
**TREAT AUTISM
LOGICALLY, EFFECTIVELY
AND
INEXPENSIVELY**



Booklet 2

Neurotoxic Metals

affecting

AUTISM / ASPERGER SYNDROME/ ADHS

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INTRODUCTION

To confirm a suspected metal intoxication and the degree of exposition, we need laboratory diagnostics. By comparing patient history information with laboratory test results, we are in a good position to select the most meaningful treatment. By carefully evaluating all information, we save money. Since insurances don't consider chronic intoxication as a problem (yet), we have to be concerned about people's budgets. Good doctors do that.

Some laboratories give kick-backs to referring doctors i.e. the more tests a doctor 'prescribes', the more income he/she acquires. We are against this. No doctor should be 'bought' to order laboratory tests, or have financial gain from ordering specific tests. A good doctors request tests only to confirm (or rule out) a diagnostic suspicion.

Good analytical work is rewarding. Questionable marketing strategies are not needed to survive in a highly competitive market. Micro Trace Minerals GmbH of Germany and Trace Minerals International of Boulder, Colorado provide one set of prices to doctors and patients alike. These prices are kept at a minimum, because we believe that patients should be able to afford *necessary* diagnostics. Good doctors get sufficient income from providing patient treatment and care.

Smart parents can do a lot for their children. A good mother or grandmother generally has an innate knowledge about a child's physical and emotional need, and many parents have learned natural health care methods from their parents to treat common health problems such as cuts, colds, coughs and more. It is not unusual that a caretaker knows more about the curative powers of herbal medicines and nutritional foods than his physician. If therapists and parents are able to communicate knowledge, children will benefit.

The internet is a great source of knowledge, but it also is a great collector of garbage information. People unfamiliar with a given subject will find it difficult to select good from bad. Clever advertisements can attract well-meaning and anxious parents to questionable remedies, which maybe useless or even counter productive for treatment. A seemingly cheap remedy turns out expensive when taken for a long time, without gain.

All sorts of pharmaceuticals can be bought via the internet. Be careful when wild promises are made, they are usually unfounded. Furthermore, pharmaceuticals or nutritional supplements sold on the internet may not be subjected to the same quality control as demanded by governing agencies.

Synthetic chelating agents, also called antidotes, are metal-binding chemicals, which have been used for the treatment of acute poisonings for decades. These antidotes are prescription items. Internet offers may be more inexpensive, but the chelating agents may be of inferior quality.

Chelation is not for self-medication. While a variety of ailments are linked to chronic metal overexposure, chelation therapy has achieved remarkable results in the treatment of neurological and other disorders. