factor in lupus, anemia, MS, eczema, inflammatory bowel disease, and glomerulonephritis. Mercury induced autoimmunity in animals and humans has been found to be associated with mercury's expression of major histocompatibility complex (MHC) class II genes (314, 181, 226, 425c). Both mercuric and methyl mercury chlorides caused dose dependent reduction in immune B-cell production. (316) B-cell expression of IgE receptors were significantly reduced (316, 165), with a rapid and sustained elevation in intracellular levels of calcium induced (316, 333). Both forms are immontoxic and cytotoxic ant very low levels seen in individuals. Mercury also inhibited B-cell and T-cell RNA and DNA synthesis. The inhibition of these functions by 50% occurred rapidly at very low levels, in the range of 10 to 25 μg/L. All types of cells exhibited a dose dependent reduction in cellular glutathione when exposed to mercury, inhibiting generation of GSH by lymphocytes and monocytes (252).

Workers occupationally exposed to mercury at levels within guidelines have been found to have impairment of lytic activity of neutrophils and reduced ability of neutrophils to kill invaders such as candida (285, 404). Immune Th1 cells inhibit candida by cytokine related activation of macrophages and neutrophils. Development of Th2 type immune responses deactivate such defenses (404b). Mercury inhibits macrophage and neutrophil defense against candida by its affects on Th1 and Th2 cytokine effects (181, 285). Low doses also induced autoimmunity in some species (181, 314, 369, 404, 405, 129, 43). Candida overgrowth results in production of the highly toxic canditoxin and ethanol which are known to cause fatigue, toxicity, and depressive symptoms (460). Another amalgam effect found is increase in the average blood white cell count significantly (35). The increased white count usually normalizes after amalgam removal.

Mercury also blocks the immune function of magnesium and zinc (198, 427, 43, 38), whose deficiencies are known to cause significant neurological effects (461, 463). The low Zn levels result in deficient CuZnSuperoxide dismustase (CuZnSOD), which in turn leads to increased levels of superoxide due to toxic metal exposure. This is in addition to mercury's effect on metallothionein and copper homeostasis as previously discussed (477). Copper is an essential trace metal which plays a fundamental role in the biochemistry of the nervous system (489, 495, 464). Several chronic neurological conditions involving copper metabolic disorders are well documented like Wilson's Disease and Menkes Disease. Mutations in the copper/zinc enzyme superoxide dismustase (SOD) have been shown to be a major factor in the motor neuron degeneration in conditions like familial ALS and similar effects on Cu/Zn SOD to be a factor in other conditions such as autism, Alzheimer's, Parkinson's, and non-familial ALS (489, 495, 464, 111). This condition can result in zinc deficient SOD and oxidative damage involving nitric oxide, peroxynitrite, and lipid peroxidation (495, 496, 489, 524), which have been found to affect glutamate mediated excitability and apoptosis of nerve cells and effects on mitochondria (495, 496, 524, 119) These effects can be reduced by zinc supplementation (464, 495), as well as supplementation with antioxidants and nitric oxide-suppressing agents and peroxynitrite scavengers such as Vit C, Vit E, lipoic acid, Coenzyme Q10, carnosine, gingko biloba, N-acetylcysteine, etc. (237, 444, 464, 494, 495, 469, 521, 524, 572, 597). Some of the antioxidants were also found to have protective effects through increasing catalase and SOD action, while reducing lipid peroxidations (494a). Ceruloplasmin in plasma can be similarly affected by copper metabolism disfunction, like SOD function, and is often a factor in neurodegeneration (489).

3. Mercury from amalgam interferes with production of cytokines that activate macrophage and neutrophils, disabling early control of viruses or micoplasma and leading to enhanced infection (131, 251, 470). Animal studies have confirmed that mercury increases effects of the herpes simplex veris type 2 for example (131). Both mercuric and methyl mercury were equally highly toxic at the cellular level and in causing cell volume reductions (131). However methyl mercury inhibits macrophage functions such as migration and phagocytosis at lower levels. Large numbers of people undergoing amalgam removal have clinically demonstrated significant improvements in the immune system parameters discussed here and recovery and significant improvement in immune system problems in most cases surveyed (Section VI). Antigen specific LST-test was performed on a large number of patients with atopic eczema (323), using T-cells of peripheral blood. 87% showed LST positive reactions to Hg, 87% to Ni, 38% to Au and 40% to Pd They removed LST positive dental metals from the oral cavities of patients. Improvement of symptoms was obtained in 82% (160/196) of the patients within 1-10 months. Similar results have been obtained at other clinics (455). Several studies found adverse health effects at mercury vapor levels of 1 to 5 mcg/m^3 (35).

4. Body mercury burden was found to play a role in resistant infections such as Chlamydia trachomatis and herpes family viral infections; it was found many cases can only be effectively treated by antibiotics after removal of body mercury burden (cilantro tablets were used with followup antibiotics) (251, 131). Various bacteria have enzymes that convert organic mercury to inorganic mercury in the intestine, facilitating excretion. However taking antibiotics kills these bacteria and significantly reduces mercury excretion, resulting in more mercury damage. Similar results regarding mercury have been found for treatment of cancer (35, 228a, 530, 543b, 597). Studies have found conventional chemotherapy to be no more effective than no treatment and clinical cases have demonstrated that detoxification and nutritional support can be effective in treating multiple myeloma (550) and other cancers (486, 597).

5. Mercury by its effect of weakening the immune system contributes to increased chronic diseases and cancer (91, 180, 228a, 237, 239, 222, 234, 355, 530, 543, 35, 38, 40, etc,). Exposure to mercury vapor causes decreased zinc and methionine availability, depresses rates of methylation, and increased free radicals-all factors in increased susceptibility to cancer (14, 34, 38, 43, 143, 144, 180, 237, 239, 251, 256, 283, 530). Amalgam fillings have also been found to be positively associated with mouth cancer (206, 251, 403, 543b). Mercury from amalgam fillings has also been found to cause increase in white blood cells and in some cases to result in leukemia (35, 180). White cell levels decline after total dental revision (TDR) and some have recovered from leukemia after removal of amalgam fillings in a very short time (35, 180). Among a group of patients testing positive as allergic to mercury, low level mercury exposure was found to cause adverse immune system response, including effects on vitro production of tumor necrosis factor TNF alfa and reductions in interleukin-1. (126, 131, 152).

Nickel and beryllium are 2 other metals commonly used in dentistry that are very carcinogenic, toxic, and cause DNA malformations (35, 456). Nickel ceramic crowns, root canals and cavitations have also been found to be a factor in some breast cancer and other cancers and some have recovered after TDR, which includes amalgam replacement, replacement of metal crowns over amalgam, nickel crowns, extraction of root canaled teeth, and treatment of cavitations where necessary (35, 200, 228a, 486, 530). Similarly nickel crowns and gold crowns over amalgam have been found to be a factor in lupus (456, 35, 229) and Belle's Palsy from which some have recovered after TDR and Felderkrais exercises (35). Nickel has also been found to accumulate in the prostate and be related to prostate cancer (581).

6. A high correlation has been found between patients subjectively diagnosed with CNS & systemic symptoms suggestive of mercury intoxication and immune reactivity to inorganic mercury (MELISA test, 118, 160) as well as with MRI positive patients for brain damage. Controls without CNS problems did not have such positive correlations. Mercury, nickel, palladium, and gold induce autoimmunity in genetically predisposed or highly exposed individuals (314, 234, 130, 342, 375, 468). Tests have found a significant portion of people to be in this category and thus more affected by

exposure to amalgam than others (see section V).

Mercury also interrupts the cytochrome C oxidase system, blocking the ATP energy function (35, 43, 84, 232, 338c). These effects along with reductions in red blood cells oxygen carrying capability often result in fatigue and reduced energy levels as well as neurological effects (35, 60, 119, 140, 141, 182, 202, 212, 232, 235, 313). The majority of those with CFS having SPECT scans were found to have 5 times more areas of regional brain damage and reduced blood flow in the cerebral areas (471). The majority studied were also found to have increased Th2 inflammatory cytokine activity and a blunted DHEA response curve to I.V. ATCH indicative of hypothalamic deficiency such as relative glucocorticoid deficiency (472). CFS and Fibromyalgia patients have also been found to commonly have abnormal enzymatic processes that affect among other things the sodium-potassium ATPase energy channels (473), for which mercury is a known cause (43, 288, 527). This also results in inflammatory processes that cause muscle tissue damage and result in higher levels of urinary excretion of creatinine, choline, and glycine in CFS, and higher levels of excretion of choline, taurine, citrate, and trimethyl amine oxide in FM (474).

7. People with chronic and immune reactive problems are increasing finding dental materials are a factor in their problems and getting biocompatiblity tests run to test their immune reactivity to the various dental materials used. A high percentage of such patients test immune reactive to many of the toxic metals. Of the many thousands who have had the Clifford immune reactivity test (445), the following percentages were immune reactive to the following metals that have very common exposures: mercury (93%), nickel (98%), aluminum (91%), arsenic (86%), chromium (83%), cobalt (78%), beryllium (74%), lead (68%), cadmium (63%), antimony (36%), copper (32%), palladium (32%), tin (32%), zinc (33%), silver (25%).

Toxic/allergic reactions to metals such as mercury often result in lichen planus lesions in oral mucosa or gums and play a roll in pathogenesis of periodontal disease. Removal of amalgam fillings usually results in cure of such lesions (60, 75, 78, 82, 86, 87, 90, 94, 101, 118, 133, 168, 192bcf, 313). A high percentage of patients with oral mucosal problems along with other autoimmune problems such as CFS have significant immune reactions to mercury, palladium, gold, and nickel (46, 60, 118, 313, 81, 90, 212, 313, 342, 369, 375, 456, 468), including to mercury preservatives such as thimerosal. 94% of such patients had significant immune reactions to inorganic mercury (MELISA test) and 72% had immune reactions to low concentrations of $HgCl_2$ (¡0.5 μg/ml). 61% also had immune reaction to phenylHg, which has been commonly used in root canals and cosmetics (313, 468). 10% of controls had significant immune reactions to HgCl and 8.3% to palladium. Other studies of patients suffering from chronic fatigue found similar results (369, 468, 342). Of 50 patients suffering from serious fatigue referred for MELISA test (369), over 70% had significant immune reaction to inorganic mercury and 50% to nickel, with most patients also reactive to one or more other metals such as palladium, cadmium, lead, and methyl mercury.

Mercury has been found to impair conversion of thyroid T4 hormone to the active T3 form as well as causing autoimmune thyroiditis common to such patients (369, 382, 459, 35, 50d). In general immune activation from toxics such as heavy metals resulting in cytokine release and abnormalities of the hypothalamus-pituitary-adrenal axis can cause changes in the brain, fatigue, and severe psychological symptoms (369, 342, 379-382, 385, 453, 118, 60) such as profound fatigue, muscosketal pain, sleep disturbances, gastrointestinal and neurological problems as are seen in CFS, Fibromyalgia, and autoimmune thyroiditis. Such symptoms usually improve significantly after amalgam removal. Such hypersensitivity has been found most common in those with genetic predisposition to heavy metal sensitivity (342, 369, 382, 60), such as found more frequently in patients with HLA-DRA antigens (342, 383). A significant portion of the population appears to fall in this category. Conditions involving allergies, chemical sensitivities, and autoimmunity have been increasing rapidly in recent years (405).

The enzymatic processes blocked by such toxic substances as mercury also result in chronic forma-

tion of metal-protein compounds (HLA antigens or antigen-presenting macrophages) that the body's immune system (T-lymphocytes) does not recognize, resulting in autoimmune reactions (114, 342, 405). The metals bind to SH-groups on proteins which can then be recognized as "foreign" and attacked by immune lymphocytes. Such has been extensively documented by studies such as the documentation of the autoimmune function test MELISA, a sophisticated immune/autoimmune test which was developed to test for such reactions (60, 405).

Very low doses and short term exposures of inorganic Hg (20-200 mug/kg) exacerbates lupus and accelerates mortality in mice. Low dose Hg exposure increases the severity and prevalence of experimental autoimmune myocarditis induced by other factors. In a study of small-scale gold mining using mercury, there was a positive interaction between Hg autoimmunity and malaria. These results suggest a new model for Hg immunotoxicity, as a co-factor in autoimmune disease, increasing the risks and severity of clinical disease in the presence of other triggering events, either genetic or acquired (234f).

Mercury has been found to accumulate in the pineal gland and reduce melatonin levels, which is thought to be a significant factor in mercury's toxic effects (569). Melatonin has found to have a significant protective action against methyl mercury toxicity, likely from antioxidative effect of melatonin on the MMC induced neurotoxicity (567).

There is also evidence that mercury affects neurotransmitter levels which has effects on conditions like depression, mood disorders, ADHD, etc. There is evidence that mercury can block the dopamine-beta-hydroxylase (DBH) enzyme (571). DBH is used to make the noradrenaline neurotransmitter and low noradrenaline can cause fatigue and depression. Mercury molecules can block all copper catalyzed dithiolane oxidases, such as coproporphyrin oxidase (260) and DBH.

8. Patients with other systemic neurological or immune symptoms such as arthritis, myalgia, eczema, CFS (60, 342, 369), MS (369, 170, 35c), lupus (369, 405), ALS, diabetes (501, 35), epilepsy (5, 35, 229, 309), Hashimoto's thyroiditis (369, 382), Scleroderma (353), etc. also often recover or improve significantly after amalgam replacement (thousands of cases - see section 1.6). Of a group of 86 patients with CFS symptoms, 78% reported significant health improvements after replacement of amalgam fillings within a relatively short period, and MELISA test found significant reduction in lymphocyte reactivity compared to pre removal tests (342, 369). The improvement in symptoms and lymphocyte reactivity imply that most of the Hg-induced lymphocyte reactivity is allergenic in nature. Although patch tests for mercury allergy are often given for unresolved oral symptoms, this is not generally recommended as a high percentage of such problems are resolved irrespective of the outcome of a patch test (87, 86, 90, 101, 168, etc.) Also using mercury in a patch test has resulted in some adverse health effects. A group of patients that had amalgams removed because of chronic health problems, were able to detect subjectively when a patch test used mercury salts in a double blind study (373).

Of the over 3,000 patients with chronic conditions tested for lymphocyte reactivity to metals (342), the following were the percentages testing positive: nickel- 34%, inorganic mercury- 20%, phenol mercury- 13%, gold- 14%, cadmium- 16%, palladium- 13%, lead-11%. For people with autoimmune conditions such as CFS, Fibromyalgia, or Multiple Chemical Sensitivity, the percentage testing immune reactive to mercury was much higher- 28% percent were immune reactive to palladium, 26% to gold, 23% to inorganic mercury, 23% to phenyl mercury, and 12% to methyl mercury, as compared to less than 5% for controls. Of 98 patients who had amalgam fillings replaced, 76% had long term health improvement and significant improvement in MELISA scores.

Other studies have also found relatively high rates of allergic reactions to inorganic mercury and nickel (81, 35, 445, 456). For groups with suspected autoimmune diseases such as neurological problems, CFS, and oral lichen planus (313); most of the patients tested positive to inorganic mercury and most of such patients health improved significantly and immune reactivity declined after amalgam removal. In a group of patients tested by MELISA before and after amalgam removal at a clinic in

Uppsala Sweden, the patients reactivity to inorganic mercury, palladium, gold and phenyl mercury all had highly significant differences from the control group, with over 20% being highly reactive to each of these metals (342). Animal studies have found that after sensitiztion to mercury, patients and animals are also usually reactive to gold (375). A high percentage were also reactive to nickel in both groups. After amalgam removal the immune reactivity to all of these metals other than nickel declined significantly, and 76% reported significant long term health improvements after 2 years. Only 2% were worse. The study concluded that immune reactivity to mercury and palladium is common and appears to be allergenic/immune related in nature since immune reactivity declines when exposure levels are reduced. Such studies have also found that deficiencies in detoxification enzymes such as glutathione transfereases cause increased susceptibility to metals and other chemicals (384). Such deficiencies can be due to genetic predisposition, but are also known to be caused by acute or chronic toxic exposures.

For MS and lupus patients, a high percentage tested positive to nickel and/or inorganic mercury (MELISA).

A patch test was given to a large group of medical students to assess factors that lead to sensitization to mercury (132). 13% tested positive for allergy to mercury. Eating fish was not a significant factor between sensitive and non-sensitized students, but the sensitized group had a significantly higher average number of amalgam fillings and higher hair mercury levels. In a population of dental students tested, 44% were positive for allergy to mercury (156).

9. A high correlation has been found between patients subjectively diagnosed with CNS & systemic symptoms suggestive of mercury intoxication and immune reactivity to inorganic mercury (MELISA test, 118) as well as with MRI positive patients for brain damage. 81% of the group with health complaints had pathological MRI results including signs of degeneration of the basal ganglia of the brain, but none in the controls. 60% of the symptom group tested positive for immune system reaction to mercury. Controls without CNS problems did not have such positive correlations. The authors concluded that immune reactions have an important role in development of brain lesions and tumors, and amalgam fillings induce immune reactions in many patients (91, 118) (270, 286, 328). Mercury, nickel, palladium, and gold induce autoimmunity in genetically predisposed or highly exposed individuals (60, 314, 234, 130, 342, 35). Tests have found a significant portion of people to be in this category and thus more affected by exposure to amalgam than others.

10. Low level mercury exposure (as well as other toxic metals) including exposure to amalgam fillings has been found to be associated with increased autoimmune diseases (19, 27, 34, 35, 44, 45, 60, 215, 234, 268, 269, 270, 313, 314), including lupus (12, 35, 60, 113, 229, 233, 234, 270, 323, 330, 331, 456), Chrons Disease, lichen planus (86, 87, 90, 168, 313), endometriosis (1, 9, 38, 229). Silver also is released from amalgam fillings and stored in the body and has been shown to cause immune complex deposits, immune reactions and autoimmunity in animal studies (77, 78, 129, 314).

11. Mercury exposure through dental fillings appears to be a major factor in chronic fatigue syndrome (CFS) through its effects on ATP and immune system (lymphocyte reactivity, neutrophil activity, effects on T-cells and B-cells) as well as its promotion of growth of candida albicans in the body and the methylation of inorganic mercury by candida and intensional bacteria to the extremely toxic methyl mercury form, which like mercury vapor crosses the blood-brain barrier, and also damages and weakens the immune system (222, 225, 226, 234, 235, 281, 293, 60, 313, 314, 342, 369, 404). Mercury vapor or Inorganic mercury have been shown in animal studies to induce autoimmune reactions and disease through effects on immune system T cells (226, 234, 268, 269, 270, 314, 425, 426, 21c/272). Chronic immune activation is common in CFS, with increase in activated CD8+ cytotoxic T-cells and decreased natural killer (NK) cells (518). Numbers of suppressor-inducer T cells and NK cells have been found to be inversely correlated with urine mercury levels (270ad). CFS patients usually improve and immune reactivity is reduced when amalgam fillings are replaced (342, 383, 405).

1.5 Medical studies finding health problems related to amalgam fillings (other than immune)

1. Neurological problems are among the most common and serious and include memory loss (119ef, 481c), moodiness, depression (119dfg, 285c, 481c, 595), anger and sudden bursts of anger/rage (119d, 285c, 290, 465, 480-483, 487, 534), self-effacement, suicidal thoughts (119g), lack of strength/force to resolve doubts or resist obsessions or compulsions, etc. Many studies of patients with major neurological diseases have found evidence amalgam fillings may play a major role in development of conditions such as depression (94, 107, 109, 212, 222, 271, 294, 212, 229, 233, 285ce, 317, 320, 322, 372, 374, 453, 595), schizophrenia (34, 35, 295, 465), bipolar disorder (294), memory problems (212, 222), and other more serious neurological diseases such as MS, ALS, Parkinson's, and Alzheimer's (see # 25). A large U.S. Centers for Disease Control study found that those with more amalgam fillings have significantly more chronic health problems, especially neurological problems and cancer (543).

Some factors that have been documented in depression are low serotonin levels, abnormal glucose tolerance (hypoglycemia), brain inflammation (584, 585), and low folate levels (480-83), which mercury has also been found to be a cause of. Occupational exposure to mercury has been documented to cause depression and anxiety (534, 285c, 119df). One mechanism by which mercury has been found to be a factor in aggressiveness and violence is its documented inhibition of the brain neurotransmitter acetylcholinesterase (175, 251c, 305, 451, 465, 254). Low serotonin levels and/or hypoglycemia have also been found in the majority of those with impulsive and violent behavior (481, 482).

Mercury causes decreased lithium levels, which is a factor in neurological diseases such as depression and Alzheimer's. Lithium protects brain cells against excess glutamate and calcium, and low levels cause abnormal brain cell balance and neurological disturbances (280, 294, 333, 33, 56). Medical texts on neurology (21, 27, 295, 503b) point out that chronic mercurialism is often not recognized by diagnosticians and misdiagnosed as dementia or neurosis or functional psychosis or just "nerves". "Early manifestations are likely to be subtle and diagnosis difficult: Insomnia, nervousness, mild tremor, impaired judgment and coordination, decreased mental efficiency, emotional lability, headache, fatigue, loss of sexual drive, excitability, depression, etc. are often mistakenly ascribed to psychogenic causes". Diagnois of mercury toxicity can be made based on exposure history and 3 or more of such symptoms mercury is known to cause (21, 27, 295). Very high levels of mercury are found in brain memory areas such as the cerebral cortex and hippocampus of patients with diseases with memory related symptoms (158, 34, 207, etc). Mercury has been found to cause memory loss by inactivating enzymes necessary for brain cell energy production and proper assembly of the protein tubulin into microtubules (258).

Mercury (as well as toxins from root canals and cavitations) interact with brain tubulin and disassembles microtubules that maintain neurite structure (207b, 258, 35, 200, 437). Thus chronic exposure to low level mercury vapor can inhibit polymerzation of brain tubulin and creatinine kinase which are essential to formation of microtubules. Studies of mercury studies on animals give results similar to that found the Alzheimer brain. The effects of mercury with other toxic metals have also been found to be synergistic, having much more effect than with individual exposure (35).

Flu shots have mercury and aluminum which both are known to accumulate in the brain over time. A study of people who received flu shots regularly found that if an individual had five consecutive flu shots between 1970 and 1980 (the years studied) his/her chances of getting Alzheimer's Disease is ten times higher than if they had one or no shots (475).

Animal studies of developmental effects of mercury on the brain have found significant effects at extremely low exposure levels, levels commonly seen in those with amalgam fillings or in dental staff working with amalgam. One study (305) found prenatal mercury vapor exposure decreased NGF

concentration in newborn rat's forebrain at 4 parts per billion (ppb) tissue concentration. Another study (175) found general toxicity effects at 1 micromole (μM) levels in immature cell cultures, increased immunoreactivity for glial fibrillary protein at 1 nanamole (0.2 ppb) concentration, and microglial response at even lower levels. Other animal studies on rodents and monkeys have found brain cellular migration disturbances, behavioral changes, along with reduced learning and adaption capacity after low levels of mercury vapor exposure (149, 175, 210, 264, 287, 305). The exposure levels in these studies are seen in the fetus and newborn babies of mother's with amalgam fillings or who had work involving amalgam during pregnancy (61). Mercury vapor has been found to primarily affect the central nervous system, while methyl mercury primarily affects the peripheral nervous system (175c).

Epidemiological studies have found that human embryos are also highly susceptible to brain damage from prenatal exposure to mercury. Studies have confirmed that there are vulnerable periods during brain and CNS development that are especially sensitive to neurotoxic exposures and affect development processes and results (429).The fetal period is most sensitive, but neural development extends through adolescence. A recent study found that prenatal Hg exposure is correlated with lower scores in neurodevelopmental screening, but more so in the linguistic pathway (32c). Maternal hypothyroidism has been found to cause endocrine system abnormalities in the fetus (458, 508, 509, 511), and mercury is documented to commonly cause hypothyroidism, both chronically or as a transient condition. Some conditions found to be related to such toxic exposures include autism, schizophrenia, ADD, dyslexia, eczema, etc. Prenatal/early postnatal exposure to mercury affects level of nerve growth factor (NGF) in the brain and causes brain damage and imbalances in development of the brain (38, 119, 181, 305, 259, 210, 175, 305, 24/ 39, 255, 149). Exposure of developing neuroblastoma cells to sub-cytotoxic doses of mercuric oxide resulted in lower levels of neurofilament proteins than unexposed cells (305). Mercury vapor exposure causes impaired cell proliferation in the brain and organs, resulting in reduced volume for cerebellum and organs and subtle deficiencies (38, 175, 305, 328). Exposure to mercury and 4 other heavy metals tested for in a study of school children accounted for 23% of the variation in test scores for reading, spelling and visual motor skills (3). A Canadian study found that blood levels of five metals were able to predict with a 98% accuracy which children were learning disabled (3). Several studies found that mercury causes learning disabilities and impairment, and reduction in IQ (3, 21, 38, 110, 264, 285c, 279, 541b). Mercury has an effect on the fetal nervous system at levels far below that considered toxic in adults, and background levels of mercury in mothers correlate significantly with incidence of birth defects and still births (23, 38, 50, 287, 338c, 10). The upper level of mercury exposure recommended by the German Commission on Human Biomonitoring is 1 micrograms per liter in the blood (39), and adverse effects such as increases in blood pressure and cognitive effects have been documented as low as 1 μg/L, with impacts higher in low birth weight babies (39).

2. Calcium plays a major role in the extreme neurotoxicity of mercury and methyl mercury. Both inhibit cellular calcium ATPase and calcium uptake by brain microsomes at very low levels of exposure (270, 288, 329, 333, 432, 56,). Protein Kinase C (PKC) regulates intracellular and extra cellular signals across neuronal membranes, and both forms of mercury inhibit PKC at micromolar levels, as well as inhibiting phorbal ester binding (43, 432). They also block or inhibit calcium L-channel currents in the brain in an irreversible and concentration dependent manner. Mercury vapor or inorganic mercury exposure affects the posterior cingulate cortex and causes major neurological effects with sufficient exposure (428, 453). Some of the resulting conditions include stomatitis, tremor, ADD, erythism, etc. Metallic mercury is much more potent than methyl mercury in such actions, with 50% inhibitation in animal studies at 13 ppb (333, 329). Motor neuron dysfunction and loss in amyotrophic lateral sclerosis (ALS) have been attributed to several different mechanisms, including increased intracellular calcium, glutamate excitotoxicity, oxidative stress and free radical damage, mitochondrial dysfunction, and neurofilament aggregation and dysfunction of transport mechanisms (507). These alterations are not mutually exclusive, and increased calcium and altered calcium

homeostatis appear to be a common denominator.

Spatial and temporal changes in intracellular calcium concentrations are critical for controlling gene expression and neurotransmitter release in neurons (432, 412). Mercury alters calcium homeostasis and calcium levels in the brain and affects gene expression and neurotransmitter release through its effects on calcium, etc. Mercury inhibits sodium and potassium (N, K)ATPase in dose dependent manner and inhibits dopamine and noreprenephrine uptake by synaptosomes and nerve impulse transfer (288, 50, 270, 35). Mercury also interrupts the cytochrome oxidase system, blocking the ATP energy function (35, 43, 84, 232, 338c), lowering immune growth factor IGF-I levels and impairing astrocyte function (119, 497). Astrocytes are common cells in the CNS involved in the feeding and detox of nerve cells. Increases in inflammatory cytokines such as caused by toxic metals trigger increased free radical activity and damage to astrocyte and astrocyte function (152). IGF-I protects against brain and neuronal pathologies like ALS, MS, and Fibromyalgia by protecting the astrocytes from this destructive process.

As far back as 1996 it was shown that the lesions produced in the myelin sheath of axons in cases of multiple sclerosis were related to excitatory receptors on the primary cells involved called oligodendroglia. The loss of myelin sheath on the nerve fibers characteristic of the disease are due to the death of these oligodendroglial cells at the site of the lesions (called plaques). Further, these studies have shown that the death of these important cells is as a result of excessive exposure to excitotoxins at the site of the lesions (576). Most of these excitotoxins are secreted from microglial immune cells in the central nervous system. This not only destroys these myelin-producing cells it also breaks down the blood-brain barrier (BBB), allowing excitotoxins in the blood stream to enter the site of damage. Some common exposures that cause such proliferation of such excitotoxins are mercury and aspartame, with additional effects from MSG and methanol. Aspartame and methanol are both in diet drinks and many may drink diet drinks with Chinese food that has MSG.

Mercury and aspartame have been found to be causes of MS, along with other contributing exicitotoixns. It is now known the cause for the destruction of the myelin in the lesions is overactivation of the microglia in the region of the myelin. An enzyme that converts glutamine to glutamate called glutaminase increases tremendously, thereby greatly increasing excitotoxicity. Any dietary excitotoxin can activate the microglia, thereby greatly aggravating the injury. This includes the aspartate in aspartame. The methanol adds to this toxicity as well. Now, the secret to treatment appears to be shutting down, or at least calming down, the microglia.

A Canadian study found those with 15 or more amalgam fillings to have more than 250% greater risk of MS than controls, and likewise higher risk for those who have had amalgam fillings more than 15 years (324). A retrospective study conducted in England found that the odds of being an MS case multiplied for every additional unit of dental fillings. Overall this represents a 21% increase in risk of MS in relation to dental caries restorations (324c).

According to neurologist Dr. RL Blaylock, the good news is that there are supplements and nutrients that calm the microglia-the most potent are: silymarin, curcumin and ibuprophen. Phosphatidylcholine helps re-myelinate the nerve sheaths that are damaged, as does B12, B6, B1, vitamin D, folate, vitamin C, natural vitamin E (mixed tocopherols) and L-carnitine (576). DHA plays a major role in repairing the myelin sheath. Vitamin D may even prevent MS, but it acts as an immune modulator, preventing further damage - the dose is 2000 IU a day. Magnesium, as magnesium malate, is needed in a dose of 500 mg 2X a day. They must avoid all excitotoxins, even natural ones in foods-such as soy, red meats, nuts, mushrooms and tomatoes. Avoid all fluoride and especially all vaccinations since these either inhibit antioxidant enzymes or triggers harmful immune reactions.

It has also been found that the antibiotic minocycline powerfully shuts down the microglia. Dr. Blaylock, tried this treatment on a friend of mine who just came down with fulmanant MS. He was confined to a wheelchair. I had him placed on minocycline and now, just a few weeks later, he is walking.

Metals like mercury bind to SH-groups (sulfhydryl) in sulfur compounds like amino acids and proteins, changing the structure of the compound that it is attached to. This often results in the immune systems T-cells not recognizing them as appropriate nutrients and attacking them (226). Such binding and autoimmune damage has been documented in the fat-rich proteins of the myelin sheaths of the CNS (478, 39b, 35c) and collagen (405), which are affected in MS. Metals by binding to SH radicals in proteins and other such groups can cause autoimmunity by modifying proteins which via T-cells activate B-cells that target the altered proteins inducing autoimmunity as well as causing aberrant MHC II expression on altered target cells (425de, 343). Studies have also found mercury and lead cause autoantibodies to neuronal proteins, neurofilaments, and myelin basic protein (MBP) (39b, 269ag, 405, 478, 515, 516). Mercury and cadmium also have been found to interfere with zinc binding to MBP (517b) which affects MS symptoms since zinc stabilizes the association of MBP with brain myelin (517a). MS has also been found to commonly be related to inflammatory activity in the CNS such as that caused by the reactive oxygen species and cytokine generation caused by mercury and other toxic metals (405, 478, 515, 126, 516, 35c, 369). Mercury from amalgam has been found to reduce antioxidant enzymes and antioxidant effects in blood plasma (13ad). Antioxidants like lipoic acid which counteract such free radical activity have been found to alleviate symptoms and decrease demyalination (572b, 597). A group of metal exposed MS patients with amalgam fillings were found to have lower levels of red blood cells, hemoglobin, hemocrit, thyroxine, T-cells, and CD8+ suppresser immune cells than a group of MS patients with amalgam replaced, and more exacerbations of MS than those without (102a). Immune and autoimmune mechanisms are thus seen to be a major factor in neurotoxicity of metals. The immune suppression caused by exposure to mercury or other toxics has also be found to increase susceptibility to other common pathogens such as viruses, mycoplasma, bacteria, candida, and parasites (469b, 470, 485). The majority of those tested with autoimmune conditions such as ALS, MS, CFS, FMS have been found to be infected with mycoplasma (470) and similar for parasites (485).

Mercury lymphocyte reactivity and effects on glutamate in the CNS induce CFS type symptoms including profound tiredness, musculoskeletal pain, sleep disturbances, gastrointestinal (21c) and neurological problems along with other CFS symptoms and Fibromyalgia (342, 346, 369, 496). Mercury has been found to be a common cause of Fibromyalgia (293, 346, 369, 527), which based on a Swedish survey occurs in about 12% of women over 35 and 5.5% of men (368). Glutamate is the most abundant amino acid in the body and in the CNS acts as excitory neurotransmitter (346, 386, 412, 496, 119), which also causes inflow of calcium. Astrocytes, a type of cell in the brain and CNS with the task of keeping clean the area around nerve cells, have a function of neutralizing excess glutamate by transforming it to glutamic acid. If astrocytes are not able to rapidly neutralize excess glutamate, then a buildup of glutamate and calcium occurs, causing swelling and neurotoxic effects (119, 152, 333, 416, 496). Mercury and other toxic metals inhibit astrocyte function in the brain and CNS (119, 131), causing increased glutamate and calcium related neurotoxicity (119, 152, 333, 226a, 416, 496, 527) which are responsible for much of the Fibromyalgia symptoms and a factor in neural degeneration in MS and ALS. There is some evidence that astrocyte damage/malfunction is a major factor in MS (544). This is also a factor in conditions such as CFS, Parkinson's, and ALS (346, 416, 496). Animal studies have confirmed that increased levels of glutamate (or aspartate, another amino acid excitory neurotransmitter) cause increased sensitivity to pain, as well as higher body temperature - both found in CFS/Fibromyalgia. Mercury and increased glutamate activate free radical forming processes like xanthine oxidase which produce oxygen radicals and oxidative neurological damage (346, 142, 13). Nitric oxide related toxicty caused by peroxynitrite formed by the reaction of NO with superoxide anions, which results in nitration of tyrosine residues in neurofilaments and manganese Superoxide Dimustase (SOD) has been found to cause inhibition of the mitochondrial respiratory chain, inhibition of the glutamate transporter, and glutamate-induced neurotoxicity involved in ALS (524, 521).

Medical studies and doctors treating Fibromyalgia have found that supplements which cause a

decrease in glutamate or protect against its effects have a positive effect on Fibromyalgia and other chronic neurologic conditions. Some that have been found to be effective include CoQ10 (444), ginkgo biloba and pycnogenol (494ab), NAC (54, 56, 494a), Vit B6, methyl cobalamine (B12), L-carnitine, choline, ginseng, vitamins C and E (444, 494c), nicotine, and omega 3 fatty acids (fish and flaxseed oil) (417, 495e).

Extremely toxic anaerobic bacteria from root canals or cavitations formed at incompletely healed tooth extraction sites have also been found to be common factors in Fibromyalgia and other chronic neurological conditions such as Parkinson's and ALS, with condensing osteitis which must be removed with a surgical burr along with 1 mm of bone around it (35, 200, 437ab). Cavitations have been found in 80% of sites from wisdom tooth extractions tested and 50% of molar extraction sites tested (35, 200, 437ab). The incidence is likely somewhat less in the general population.

A recent study assessed the large decrease in ALS incidence in Guam and similar areas to look for possible explanations in the cause of past high incidence and recent declines. One of the studies conclusions was that a likely major factor for the high ALS rates in Guam and similar areas in the past was chronic dietary deficiency since birth in Ca, Mg and Zn induced excessive absorption of divalent metal cations which accelerates oxidant-mediated neuronal degenerations in a genetically susceptible population (466).

3. Numerous studies have found long term chronic low doses of mercury cause neurological, memory, behavior, sleep, and mood problems (3, 34, 60, 69, 70, 71, 74, 107-109, 119, 140, 141, 160, 199, 212, 222, 246, 255, 257, 282, 285, 290, 453). Neurological effects have been documented at very low levels of exposure (urine Hg¡ 4 μg/L), levels commonly received by those with amalgam fillings (290). One of the studies at a German University (199) assessed 20,000 people. There is also evidence that fetal or infant exposure causes delayed neurotoxicity evidenced in serious effect at middle age (255, 306). Substantial occupational mercury exposure can have long-term adverse effects on the peripheral nervous system detectable decades after cessation of exposure (255c).

Organic tin compounds formed from amalgam are even more neurotoxic than mercury (222, 262). Studies of groups of patients with amalgam fillings found significantly more neurological, memory, mood, and behavioral problems than the control groups. (3, 34, 107, 108, 109, 140, 141, 160, 199, 212, 222, 290, 453).

4. Mercury binds to hemoglobin oxygen binding sites in the red blood cells thus reducing oxygen carrying capacity (232, 35) and adversely affects the vascular response to norepinephrine and potassium. Mercury's effect on pituitary gland vasopressin is a factor in high blood pressure (35, 201). Mercury also increases cytosolic free calcium levels in lymphocytes in a concentration-dependant manner causing influx from the extracellular medium (270c), and blocks entry of calcium ions into the cytoplasm (1, 16, 17, 21, 33, 35, 333), and at 100 ppb can destroy the membrane of red blood cells (35, 22, 17, 270c) and damage blood vessels - reducing blood supply to the tissues (34, 202, 306).

Amalgam fillings have been found to be related to higher blood pressure, hemoglobin irregularities, tachycardia, chest pains, etc. (201, 202, 205, 212, 222, 306, 310, 539, 35, 59). Mercury also accumulates in the heart and damages myocardial and heart valves (Turpayev, in (35) & 59, 201, 205, 306, 351, 370).

Mercury has been found to be a cause of athersclerosis, hypertension, and tachycardia in children and adults (539, 59, 201, 205, 306, 308, 35) and heart attacks in adults (59, 201, 310).

Mercury also interrupts the cytochrome oxidase system, blocking the ATP energy function (35, 43, 84, 232, 338c) and impairing astrocyte function (119). These effects often result in fatigue and reduced energy levels (35, 60, 119, 140, 141, 182, 202, 212, 232, 235, 313). Both mercury and methyl mercury have been shown to cause depletion of calcium from the heart muscle and to inhibit myosin ATPase activity by 50% at 30 ppb (59), as well as reducing NK-cells in the blood and

spleen. The interruption of the ATP energy chemistry results in high levels of porphyrins in the urine (260). Mercury, lead, and other toxics have different patterns of high levels for the 5 types of porphyrins, with pattern indicating likely source and the level extent of damage. The average for those with amalgams is over 3 time that of those without, and is over 20 times normal for some severely poisoned people (232, 260). The FDA has approved a test measuring porphyrins as a test for mercury poisoning. However some other dental problems such as nickel crowns, cavitations, and root canals also can cause high porphyrins. Cavitations are diseased areas in bone under teeth or extracted teeth usually caused by lack of adequate blood supply to the area. Tests by special equipment (Cavitat) found cavitations in over 80% of areas under root canals or extracted wisdom teeth that have been tested, and toxins such as anaerobic bacteria and other toxics which significantly inhibit body enzymatic processes in virtually all cavitations (200, 437ab). These toxins have been found to have serious systemic health effects in many cases, and significant health problems to be related such as arthritis, MCS, and CFS. These have been found to be factors along with amalgam in serious chronic conditions such as MS, ALS, Alzheimer's, MCS, CFS, etc. (35, 200, 204, 222, 292, 437). The problem occurs in extractions that are not cleaned out properly after extraction. Supplements such as glucosamine sulfate and avoidance of orange juice and caffeine have been found to be beneficial in treating arthritic conditions as well (35).

A study funded by the Adolf Coors Foundation (232) found that toxicity such as mercury is a significant cause of abnormal cholesterol levels, increasing as a protective measure against metals toxicity, and that cholesterol levels usually normalize after amalgam replacement. However lowering cholesterol levels by other means below 160 correlates with much higher rates of depression, suicide, cancer, violent deaths, cerebral hemorrhage, and deaths - all known to be affected by mercury effects (35, 228a, 530). The study also found that mercury has major adverse effects on red and white blood cells, oxygen carrying capacity, and porphyrin levels (232), with most cases seeing significant increase in oxyhemoglobin level and reduction in porphyrin levels along with 100% experiencing improved energy.

5. Patch tests for hypersensitivity to mercury have found from 2% to 44% to test positive (87, 154, 156, 178, 267), much higher for groups with more amalgam fillings and length of exposure than those with less. In studies of medical and dental students, those testing positive had significantly higher average number of amalgam fillings than those not testing positive (and higher levels of mercury in urine (132, 156). Of the dental students with 10 or more fillings at least 5 years old, 44% tested allergic. Based on these studies and statistics for the number with 10 or more fillings, the percent of Americans allergic to mercury just from this group would be about 17 million people especially vulnerable to increased immune system reactions to amalgam fillings. However, the total would be much larger and patch tests do not measure the total population getting toxic reactions from mercury. The most sensitive reactions are immune reactions, DNA mutations, developmental, enzyme inhibition, nerve growth inhibition, and systemic effects (34, 38, 61, 149, 175, 186, 226, 263, 264, 270, 272, 296, 305, 410-412/149, 357).

6. People with amalgam fillings have an increased number of intestinal microorganisms resistant to mercury and many standard antibiotics (35, 116, 117, 161, 389, 79). Mercury is extremely toxic and kills many beneficial bacterial, but some forms of bacteria can alter their form to avoid being killed by adding a plasmid to their DNA making the bacteria mercury resistant. But this transformation also increases antibiotic resistance and results in adversely altered populations of bacteria in the intestines. Recent studies have found that drug resistant strains of bacteria causing ear infections, sinusitis, tuberculosis, and pneumonia more than doubled since 1996, and similar for strains of bacteria in U.S. rivers (53). Studies have found a significant correlation between mercury resistance and multiple antibiotic resistance (116, 117, 161, 369), and have found that after reducing mercury burden antibiotic resistance declines (251, 389, 40). The alteration of intestinal bacterial populations necessary for proper digestion along with other damage and membrane permeability effects of mercury are major factors in creating "leaky gut" conditions with poor digestion and absorption of nutrients

and toxic incompletely digested compounds in the bloodstream (338, 21c, 222, 228b35, etc.). Some of the gastrointestional problems caused by mercury include poor mineral absorption, diarrhea, stomatis, bloating, wasting disease, etc. (21c, 338, 35, etc).

When intestinal permeability is increased, food and nutrient absorption is impaired. Dysfunction in intestinal permeability can result in leaky gut syndrome, where larger molecules and toxins in the intestines can pass through the membranes and into the blood, triggering immune response (598). Progressive damage can occur to the intestinal lining, eventually allowing disease-causing bacteria, undigested food particles, and toxins to pass directly into the blood stream. Dysfunctions in intestinal permeability have been found to be associated with diseases such as ulcerative colitis, irritable bowel syndrome (IBS), Crohn's disease, CFS, eczema, psoriasis, food allergies, autoimmune disease, and arthritis (591 abcdefgh, 592b, 598).

Mercury and toxic metals have been found to be common toxic exposures that have been found to cause increased intestinal permeability and intestinal dysfunction (592, 338), as well as of the kidney epithelial and brush border cells. Mercury exposure also reduced the mucosal entry of sugars and amino acids to 80-90% of control levels in the small intestine cells within several minutes (593a). Mercury exposure blocks intestinal nutrient transport by interacting directly with brush border membrane transport proteins (593b).

Mercury causes significant destruction of stomach and intestine epithelial cells, resulting in damage to stomach lining which along with mercury's ability to bind to SH hydroxyl radical in cell membranes alters permeability (338, 405, 35, 21c, 592) and adversely alters bacterial populations in the intestines causing leaky gut syndrome with toxic, incompletely digested complexes in the blood (116, 228b, 35, 598) and accumulation of heliobacter pylori, a suspected major factor in stomach ulcers and stomach cancer (256, 6bc) and Candida albicans, as well as poor nutrient absorption (338, 593).

Dental amalgam has been found to be the largest source of mercury exposure in most people who have several amalgam fillings. Replacement of amalgam fillings and metals detoxification have been found to significantly improve the health of most with conditions related to bowel dysfunction and leaky gut syndrome.

Other common causes or factors in leaky gut and the related conditions include food allergies and intolerances; drugs (NSAIDs, aspirin, stomach h2 blockers, steroids, etc.); Dysbiosis (overgrowth of harmful organisms due to antibiotic use and/or low probiotic levels); chronic alcohol consumption; toxic exposures and chemical sensitivity; chronic infections; inadequate digestive enzymes (598b).

Clinical studies have found that diets high in flavanoids, cartenoids, and including nutritional supplements such as buffered Vit C and natural E, selenium, omega-3 oils, probiotics are effective in preventing ear infections and other chronic conditions (598b). These in addition to multiple B vitamins, the flavanoids curcumin, hesperidin, and quercetin are effective in preventing and treating leaky gut related conditions (598). Supplements and other treatments that reduce intestinal permeability have also been found to be protective against and to improve these conditions. Glutamine, berberine, probiotics, and vitamin D have been found to decrease intestinal permeability and protect against effects caused by leaky gut syndrome (594, 586, 597).

7. Mercury from amalgam binds to the -SH (sulfhydryl) groups, resulting in inactivation of sulfur and blocking of enzyme functions such as cysteine dioxygenase (CDO), gamma-glutamyltraspeptidase (GGC) and sulfite oxidase, producing sulfur metabolites with extreme toxicity that the body is unable to properly detoxify (33, 111, 114, 194, 258, 405), along with a deficiency in sulfates required for many body functions. Sulfur is essential in enzymes, hormones, nerve tissue, and red blood cells. These exist in almost every enzymatic process in the body. Blocked or inhibited sulfur oxidation at the cellular level has been found in most with many of the chronic degenerative diseases, including Parkinson's, Alzheimer's, ALS, lupus, rheumatoid arthritis, MCS, autism, etc (330, 331, 464, 514, 33, 35, 56, 194), and appears to be a major factor in these conditions. Mercury also blocks the

metabolic action of manganese and the entry of calcium ions into cytoplasm (333). Mercury from amalgam thus has the potential to disturb all metabolic processes (25, 21, 33, 35, 56, 60, 111, 180, 194, 197). Mercury is transported throughout the body in blood and can affect cells in the body and organs in different ways.

Parkinson's disease involves the aggregation of alpha-synuclein to form fibrils, which are the major constituent of intracellular protein inclusions (Lewy bodies and Lewy neurites) in dopaminergic neurons of the substantia nigra (564). Occupational exposure to specific metals, especially manganese, copper, lead, iron, mercury, zinc, aluminum, appears to be a risk factor for Parkinson's disease based on epidemiological studies (98, 145, 564, 565). Elevated levels of several of these metals have also been reported in the substantia nigra of Parkinson's disease subjects (564). One study found that EDTA chelation was effective at reducing some of the effects (145). In some cases, Molybdenum, B12-vitamin, P5P-vitamin, B1-vitamin, and tetrahydrofolate supplementation has helped to boost the protective sulfite oxidase.

8. A large study of 20,000 subjects at a German university found a significant relation between the number of amalgam fillings with periodontal problems, neurological problems, and gastrointestinal problems (199). Allergies and hair-loss were found to be 2-3 times as high in a group with large number of amalgam fillings compared to controls (199, 9). Levels of mercury in follicular fluid was significantly higher for those with amalgam fillings (9, 146). Based on this finding, a Gynecological Clinic that sees a large number of women suffering from alopecia/hair loss that was not responding to treatment had amalgams replaced in 132 women who had not responded to treatment. 68% of the women then responded to treatment and alopecia was alleviated (187). In other studies involving amalgam removal, the majority had significant improvement (40, 317). Higher levels of hormone disturbances, immune disturbances, infertility, and recurrent fungal infections were also found in the amalgam group. The results of hormone tests, cell culture studies, an intervention studies agree (9, 146). Other clinics have also found alleviation of hair loss/alopecia after amalgam removal and detox (40, 317). Another study in Japan found significantly higher levels of mercury in gray hair than in dark hair (402).

9. Mercury accumulates in the kidneys with increasing levels over time. One study found levels ranging from 21 to 810 ppb. A study of levels in kidney donors found an average of 3 times higher mercury level in those with amalgams versus those without (14c). Mercury exposure has been shown to adversely affect kidney function in occupational and animal studies (20, 203, 211, 223, 260, 438), and also in those with more than average number of amalgam fillings (254, 223). Richardson (Health Canada) has estimated that about 20% of the population suffers a subclinical impairment of kidney or CNS function related to amalgam mercury (209c). Inorganic mercury exposure has been found to exert a dose-dependent cytotoxicity by generating extremely high levels of hydrogen peroxide, which is normally quenched by pyruvate and catalase (203). $HgCl_2$ also has been found to impair function of other organelles such as lysomomes that maintain transmembrane proton gradient, and to decrease glutathione peroxidase activity in the kidneys while upregulating heme oxidase function. The Government's toxic level for mercury in urine is 30 mcg/L (189), but adverse effects have been seen at lower levels and low levels in urine often mean high mercury retention and chronic toxicity problems (258). For this reason urine tests are not a reliable measure of mercury toxicity (11, 36, 57, 183, 216, 258, 260, 503).

10. Amalgam fillings produce electrical currents which increase mercury vapor release and may have other harmful effects (19, 27, 28, 29, 30, 35, 100, 192, 194). These currents are measured in micro amps, with some measured at over 4 micro amps. The central nervous system operates on signals in the range of nano-amps, which is 1000 times less than a micro amp (28). Negatively charged fillings or crowns push electrons into the oral cavity since saliva is a good electrolyte and cause higher mercury vapor losses (35, 192). Patients with autoimmune conditions like MS, or epilepsy, depression, etc. are often found to have a lot of high negative current fillings (35). The Huggins total dental revision (TDR) protocol calls for teeth with the highest negative charge to be replaced

first (35). Other protocols for amalgam removal are available from international dental associations like IAOMT (153) and mercury poisoned patients organizations like DAMS (447). For these reasons it is important that no new gold dental work be placed in the mouth until at least 6 months after replacement. Some studies have also found persons with chronic exposure to electromagnetic fields (EMF) to have higher levels of mercury exposure and excretion (28, 251c) and higher likelihood of getting chronic conditions like ALS (526) and Alzheimer's (251c) and cancer (546).

11. Mercury from amalgam fillings is transferred to the fetus of pregnant women and children who breast feed at levels usually higher than those of the mother (18, 19, 20, 23, 31, 38, 61, 112, 186, 281). Mercury has an effect on the fetal nervous system at levels far below that considered toxic in adults, and background levels of mercury in mothers correlate significantly with incidence of birth defects and still births (10, 23, 38, 50, 197, 210, 287, 338c, 361). Mercury vapor exposure causes impaired cell proliferation in the brain and organs, resulting in reduced volume for cerebellum and organs and subtle deficiencies (38, 305).

12. Since mercury (all forms) is documented from studies of humans and animals to be a reproductive and developmental toxin (23, 38, 61, 105, 186, 224, 255, 287.305, 381, etc.), mercury can reduce reproductive function and cause birth defects and developmental problems in children (2, 4, 9, 10, 20, 23, 24, 31, 37, 38, 39, 41, 50, 55, 61, 104, 146, 159, 162, 224, 255, 458). Clinical evidence indicates that amalgam fillings lead to hormone imbalances that can reduce fertility (9, 38, 55, 4, 105, 146, 367). Mercury has been found to cause decreased sperm volume and motility, increased sperm abnormalities and spontaneous abortions, increased uterine fibroids/endometritis, and decreased fertility in animals (4, 104, 105, 162) and in humans (9, 10, 23, 31, 37, 105, 146, 159, 395, 433, 27, 35, 38). In studies of women having miscarriages or birth defects, husbands were found to typically have low sperm counts and significantly more visually abnormal sperm (393). It's now estimated that up to 85 per cent of the sperm produced by a healthy male is DNA-damaged (433). Abnormal sperm is also being blamed for a global increase in testicular cancer, birth defects, and other reproductive conditions. Studies indicate an increase in the rate of spontaneous abortions with an increasing concentration of mercury in the fathers' urine before pregnancy (37). Studies have found that mercury accumulates in the ovaries and testes, inhibits enzymes necessary for sperm production, affects DNA in sperm, causes aberrant numbers of chromosomes in cells, causes chromosome breaks, etc.- all of which can cause infertility, spontaneous abortions, or birth defects (10, 31, 35, 296). Subfertile males in Hong Kong were found to have 40% more mercury in their hair than fertile controls. 'Infertile males with abnormal semen' and 'infertile females with unexplained infertility' also had higher blood mercury concentrations than their fertile counterparts. (55). The number of amalgam fillings was found to be an important factor in success of treating male infertility (55c).

Studies in monkeys have found decreased sperm motility, abnormal sperm, increased infertility and abortions at low levels of methyl mercury (162, 365). Astrocytes play a key role in MeHg-induced excitotoxicity (162c). MeHg preferentially accumulates in astrocytes. MeHg potently and specifically inhibits glutamate uptake in astrocytes. Neuronal dysfunction is secondary to disturbances in astrocytes. Co-application of nontoxic concentrations of MeHg and glutamate leads to the typical appearance of neuronal lesions associated with excitotoxic stimulation. MeHg induces swelling of astrocytes. These observations are fully consistent with MeHg-induced dysregulation of excitatory amino acid homeostasis, and indicate that a glutamate-mediated excitotoxic mechanism is involved (162c).

Researcher's advise pregnant women should not be exposed to mercury vapor levels above government health standards (2, 19, 25, 227, 61, 100, 182, 282, 366); currently U.S. ATSDR mercury health MRL of 0.2 mcg/m^3 which is exceeded by any dental work involving amalgam (Section III). Many governments have bans or restrictions on use of amalgam by women of child-bearing age.

13. Mercury and other toxic metals such as copper and lead cause breaks in DNA (4, 38, 41, 42, 197, 272, 296) and also have synergistic effects with x-rays (296). Low non-cytotoxic levels of mercury

induce dose dependent binding of mercury to DNA and significantly increased cell mutations (142, 4) and birth defects (197, 38, 105). In addition to effects on DNA, mercury also promotes cancer in other ways. Mercury depletes and weakens the immune system in many ways documented throughout this paper. A large U.S. Centers for Disease Control epidemiological study, found that those with more amalgam fillings have much higher cancer rates (543) and MS, as well as more chronic health problems.

14. Mercury has been well documented to be an endocrine system disrupting chemical in animals and people, disrupting function of the pituitary gland, hypothalamus, thyroid gland (50, 369, 382, 405, 459, 543b), enzyme production processes (111, 194, 33, 56), and many hormonal functions at very low levels of exposure (9, 105, 146, 210, 312, 369). The pituitary gland controls many of the body's endocrine system functions and secretes hormones that control most bodily processes, including the immune system and reproductive systems (105, 312, 381, 543b). The hypothalamus regulates body temperature and many metabolic processes. Mercury damage thus commonly results in poor bodily temperature control, in addition to many problems caused by hormonal imbalances. Such hormonal secretions are affected at levels of mercury exposure much lower than the acute toxicity effects normally tested. Mercury also damages the blood brain barrier and facilitates penetration of the brain by other toxic metals and substances (311). Low levels of mercuric chloride also inhibit ATPase activity in the thyroid, with methyl mercury inhibiting ATP function at even lower levels (50, 35). Both types of mercury were found to cause denaturing of protein, but inorganic mercury was more potent. These effects result commonly in a reduction in thyroid production (50) and an accumulation in the thyroid of radiation. Toxic metal exposure's adverse influence on thyrocytes can play a major role in thyroid cancer etiology (144). Among those with chronic immune system problems with related immune antibodies, the types showing the highest level of antibody reductions after amalgam removal include thyroglobulin and microsomal thyroid antigens (91).

15. There has been no evidence found that there is any safe level of mercury in the body that does not kill cells and harm body processes (WHO, 183, 189, etc.). This is especially so for the pituitary gland of the developing fetus where mercury has been shown to accumulate and which is the most sensitive to mercury (2-4, 19-24, 30, 31, 36-44, 61, 186).

16. Low levels of mercury and toxic metals have been found to inhibit dihydroteridine reductase, which affects the neural system function by inhibiting transmitters through its effect on phenylalanine, tyrosine and tryptophan transport into neurons (27, 98, 122, 257, 372, 342, 372, 412). This was found to cause severe impaired amine synthesis and hypokinesis. Tetrahydrobiopterin, which is essential in production of neurotransmitters, is significantly decreased in patients with Alzheimer's, Parkinson's, MS, ALS, and autism. Such patients have abnormal inhibition of neurotransmitter production. Such symptoms improved for most patients after administration of R-tetrahydrobiopterin (412), and some after 5-formyltetrahydrofolate, tyrosine (257), and 5-HTP (412).

17. The level of mercury released by amalgam fillings is often more than the levels documented in medical studies to produce adverse effects and above the U.S. government health guidelines for mercury exposure (see previous text).

18. Many studies of patients with major neurological or degenerative diseases have found evidence amalgam fillings may play a major role in development of conditions such as such as Alzheimers (66, 67, 158, 166, 204, 221, 238, 242, 244, 257, 258, 295, 300, 462, 577, 35), ALS (92, 97, 325, 346, 416, 423, 35), MS (102, 163, 170, 183, 184, 212, 229, 285, 291, 302, 324, 326, 537, 35c), Parkinson's (98, 117c, 169, 248, 250, 363, 469, 56, 84, 35), ADD (285e, 461, 160, 504b), etc. Mercury exposure causes high levels of oxidative stress/reactive oxygen species (ROS) (13, 442), which has been found to be a major factor in neurological disease (56, 442). Mercury and quinones form conjugates with thiol compounds such as glutathione and cysteine and cause depletion of glutathione, which is necessary to mitigate reactive damage. Such conjugates are found to be highest in the brain substantia nigra with similar conjugates formed with L-Dopa and dopamine in Parkinson's disease (56). Mercury depletion

of GSH and damage to cellular mitochondria and the increased lipid peroxidation in protein and DNA oxidation in the brain appear to be a major factor in Parkinson's disease (33, 346).

One study found higher than average levels of mercury in the blood, urine, and hair of Parkinson's disease patients (363). Another study (169) found blood and urine mercury levels to be very strongly related to Parkinson's with odds ratios of approximately 20 at high levels of Hg exposure. Increased formation of reactive oxygen species (ROS) has also been found to increase formation of advanced glycation end products (AGEs) that have been found to cause activation of glial cells to produce superoxide and nitric oxide, they can be considered part of a vicious cycle, which finally leads to neuronal cell death in the substantia nigra in PD (424). Another study (145) that reviewed occupational exposure data found that occupational exposure to manganese and copper have high odds rations for relation to PD, as well as multiple exposures to these and lead, but noted that this effect was only seen for exposure of over 20 years.

Mercury has been found to accumulate preferentially in the primary motor function related areas such as the brain stem, cerebellum, rhombencephalon, dorsal root ganglia, and anterior horn motor neurons, which enervate the skeletal muscles (48, 291, 327, 329, 442). Mercury, with exposure either to vapor or organic mercury tends to accumulate in the glial cells in a similar pattern, and the pattern of deposition is the same as that seen from morphological changes (327g, 287a). Though mercury vapor and organic mercury readily cross the blood-brain barrier, mercury has been found to be taken up into neurons of the brain and CNS without having to cross the blood-brain barrier, since mercury has been found to be taken up and transported along nerve axons as well through calcium and sodium channels and along the olfactory path (329, 288, 333, 34). In addition to the documentation showing the mechanisms by which mercury causes the conditions and symptoms seen in ALS and other neurodegenerative diseases, many studies of patients with major neurological or degenerative diseases have found direct evidence mercury and amalgam fillings play a major role in development of neurological conditions such as such as ALS (92, 97, 207, 229b, 305, 325, 327, 416, 423, 442, 468, 470, 520, 35). Mercury penetrates and damages the blood brain barrier allowing penetration of the barrier by other substances that are neurotoxic (20, 38, 85, 105, 162, 301, 311/262). Such damage to the blood brain barrier's function has been found to be a major factor in chronic neurological diseases such as MS (286, 289, 291, 302, 324, 326, 369, 478). MS patients have been found to have much higher levels of mercury in cerebrospinal fluid compared to controls (163, 35c, 139). Large German studies including studies at German universities have found that MS patients usually have high levels of mercury body burden, with one study finding 300% higher than controls (271). Most recovered after mercury detox, with some requiring additional treatment for viruses and intestinal dysbiosis. Studies have found mercury related mental effects to be indistinguishable from those of MS (207, 212, 222, 244, 271, 289, 291, 302, 183, 184, 324, 326, 369, 35c).

Low levels of toxic metals have been found to inhibit dihydroteridine reductase, which affects the neural system function by inhibiting brain transmitters through its effect on phenylalanine, tyrosine and tryptophan transport into neurons (122, 257, 372). This was found to cause severe impaired amine synthesis and hypokinesis. Tetrahydro-biopterin, which is essential in production of nerurotransmitters, is significantly decreased in patients with Alzheimer's, Parkinson's, and MS. Such patients have abnormal inhibition of neurotransmitter production (supplements which inhibit breach of the blood brain barrier such as bioflavonoids have been found to slow such neurological damage).

Clinical tests of patients with MND, ALS, Parkinson's, Alzheimer's, Lupus (SLE), rheumatoid arthritis and autism have found that the patients generally have elevated plasma cysteine to sulphate ratios, with the average being 500% higher than controls (330, 331, 56, 33d), and in general being poor sulphur oxidizers. This means that these patients have insufficient sulfates available to carry out necessary bodily processes. Mercury has been shown to diminish and block sulphur oxidation and thus reducing glutathione levels which is the part of this process involved in detoxifying and excretion of toxics like mercury (33). Glutathione is produced through the sulphur oxidation side of

this process. Low levels of available glutathione have been shown to increase mercury retention and increase toxic effects (111), while high levels of free cysteine have been demonstrated to make toxicity due to inorganic mercury more severe (333, 194, 56, 33d). Mercury has also been found to play a part in inducing intolerance and neuronal problems through blockage of the P-450 enzymatic process (84, 33d). Mercury has been shown to be a factor that can cause rheumatoid arthritis by activating localized CD4+ T-cells which trigger production of immune macrophages and immunoglobulin (Ig) producing cells in joints (405, 513, 514). This has been found to produce inflammatory cytokines Such as IL-1 and TNF that contribute to cartilage and bone destruction. Also, it is documented that the process thus involves free radical/reactive oxygen species effects, and antioxidants have been found to have benefits in treatment (514, 597).

In one subtype of ALS, damaged, blocked, or faulty enzymatic superoxide Dismustase (SOD) processes appear to be a major factor in cell apoptosis involved in the condition (443). Mercury is known to damage or inhibit SOD activity (13, 33, 111, 254).

19. Mercury at extremely low levels also interferes with formation of tubulin producing neurofibrillary tangles in the brain similar to those observed in Alzheimer's patients, with high levels of mercury in the brain (207, 305), and low levels of zinc (363, 43). Mercury and the induced neurofibrillary tangles also appear to produce a functional zinc deficiency in the of AD sufferers (242), as well as causing reduced lithium levels which is another factor in such diseases. Lithium protects brain cells against excess glutamate induced excitability and calcium influx (280, 56).

It has been documented that conditions like depression and other chronic neurological conditions often involve damage and nerve cell death in areas of the brain like the hippocampus, and lithium has been found to not only prevent such damage but also promote cell gray matter cell growth in such areas (280), and to be effective in treating not only depressive conditions but degenerative conditions like Huntington's Disease which are related to such damage.

Also mercury binds with cell membranes interfering with sodium and potassium enzyme functions, causing excess membrane permeability, especially in terms of the blood-brain barrier (155, 207, 311). Less than 1 ppm mercury in the blood stream can impair the blood-brain barrier. Mercury was also found to accumulate in the mitochondria and interfere with their vital functions, and to inhibit cytochrome C enzymes which affect energy supply to the brain (43, 84, 232, 338c, 35). Persons with the Apo-E4 gene form of apolipoprotein E which transports cholesterol in the blood, are especially susceptible to this damage (207, 221, 346), while those with Apo-E2 which has extra cysteine and is a better mercury scavenger have less damage. The majority have an intermediate form Apo-E3. This appears to be a factor in susceptibility to Alzheimer's disease, Parkinson's disease and multiple sclerosis. Ones susceptibility can be estimated by testing for this condition. In many cases (many thousand documented) removal of amalgam fillings and treatment for metal toxicity led to "cure' or significant improvement in health (see Section V). Mercury causes an increase in white blood cells, with more created to try to react to a foreign toxic substance in the body. There is evidence that some forms of leukemia are abnormal response to antigenic stimulation by mercury or other such toxics, and removal of amalgam has led to remission very rapidly in some cases (35, 38, 180, 239).

20. Mercury and methyl mercury impair or inhibit all cell functions and deplete calcium stores (96, 258). This can be a major factor in bone loss of calcium (osteoporosis). Mercury (like copper) also accumulates in areas of the eyes such as the endothelial layer of the cornea and macula and is a major factor in chronic and degenerative eye conditions such as iritis, astigmatism, myopia, black streaks on retina, cataracts, macula degeneration, retinitis pigmentosa, color vision loss, etc. (529). Most of these conditions have been found to improve after amalgam replacement (35, 212, 271, 322, 529, etc.)

1.6 Documented results of removal of amalgam fillings

1. For the week following amalgam removal, body mercury levels increase significantly, depending on protective measures taken, but within 2 weeks levels fall significantly (82, 89). Chronic conditions can worsen temporarily, but usually improve if adequate precautions are taken to reduce exposure during removal. In a study comparing replacement protocols, only the non-rubber dam group showed significant increases in the mercury levels found in plasma and urine after replacement (89a).

Compared to the pre-removal mercury levels in plasma and urine, the levels found 1 year after removal of all amalgam restorations were on average 52% lower in plasma **and** 76% lower in urine (89a).

2. Removal of amalgam fillings resulted in a significant reduction in body burden and body waste product load of mercury (75, 82, 88, 89, 93, 95, 115). Total reduction in mercury levels in blood and urine is often over 80% within a few months (79, 82, 89, 93, 115, 57). On average those with 29 amalgam surfaces excreted over 3 times more mercury in urine after DMPS challenge than those with 3 amalgam surfaces, and those with 45 amalgam surfaces more than 6 times as much mercury (12b).

For the following case studies of amalgam replacement, some clinics primarily replaced amalgam fillings using patient protective measures and supportive supplements, whereas some clinics do something comparable to Hal Huggins total dental revision where in addition to amalgam replacement, patients gold or nickel crowns over amalgam are replaced by biocompatible alternatives, root canals extracted and cavitations checked for and cleaned. There are extensive documented cases (many thousands) where removal of amalgam fillings led to cure or significant improvement of serious health problems such as *periodontal diseases*[8] (tissue inflamation, metal mouth, mouth sores, bone loss, burning mouth, etc.) (8, 35, 40, 46, 57, 60, 62, 75, 78, 82, 94, 95, 100, 115, 133, 192bcf, 212, 222, 233abcdefgh, 271, 313, 317, 321, 322, 341, 376, 525, 532, 538, 551, 552, 572, 583), *oral lichen planus/leukaplakia*[9] (56, 86, 87, 90, 101, 168, 313a) (oral keratosis - pre cancer) (87, 251, 543b), immune system/ *autoimmune*[10] problems (8, 35, 60, 62, 222, 270, 271, 313, 323, 322, 342, 91, 212, 229, 291, 452, 470, 485, 523, 532, 552), multiple chemical *sensitivities*[11] (26, 35, 60, 62, 95, 222, 229, 232, 233, 115, 313, 342, 537, 583), *allergies*[12] (8, 26, 35, 40, 46, 62, 94, 95, 97, 165, 212, 222, 228, 229, 233, 271, 317, 322, 349, 376, 469, 525c, 532, 557, 583), *asthma*[13] (8, 75, 97, 222, 228, 271, 322, 552, 556, 557), chronic headaches/migraines (5, 8, 34, 35, 47f, 62, 95, 185, 212ab, 222, 229, 233abdefgh, 271, 317, 322, 349, 354, 115, 376, 440, 453, 523, 525, 532, 537, 538, 552, 556, 583, 595), epilepsy (5, 35, 309, 229, 386e, 557), tachycardia and *heart problems*[14] (8, 35, 59, 94, 115, 205, 212, 222, 232, 233bcdg, 271, 306, 310, 322, 525c, 554, 556, 557), blood conditions (8, 212, 222, 232, 233, 271, 322, 523, 551, 35, 95), Chron's disease (60, 222, 229, 469, 485), stomach (gastrointestinal) problems (8, 35, 62, 95, 212ab, 222, 228, 229, 233bdg, 271, 317, 322, 440, 469, 525c, 532), *lupus*[15] (12, 35, 60, 113, 222, 233, 323, 537), dizzyness/vertigo (8, 40, 95, 212, 222, 229, 233bcdgh, 271, 322, 376, 453, 525c, 551, 552), joint pain/ arthritis (8, 35, 62, 95, 103, 212ab, 222, 229, 233abcg, 271, 313, 322, 358, 386de, 469, 523, 525c, 538, 551, 552, 556, 557, 583), insomnia (35, 62, 94, 212, 222, 233ag, 271, 317, 322, 376, 525c, 583), *MS*[16] (62, 94, 95, 102, 163, 170, 212, 222, 229, 271, 291, 302, 322, 369, 469, 485, 34, 35c, 229, 523, 532), *ALS*[17] (97, 246, 423, 405, 469, 470, 485, 535, 35),

[8] **Internet:** "http://www.home.earthlink.net/%7Eberniew1/periodon.html".
[9] **Internet:** "http://www.home.earthlink.net/%7Eberniew1/periodon.html".
[10] **Internet:** "http://www.home.earthlink.net/%7Eberniew1/ms.html".
[11] **Internet:** "http://www.home.earthlink.net/%7Eberniew1/cfsfm.html".
[12] **Internet:** "http://www.home.earthlink.net/%7Eberniew1/immunere.html".
[13] **Internet:** "http://www.home.earthlink.net/%7Eberniew1/inflamhg.html".
[14] **Internet:** "http://www.home.earthlink.net/%7Eberniew1/cardio.html".
[15] **Internet:** "http://www.home.earthlink.net/%7Eberniew1/ms.html".
[16] **Internet:** "http://www.home.earthlink.net/%7Eberniew1/ms.html".
[17] **Internet:** "http://www.home.earthlink.net/%7Eberniew1/als.html".

Alzheimer's[18] (62, 204, 251c, 386e, 535, 35), *Parkinson's*[19]/ muscle tremor (222, 248, 228a, 229, 233f, 271, 322, 469, 557, 212, 62, 94, 98, 35), Chronic *Fatigue*[20] Syndrome (8, 35, 47f, 60, 62, 88, 185, 212, 293, 229, 222, 232, 233abcdfgh, 271, 313, 317, 322, 323, 342, 346, 369, 376, 386de, 440, 469, 470, 523, 532, 537, 538, 551, 552, 556, 557, 595), nausea (525c), *neuropathy/paresthesia*[21] (8, 35, 62, 94, 163, 212, 222, 322, 556, 557), muscular/jointpain/*Fibromyalgia*[22] (5, 8, 35, 60, 62, 185, 222, 233bcfg, 293, 317, 322, 346, 369, 440, 469, 470, 523, 527, 532, 538, 552, 94), infertility (9, 35, 38, 229, 367), endometriosis (229, 35, 38, 9), *autism*[23] (601) *schizophrenia*[24] and bipolar disorder (294, 465, 34, 35), memory disorders (8, 35, 94, 212, 222, 322, 437, 440, 453, 552, 557, 595), *depression*[25] (62, 94, 107, 163, 185, 212, 222, 229, 233bcfh, 271, 294, 285e, 317, 322, 376, 386de, 437, 453, 465, 485, 523, 525c, 532, 538, 551, 556, 557, 583, 595, 35, 40), *anger*[26] (212, 233, 102, 557, 35, 62), anxiety & mental confusion (62, 94, 212, 222, 229, 233abcfgh, 271, 317, 322, 440, 453, 525c, 532, 551, 557, 583, 35, 57), *susceptibility to infections*[27] (35, 40, 62, 222, 233cd, 251, 317, 322, 349, 350, 469, 470, 532), antibiotic resistant infection (251), *cancer*[28] (breast, etc./leukemia/oral) (35, 38, 94, 180, 228a, 469, 486, 530, 543b), neuropathy/paresthesia (8, 35, 62, 94, 163, 212, 222, 322, 556, 557), alopecia/hair loss (40, 187, 271, 317, 322, 349, 583), sinus problems (35, 40, 47f, 94, 222, 271, 322, 532, 583), tinnitus (8, 35, 62, 94, 222, 233cdg, 271, 322, 349, 376, 525c), chronic *eye conditions*[29]: inflamation/ iritis/ astigmatism/myopia /cataracts/macula degeneration/retinitis pigmentosa, color vision loss, etc. (35, 222, 233abcg, 271, 322, 440, 529), vision disturbances (8, 35, 62, 212, 233abcg, 271, 322, 525c), *eczema and psoriasis*[30] (62, 168b, 212b, 233c, 322, 323, 385, 342, 375, 408, 459, 525c, 557), *autoimmune thyroiditis*[31] (369, 382, 91), skin conditions (8, 62, 212, 222, 233bc, 322, 525c, 583), urinary/prostrate problems (212, 222), hearing loss (102, 322, 35), candida (26, 35, 404, 537, etc.), PMS (35, 6, 322, etc.), diabetes (35, 369, etc.), etc.

The above over 60,000 cases of cure or significant improvements were not isolated cases of cures; the clinical studies indicated a large majority of most such type cases treated showed significant improvement. Details are available and case histories. For example, one of the clinics (95) replacing amalgams in a large number of patients with chronic conditions had full recovery or significant improvement:

in over 90% of cases for: metallic taste, tender teeth, bad breath, and mouth sores;

in over 80% of cases for: depression, irrational fear, head aches/migraines, irritability, dizziness.

insomnia, bleeding gums, throat irritation, nasal congestion or discharge, muscle tremor, and leg cramps;

in over 70% of cases for: bloating or intestinal cramps, skin reactions, sciatic pain, chest pain, poor memory, urinary disorders, fatigue, poor concentration/ADD, watery eyes;

in over 60% of cases for: allergies, constipation, muscle fatigue, cold hands/feet, heart problems.

A Jerome meter was used to measure mercury vapor level in the mouth, and the average was 54.6 micrograms mercury per cubic meter of air, far above the Government health guideline for mercury

[18] **Internet:** "http://www.home.earthlink.net/%7Eberniew1/alzhg.html".
[19] **Internet:** "http://www.home.earthlink.net/%7Eberniew1/parkins.html".
[20] **Internet:** "http://www.home.earthlink.net/%7Eberniew1/cfsfm.html".
[21] **Informativo:** "Neurological Effects of Mercury Exposure".
[22] **Internet:** "http://www.home.earthlink.net/%7Eberniew1/cfsfm.html".
[23] **Internet:** "http://www.home.earthlink.net/%7Eberniew1/autism.html".
[24] **Internet:** "http://www.flcv.com/autismgc.html".
[25] **Internet:** "http://www.home.earthlink.net/%7Eberniew1/depress.html".
[26] **Internet:** "http://www.home.earthlink.net/%7Eberniew1/damspr4.html".
[27] **Internet:** "http://www.home.earthlink.net/%7Eberniew1/immunere.html".
[28] **Informativo:** "Cancer Connection to Mercury, Toxic Metals, and Dental Cavitations".
[29] **Internet:** "http://www.home.earthlink.net/%7Eberniew1/eyeshg.html".
[30] **Internet:** "http://www.home.earthlink.net/%7Eberniew1/immunere.html".
[31] **Internet:** "http://www.home.earthlink.net/%7Eberniew1/endohg.html".

(217).

Some of the above cases used chemical or natural chelation to reduce accumulated mercury body burden in addition to amalgam replacement. Some clinics using DMPS for chelation reported over 80% with chronic health problems were cured or significantly improved (222, 271, 359).

Other clinics reported similar success. But the recovery rate of those using dentists with special equipment and training in protecting the patient reported much higher success rates than those with standard training and equipment, 97% versus 37 to 88%(435). The Huggins TDR protocol includes testing teeth with metal for level of galvanic current caused by the mixed metals, and removal of the teeth with highest negative galvanic current first (35, 228a). This has been found to improve recovery rate for chronic conditions like epilepsy and autoimmune conditions. Metals are being pushed into the body from negatively charged metal dental work with saliva as electrolyte and the highest charged teeth lose the most metal to the body (35).

Clinical studies have found that patch testing is not a good predictor of success of amalgam removal, as a high percentage of those testing negative also recovered from chronic conditions after replacement of fillings (86, 87, 168, etc.).

The Huggins Clinic using TDR has successfully treated over a thousand patients with chronic autoimmune conditions like MS, Lupus, ALS, AD, diabetes, etc. (35), including himself with the population of over 600 (approximately 85%) who experienced significant improvement in MS. In a large German study of MS patients after amalgam revision, extraction resulted in 85% recovery rate versus only 16% for filling replacement alone (222, 302). Other cases have found that recovery from serious autoimmune diseases, dementia, or cancer may require more aggressive mercury removal techniques than simple filling replacement due to body burden. This appears to be due to migration of mercury into roots & gums that is not eliminated by simple filling replacement. That such mercury (and similarly bacteria) in the teeth and gums have direct routes to the brain and CNS has been documented by several medical studies (34, 325, etc.).

Among those with chronic immune system problems with related immune antibodies, the types showing the highest level of antibody reductions after amalgam removal include glomerular basal membrane, thyroglobulin, and microsomal thyroid antigens (91). TDR and other measures used in metals detox have been found to increase T-cells and immune function in AIDS patients (35).

Swedish researchers have developed a sophisticated test for immune/autoimmune reactions that has proved successful in diagnosing and treating environmentally caused diseases such as lichen planus, CFS, MS, etc. related to mercury and other immunotoxics (60, 313, etc.).

Interviews of a large population of Swedish patients that had amalgams removed due to health problems found that virtually all reported significant health improvements and that the health improvements were permanent (233). (study period 17 years) A compilation of an even larger population found similar results (212, 282). For example 89% of those reporting allergies had significant improvements or total elimination; extrapolated to U.S. population this would represent over 17 million people who would benefit regarding allergies alone.

1.7 Tests for mercury level or toxicity and treatment

1. Feces is the major path of excretion of mercury from the body, having a higher correlation to systemic body burden than urine or blood, which tend to correlate with recent exposure level (6b, 21abd, 35, 36, 79, 80, 183, 278). For this reason many researchers consider feces to be the most reliable indicator of daily exposure level to mercury or other toxics. The average level of mercury in feces of populations with amalgam fillings is as much as 1 ppm and approximately 10 times that of a similar group without fillings (79, 80, 83, 335, 386, 528, 25), with significant numbers of those with several filings having over 10 ppm and 170 times those without fillings (80). For those with several

fillings daily fecal mercury excretion levels range between 20 to 200 μg/day. The saliva test is another good test for daily mercury exposure, done commonly in Europe and representing one of the largest sources of mercury exposure. There is only a weak correlation between blood or urine mercury levels and body burden or level in a target organ (36, 157, 183, 258, 278, 11, 21abd, 6b). Mercury vapor passes through the blood rapidly (half-life in blood is 10 seconds (370)) and accumulates in other parts of the body such as the brain, kidneys, liver, thyroid gland, pituitary gland, etc. Thus blood test measures mostly recent exposure. Kidneys have a lot of hydroxyl (SH) groups which mercury binds to causing accumulation in the kidneys, and inhibiting excretion (503). As damage occurs to kidneys over time, mercury is less efficiently eliminated (11, 36, 57, 183, 216, 258, 260, 503), so urine tests are not reliable for body burden after long term exposure. Some researchers suggest hair offers a better indicator of mercury body burden than blood or urine (279, 21ab), though still not totally reliable and may be a better indicator for organic mercury than inorganic. In the early stages of mercury exposure before major systemic damage other than slight fatigue results you usually see high hemoglobin, hemocrit, alkaline phosphatase, and lactic dehydroganese; in later states you usually see marginal hemoglobin, hemocrit, plus low oxyhemoglobin (35). Hair was found to be significantly correlated with fish consumption, as well as with occupational dental exposure and to be a good medium for monitoring internal mercury exposure, except that external occupational exposure can also affect hair levels. Mercury hair level in a population sampled in Madrid Spain ranged from 1.3 to 92.5 ppm. This study found a significant positive correlation between maternal hair mercury and mercury level in nursing infants. Hair mercury levels did not have a significant correlation with urine mercury in one study (340) and did not have a significant correlation to number of fillings (350). One researcher suggests that mercury levels in hair of greater than 5 ppm are indicative of mercury intoxication.

A new test approved by the FDA for diagnosing damage that has been caused by toxic metals like mercury is the fractionated porphyrin test (260, 35), that measures amount of damage as well as likely source. Mercury blocks enzymes needed to convert some types of porphyrins to hemoglobin and adenosine tri phosphate (ATP). The pattern of which porphyrins are high gives an indication of likely toxic exposure, with high precoproporphyrin almost always high with mercury toxicity and often coproporphyrin.

Provocation challenge tests after use of chemical chelators such as DMPS or DMSA also are effective at measuring body burden (57, 58), but high levels of DMPS can be dangerous to some people - especially those still having amalgam fillings or those allergic to sulfur drugs or sulfites. Many studies using chemical chelators such as DMPS or DMSA have found post chelation levels to be poorly correlated with prechelation blood or urine levels (57, 115, 303), but one study (340) found a significant correlation between pre and post chelation values when using DMPS. Challenge tests using DMPS or DMSA appear to have a better correlation with body burden and toxicity symptoms such as concentration, memory, and motor deficits (290)- with many studies finding a significant correlation between post chelation mercury level and the number of amalgam surfaces (57, 172, 173, 222, 290, 292, 273, 303). On average those with 29 amalgam surfaces excreted over 3 times more mercury in urine after DMPS challenge than those with 3 amalgam surfaces, and those with 45 amalgam surfaces more than 6 times as much mercury (12b). Several doctors use 16 μg/L as the upper bound for mercury after DMPS challenge, and consider anyone with higher levels to have excess body burden (222, 352). However one study (290) found significant effects at lower levels. Some researchers believe DMSA has less adverse side effects than DMPS and prefer to use DMSA for chelation for this reason. Some studies have also found DMSA as more effective at removing mercury from the brain (58). A common protocol for DMSA (developed to avoid redistribution effects) is 50 mg orally every 4 hours for 3 days and then off 11 days.

Another chelator used for clogged arteries, EDTA, forms toxic compounds with mercury and can damage brain function (307). Use of EDTA may need to be restricted in those with high Hg levels. N-acetylcysteine (NAC) has been found to be effective at increasing cellular glutathione levels and

chelating mercury (54). Experienced doctors have also found additional zinc to be useful when chelating mercury (222) as well as counteracting mercury's oxidative damage (43). Zinc induces metallothionein which protects against oxidative damage and increases protective enzyme activities and glutathione which tend to inhibit lipid peroxidation and suppress mercury toxicity (430, 464). Also lipoic acid, LA, has been found to dramatically increase excretion of inorganic mercury (over 12 fold), but to cause decreased excretion of organic mercury (572d) and copper. Lipoic acid has a protective effect regarding lead or inorganic mercury toxicity through its antioxidant properties (572), but should not be used with high copper. Lipoic acid and N-acetylcysteine (NAC) also increase glutathione levels and protect against superoxide radical/peroxynitrite damage, so thus have an additional neuroprotective effect (494a, 521, 524, 572b, 54, 56). Zinc is a mercury and copper antagonist and can be used to lower copper levels and protect against mercury damage. Lipoic acid has been found to have protective effects against cerebral ischemic-reperfusion, excitotoxic amino acid (glutamate) brain injury, mitochondrial dysfunction, diabetic neuropathy (572). Other antioxidants such as carnosine (495a), Coenzyme Q10, Vitamins C & E, gingko biloba, pycnogenol and selenium have also been found protective against degenerative neurological conditions (494, 495e, 444, 237, 597).

2. Tests suggested by Huggins/Levy (35) for evaluation and treatment of mercury toxicity:

(a) hair element test (386) (low hair mercury level does not indicate low body level) (more than 3 essential minerals out of normal range indicates likely metals toxicity)

(b) CBC blood test with differential and platelet count

(c) blood serum profile

(d) urinary mercury (for person with average exposure with amalgam fillings, average mercury level is 3 to 4 ppm; lower test level than this likely means person is poor excreter and accumulating mercury, often mercury toxic (35)

(e) fractionated porphyrin (note test results sensitive to light, temperature, shaking)

(f) individual tooth electric currents (replace high negative current teeth first)

(g) patient questionnaire on exposure and symptom history

(h) specific gravity of urine (test for pituitary function, s.g¿1.022 normal; s.g.¡1.008 consistent with depression and suicidal tendencies) (35).

3. Note: during initial exposure to mercury the body marshals immune system and other measures to try to deal with the challenge, so many test indicators will be high; after prolonged exposure the body and immune system inevitably lose the battle and measures to combat the challenge decrease - so some test indicator scores decline. Chronic conditions are common during this phase. Also high mercury exposures with low hair mercury or urine mercury level usually indicates body is retaining mercury and likely toxicity problem (35). In such cases where (calcium¿ 1100 or ¡ 300 ppm) and low

test mercury, manganese, zinc, potassium; mercury toxicity likely and hard to treat since retaining mercury.

Test results indicating mercury/metals toxicity (35):

(a) white blood cell count ¿7500 or ¡ 4500

(b) hemocrit ¿ 50% or ¡ 40%

(c) lymphocyte count ¿ 2800 or ¡ 1800

(d) blood protein level ¿ 7.5 gm/100 ml

(e) triglycerides ¿ 150 mg % ml

(f) BUN ¿ 18 or ¡ 12

(g) hair mercury ¿ 1.5 ppm or ¡ .4 ppm

(h) oxyhemoglobin level ¡ 55% saturated

(i) carboxyhemoglubin ¿ 2.5% saturated

(j) T lymphocyte count ¡ 2000

(k) DNA damage/cancer

(l) TSH ¿ 1 μg

(m) hair aluminum ¿ 10 ppm

(n) hair nickel ¿ 1.5 ppm

(o) hair manganese ¿ 0.3 ppm

(p) immune reactive to mercury, nickel, aluminum, etc.

(q) high hemoglobin and hemocrit and high alkaline phosphatase (alk phos) and lactic dehydrogenese (LDA) during initial phases of exposure; with low/marginal hemoglobin and hemocrit plus low oxyhemoglobin during long term chronic fatigue phase.

4. Huggins Total Dental Revision Protocol (35):

(a) history questionnaire and panel of tests.

(b) replace amalgam fillings starting with filling with highest negative current or highest negative quadrant, with supportive vitamin/mineral supplements.

(c) extract all root canaled teeth using proper finish protocol.

(d) test and treat cavitations and amalgam tattoos where relevant

(e) supportive supplementation, periodic monitoring tests, evaluate need for further treatment (not usually needed).

(f) avoid acute exposures/challenge to the immune system on a weekly 7/14/21 day pattern.

note: after treatment of many cases of chronic autoimmune conditions such as MS, ALS, Parkinson's, Alzheimer's, CFS, Lupus, Rheumatoid Arthritis, etc., it has been observed that often mercury along with root canal toxicity or cavitation toxicity are major factors in these conditions, and most with these conditions improve after TDR if protocol is followed carefully (35). Also, it is documented that the process is inflammatory involving free radical/reactive oxygen species effects, and antioxidants have been found to have benefits in treatment (514, 597). Other measures in addition to TDR that have been found to help in treatment of MS in clinical experience are avoidance of milk products, get lots of sunlight, supplementation of calcium AEP (448) and alpha lipoic acid (572). Progesterone creme has been found to promote regrowth of myelin sheaths in animals (448c).

1.8 Health effects from dental staff exposure to mercury vapor

1. Dental offices are known to be one of the largest users of inorganic mercury (71b, etc.). It is well documented that dentists and dental personnel who work with amalgam are chronically exposed to mercury vapor, which accumulates in their bodies to much higher levels than for most non-occupationally exposed. Adverse health effects of this exposure including subtle neurological effects have also been well documented that affect most dentists and dental assistants, with measurable effects among those in the lowest levels of exposure. Mercury levels of dental personnel average at least 2 times that of controls for hair (397-401), urine (25d, 57, 64, 69, 99, 123, 124, 138, 171, 173, 222, 249, 290, 362, 397-399), toenails (562), and for blood (124, 195, 253, 249, 397, 563). A Lebonese study (398b) found 25% of dentists had hair mercury levels over 5 ppm and 8% had level over 10 ppm.

Sweden, which voted to phase out use of mercury in fillings, is the country with the most exposure and health effects studies regarding amalgam, and urine levels in dental professionals from Swedish and European studies ranged from 0.8 to 30.1 μg/L with study averages from 3.7 to 6.2 μg/L (124, 172, 253, 64, 68). The Swedish safety guideline for mercury in urine is 5.6 nmol Hg/nmol (11.6 μg/L). Study averages for other countries ranged from 3.3 to 36 microgram/liter (μg/L) (69, 70, 171, 290, 397). A large survey of dentists at the Norwegian Dental Assoc. meeting (171) found that the mean mercury level in 1986 was 7.8 μg/L with approximately 16% above 13.6ug/L, and for 1987

found an average of 8.6 μg/L with approximately 15% above 15.8 μg/L, with women having higher levels than men in general.

A U.S. national sample of dentists provided by the American Dental Association had an average of 5.2 μg/L (70, 290). In that large sample of dentists, 10% of dentists had urine mercury levels over 10.4 μg/L and 1% had levels over 33.4ug/L (290, 25c), indicating daily exposure levels of over 100 μg/day. Researchers from the Univ. of Washington School of Dentistry and Dept. of Chemistry tested a sample of dentists at an annual ADA meeting (230). The study found that the dentists had a significant body burden of mercury and the group with higher levels of mercury had significantly more adverse health conditions than the group with lower exposure. The increased effects in the group with more mercury exposure included mood disturbances, memory deficits, fatigue, confusion, anxiety, and delay in simple reaction time. A Norwegian study compared the occurrence of neurological symptoms among dental assistants likely to be exposed to mercury from work with dental filling material, compared to similar health personnel with no such exposure (596). The dental assistants reported significant higher occurrence of neurological symptoms; psychosomatic symptoms, problems with memory, concentration, fatigue and sleep disturbance. Another study of a group of 194 U.S. male dentists with mean urine mercury level of 3.3 μg/L and 233 female dental assistants with mean urine mercury level of 2.0 μg/L considered effects of polymorphism in brain-derived neurotrophic factor (BDNF) as well as mercury level (290b). The study found significant effects of mercury level on 9 measures of neurologicial deficits for the dentists and on 8 measures of neurological deficits for dental assistants (290b), as well as a significant difference relating to BDNF.

Mercury excretion levels were found to have a positive correlation with the number of amalgams placed or replaced per week, the number of amalgams polished each week, and with the number of fillings in the dentist (171, 172, 173). In one study, each filling was found to increase mercury in the urine approximately 3%, though the relationship was nonlinear and increased more with larger number of fillings (124). Much higher accumulated body burden levels in dental personnel were found based on challenge tests than for controls (303), with excretion levels after a dose of a chelator as high as 10 times the corresponding levels for controls (57, 69, 290a, 303). Autopsy studies have found similar high body accumulation in dental workers, with levels in pituitary gland and thyroid over 10 times controls and levels in renal cortex 7 times controls (99, 363, 38). Autopsies of former dental staff found levels of mercury in the pituitary gland averaged as high as 4,040 ppb. They also found much higher levels in the brain occipital cortex (as high as 300 ppb), renal cortex (as high as 2110 ppb) and thyroid (as high as 28,000 ppb. In general dental assistants and women dental workers showed higher levels of mercury than male dentists (171, 172, 173, 253, 303, 362).

Mercury levels in blood of dental professionals ranged from 0.6 to 57 μg/L, with study averages ranging from 1.34 to 9.8 μg/L (124, 195, 253, 249, 531). A review of several studies of mercury level in hair or nails of dentists and dental workers found median levels were 50 to 300% more than those of controls (38, p287-288, & 10, 16, 178, 531). Dentists have been found to have elevated skeletal mercury levels, which has been found to be a factor in osteoporosis, as well as mercury retention and kidney effects that tend to cause lower measured levels of mercury in urine tests (258). A group of dental students taking a course involving work with amalgam had their urine tested before and after the course was over. The average urine level increased by 500% during the course (63). Allergy tests given to another group of dental students found 44% of them were allergic to mercury (156). Studies have found that the longer time exposed, the more likely to be allergic and the more effects (6b, 154c, 156, 503a). One study found that over a 4 year period of dental school, the sensitivity rate increased 5 fold to over 10%(154c). Another group of dental students had similar results (362), while another group of dental student showed compromised immune systems compared to medical students. The total lymphocyte count, total T cell numbers (CD3), T helper/ inducer (CD4+CD8-), and T suppressor/cytotoxic (CD4-CD8+) numbers were significantly elevated in the dental students compared to the matched control group (408). Similar results have been seen in other studies as well (408).

More than 10,000 dental assistants were exposed to extremely high concentrations of mercury fumes while working with amalgam in dental offices during the 60's, 70's, 80's, and early 90's (575). 25% of them report they often or very often have neurological problems. They have been compared with a group of nurses of the same age. Dental assistants scored much higher than nurses on 4 health problems: tremor/shaking; heart and lung problems, depression, and lack of memory/memory failure.

Urinary porphyrin profiles were found to be an excellent biomarker of level of body mercury level and mercury damage neurological effects, with coproporphyrin significantly higher in those with higher mercury exposure and urine levels (70, 260). Coproporphyrin levels have a higher correlation with symptoms and body mercury levels as tested by challenge test (69, 303), but care should be taken regarding challenge tests as the high levels of mercury released can cause serious health effects in some, especially those who still have amalgam fillings or high accumulations of mercury. Screening test that are less burdensome and less expensive are now available as first morning void urine samples have been found to be highly correlations to 24 hour urine test for mercury level or porphyrins (73).

2. The average dental office exposure affects the body mercury level at least as much as the workers on fillings (57, 64, 69, 123, 138, 171, 173, 303), with several studies finding levels approximately the same as having 19 amalgam fillings (123, 124, 173). Many surveys have been made of office exposure levels (1, 6, 7, 10, etc.) The level of mercury at breathing point in offices measured ranged form 0.7 to over 300 micrograms per cubic meter ($\mu g/m^3$) (120, 172, 253, 249). The average levels in offices with reasonable controls ranged from 1.5 to 3.6 $\mu g/m^3$, but even in Sweden which has had more office environmental controls than others spot levels of over 150 $\mu g/m^3$ were found in 8 offices (172). Another study found spot readings as high as 200 $\mu g/m^3$ in offices with few controls that only used saliva extractor (120). OSHA surveys find 6-16% of U.S. dental offices exceed the OSHA dental office standard of 50 $\mu g/m^3$, and residual levels in equipment sterilizers often exceed this level (454a). Note that the OSHA standard of 50 $\mu g/m^3$ assumes a 40 hour work week exposure period with no other exposures, assumptions which are never met but the standard hasn't been revised based on new toxicity information like those of other agencies. The German workplace mercury standard of 1 $\mu g/m^3$ is almost always exceeded (258). Hursh and coworkers (454b), in a study of five male volunteers, measured absorption of mercury vapor through the forearm skin. On the basis of their measurements, and exposure assumptions comparable to the OSHA air concentration of 50 $\mu g/m^3$, (and a skin area of 18,000 cm^2), these investigators calculated a mean uptake of 10.4 μg/day mercury by this route during an 8-hour period

The U.S. ATSDR mercury vapor exposure MRL for chronic exposure is much lower, 0.2 $\mu g/m^3$ (217) (giving approximately 4 μg/day exposure), similar to U.S. EPA and Health Canada guidelines (2, 209). Thus most office mercury levels were found to far exceed the U.S. guidelines for chronic mercury exposure.

Use of high speed drill in removal or replacement has been found to create high volume of mercury vapor and respirable particles, and dental masks to only filter out about 40% of such particles (219, 247). Amalgam dust generated by high speed drilling is absorbed rapidly into the blood through the lungs and major organs such as the heart receive a high dose within minutes (219a, 395c, 503c). This produces high levels of exposure to patient and dental staff and common adverse health efffects. Use of water spray, high velocity evacuation and rubber dam reduce exposure to patient and dental staff significantly, as seen in previous discussion. In addition to these measures researchers also advise all dental staff should wear face masks and patients be supplied with outside air (120, 153). Some studies note that carpeting and rugs in dental offices should be avoided as it is a major repository of mercury (6, 7, 21d, 71b, 188, 395c, 503) For office's using an aspirator, at the dentist's breathing zone, mercury vapor concentrations of ten times the current occupational exposure limit of 25 microg/m^3 were recorded after 20 minutes of continuous aspirator operation (219). A build up of amalgam contamination within the internal corrugated tubing of the aspirator was found to be the main source of mercury vapor emissions followed by particulate amalgam trapped within the vacuum motor. As the vacuum motor heated up with run time, mercury vapor emissions increased. It was

found that the bacterial air exhaust filter (designed to clean the contaminated waste air entering the surgery) offered no protection to mercury vapor. Use of such measures along with a Clean-UpTM aspirator tip was found to reduce exposure to patient and staff approximately 90%(397).

3. Dentists were found to score significantly worse than a comparable control group on neurobehavioral tests of motor speed, visual scanning, and visuomotor coordination (69, 70, 123, 249, 290ab, 395, 531, 563, 1b), concentration, verbal memory, visual memory (68, 69, 70, 249, 290ab, 395, 531, 1b), and emotional/mood tests (70, 249, 290a, 395, 563, 1b). Test performance was found to be proportional to exposure/body levels of mercury (68, 70, 249, 290ab, 395, 1b). Significant adverse neurobehavioral effects were found even for dental personnel receiving low exposure levels (less than 4 μg/l Hg in urine) (70). This study was for dental personnel having mercury excretion levels below the 10^{th} percentile of the overall dental population. Such levels are also common among the general population of non-dental personnel with several fillings. This study used a new methodology which used standard urine mercury levels as a measure of recent exposure, and urine levels after chelation with a chemical, DMPS, to measure body burden mercury levels. Thirty percent of dentists with more than average exposure were found to have neuropathies and visuographic dysfunction (395). Mercury exposure has been found to often cause disability in dental workers (230b, 395c, 503, 504a, etc.)

Chelators like DMPS have been found after a fast to release mercury from cells in tissue to be available for excretion. This method was found to give enhanced precision and power to the results of the tests and correlations. Even at the low levels of exposure of the subjects of this study, there were clear demonstrated differences in test scores involving memory, mood, and motor skills related to the level of exposure pre and post chelation (70). Those with higher levels of mercury had deficits in both memory, mood, and motor function compared to those with lower exposure levels. And the plotted test results gave no indication of there existing a threshold below effects were not measurable. Mood scores including anger were found to correlate more strongly with pre chelation urine mercury levels; while toxicity symptoms, concentration, memory (vocabulary, word), and motor function correlated more strongly with post-chelation mercury levels. Another study using DMPS challenge test found over 20 times higher mercury excretion in dentists than in controls, indicating high body burden of mercury compared to controls (491).

Many dentists have been documented to suffer from mercury poisoning (6f, 71, 72, 74, 193, 246, 247, 248, 369, 531) other than the documented neurological effects, such as chronic fatigue, muscle pains, stomach problems, tremors, motor effects, immune reactivity, etc. One of the common effects of chronic mercury exposure is chronic fatigue due to immune system overload and activation. Many studies have found this occurs frequently in dentists and dental staff along with other related symptoms - lack of ability to concentrate, chronic muscular pain, burnout, etc. (249, 369, 377, 378, 490, 531, 1b). In a group of dentists and dental workers suffering from extreme fatigue and tested by the immune test MELISA, 50% had autoimmune reaction to inorganic mercury and immune reactions to other metals used in dentistry were also common (369). Tests of controls did not find such immune reactions common. In another study nearly 50% of dental staff in a group tested had positive autoimmune ANA titers compared to less than 1% of the general population (35).

One dentist with severe symptoms similar to ALS improved after treatment for mercury poisoning (246), and another with Parkinson's disease recovered after reduction of exposure and chelation (248). Similar cases among those with other occupational exposure have been seen. 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 (99, 193). A recent study in Scotland found similar results (531). Other studies reviewed found increased rates of brain cancer and allergies (99, 193, 328). Swedish male dentists were found to have an elevated standardized mortality ratio compared to other male academic groups (284). Dental workers and other workers exposed to mercury vapor were found to have a shortening of visual evoked potential latency and a decrease in amplitude, with magnitudes correlated with

urine excretion levels (190). Dentists were also found to have a high incidence of radicular muscular neuralgia and peripheral sensory degradation (190, 395, 490). In one study of dentists and dental assistants, 50% reported significant irritability, 46% arthritic pains, and 45% headaches (490a), while another study found selective atrophy of muscle fibre in women dental workers (490b). In a study in Brazil (492a), 62% of dental workers had urine mercury levels over 10 mg/L, and indications of mild to moderate mercury poisoning in 62% of workers. The most common problems were related to the central nervous system. A recent study in Turkey (492b) found the dental staff group had higher whole blood (B-Hg) and urine (U-Hg) Hg levels than the control group. The mean B-Hg value was 2.18 nmol/l and U-Hg was 1.17 nmol/mmol creatinine. U-Hg had an inverse relationship with logical memory (in WMS-R test) and total retention score (in VTMP test), and a positive relationship with increased scores of Anxiety and Psychoticism (in SCL-90-R).

4. Both dental hygienists and patients get high doses of mercury vapor when dental hygienists polish or use ultrasonic scalers on amalgam surfaces (240, 400, 503c). Pregnant women or pregnant hygienist especially should avoid these practices during pregnancy or while nursing since maternal mercury exposure has been shown to affect the fetus and to be related to birth defects, SIDS, etc. (10, 23, 31c, 37, 38, 110, 142, 146, 401, 19, 31, 50). Amalgam has been shown to be the main source of mercury in most infants and breast milk, which often contain higher mercury levels than in the mother's blood (20, 61, 112, 186, 287). Because of high documented exposure levels when amalgam fillings are brushed (182, 222, 348) dental hygienist are advised not to polish dental amalgams when cleaning teeth. Face masks worn by dental workers filter out only about 40% of small dislodged amalgam particles from drilling or polishing, and very little mercury vapor (247). Dental staff have been found to have significantly higher prevalence of eye problems, conjunctivitis, atopic dermatitis, and contact urticaria (247, 156, 74). Finnish dental staff have the highest occupational risk of contact dermatitis with 71% affected over time (247b) with plastics, rubber, and mercury the most common causes of sensitization.

Korean dental technicians have a high incidence of contact dermatitis, with dental metals the most common sensitizers. Over 25% had contact dermatitis with over 10% sensitive to 5 metals, cromium, mercury, nickel, cobalt, and palladium (247c). Another study found a high prevalence of extrapyramidal signs and symptoms (tremor) in a group of male dental technicians working in a state technical high school in Rome (247d).

An epidemiological survey conducted in Lithuania on women working in dental offices (where Hg concentrations were ¡ 80 $\mu g/m^3$) had increased incidence of spontaneous abortions and breast pathologies that were directly related to the length of time on the job (277a). A large U.S. survey also found higher spontaneous abortion rate among dental assistants and wives of dentists (193), and another study found an increased risk of spontaneous abortions and other pregnancy complications among women working in dental surgeries (277b). A study of dentist and dental assistants in the Netherlands found 50% higher rates of spontaneous abortions, stillbirths, and congenital defects than for the control group (394), with unusually high occurrence of spina bifida.

A study in Poland also found a significant positive association between mercury levels and occurrence of reproductive failures and menstrual cycle disorders, and concluded dental work to be an occupational hazard with respect to reproductive processes (401).

5. Body burden increases with time and older dentists have median mercury urine levels about 4 times those of controls, as well as higher brain and body burdens (1, 34, 68-74, 99), and poor performance on memory tests (68, 69, 70, 249, 290) Some older dentists have mercury levels in some parts of the brain as much as 80 times higher than normal levels (14, 34, 99). Dentists and dental personnel experience significantly higher levels of neurological, memory, musculoskeletal, visiomotor, mood, and behavioral problems, which increase with years of exposure (1, 34, 68-73, 88, 123, 188, 246, 247, 248, 249, 290,, 395). Even dental personnel with relatively low exposure (urine Hg¡4 $\mu g/l$) were found to have significant neurological effects (290) and was found to be correlated with body

burden of mercury. Most studies find dentists have increased levels of irritability and tension (1, 490, 504b), high rates of drug dependancy and disability due to psychological problems (15, 1b), and higher suicide rates than the general white population (284, 493, 1b), but one study found rates in same range as doctors.

6. Female dental technicians who work with amalgam tend to have increased menstrual disturbances (275, 401, 10, 38), significantly reduced fertility and lowered probability of conception (10, 24, 38, 121), increased spontaneous abortions (10, 31, 38, 277, 433), and their children have significantly lower average IQ compared to the general population (1, 279, 541, 38, 110). Populations with only slightly increased levels of mercury in hair had decreases in academic ability (3). Effects are directly related to length of time on the job (277). The level of mercury excreted in urine is significantly higher for female dental assistants than dentists due to biological factors (171, 172, 173, 247, 124a). Several dental assistants have been diagnosed with mercury toxicity and some have died of related health effects (32, 245, 246, 247, 248). From the medical register of births since 1967 in Norway, it can be seen that dental nurse/assistants have a clearly increased risk of having a deformed child or spontaneous abortion (433). Female dentists have increased rates of spontaneous abortion and perinatal mortality (193, 38, 10, 433)), compared to controls. A study in Poland found a much higher incidence of birth defects among female dentist and dental assistants than normal (10). A chronically ill dental nurse diagnosed with mercury sensitivity recovered after replacement of fillings and changing jobs (60), and a female dentist recovered from Parkinson's after mercury detox (248). Some studies have found increased risk of lung, kidney, brain, and CNS system cancers among dental workers (14, 34, 99, 143, 283).

7. Many homes of dentists have been found to have high levels of mercury contamination used by dentists bringing mercury home on shoes and clothes (188).

1.9 Scientific Panel and Government Bodies That Have Found Amalgam Fillings Unsafe

1. A World Health Organization Scientific Panel concluded that there is no safe level of mercury exposure (183, 189, 208). The Chairman of the panel, Lars Friberg stated that "dental amalgam is not safe for everyone to use" (208, 238). A study of dental personnel having very low levels of mercury excretion found measurable neurological effects including memory, mood, and motor function related to mercury exposure level as measured by excretion levels (290). and found no threshold level below which effects were not measurable. Other studies have found measurable effects to the immune, cardiovascular, hormonal, and reproductive systems from common levels of exposure (Section IV). Studies have found significant measurable adverse health effects at levels far below current government regulatory levels for mercury (290).

2. In 1987 the Federal Dept. of Health in Germany issued an advisory warning against use of dental amalgam in pregnant women (61). Most major countries other than the U.S. have similar or more extensive bans or health warnings regarding the use of amalgam, including Canada (209), Great Britain, France, Austria, Norway (435), Sweden (164), Switzerland (536), Italy (434), Japan (536), Australia (573), New Zealand, etc. Mercury fillings for youth are already banned or restricted in a host of first-world countries, including Germany, Sweden Denmark and Austria. In Japan and Switzerland, dental schools have stopped teaching amalgam use as the primary source of dental care (536). A Swedish National Mercury Amalgam Review Panel and a similar Norwegian panel found that "from a toxicological point of view, mercury is too toxic to use as a filling material" (164, 435). A Swedish medical panel unanimously recommended to the government "discontinuing the use of amalgam as a dental material" (282). A futher review also recommended banning amalgam use (282b). Both countries have banned use of amalgam in dentistry (435).

Amalgam has been found to be the largest source of mercury in sewers and most sewer systems

have dangerous levels of mercury. Thus installation of an approved amalgam-separating apparatus in dental clinics is now mandatory in most countries with advanced medical systems - for example, Switzerland, Germany, Sweden, Denmark, and Canada.

A major amalgam manufacturer, Caulk Inc., advises that amalgam should not be used as a base for crowns or for retrograde root fillings as is commonly done in some countries (387). Other manufacturers have similar warnings. U.S. EPA found that removed amalgam fillings are hazardous and must be sealed airtight and exposed of as hazardous waste (214). Most European countries require controls on dental waste amalgam emissions to sewers or air. A Canadian Government study for Health Canada concluded that any person with any number of amalgam fillings receives exposure beyond that recommended by the USPHS Standard (209). Many of those researching amalgam related health effects including several very prominent scientists have concluded that the health effects are widespread and serious so that mercury should not be used as a filling material (1, 18, 19, 20, 36, 38, 57, 60, 61, 88, 94, 99, 115, 148, 153, 164, 170, 183, 208, 209, 210, 212, 222, 227, 236, 238, 282, 541, etc.).

3. The Legislature of the State of California passed a law, Proposition 65, that requires all dentists in the state to discuss the safety of dental materials with all patients and to post the following warning about use of amalgam on the wall of their office: "This office uses amalgam filling materials which contain and expose you to a chemical known to the State of California to cause birth defects and other reproductive harm". Maine and New Hampshire also require such warnings (542).

4. The use of mercury amalgams has been banned for children and women of child-bearing age or put on a schedule for phase out by several European countries. The use of amalgam is declining in Europe and Germany's largest producer of amalgam has ceased production, The director of the U.S. Federal program overseeing dental safety advises against using mercury amalgam for new fillings.

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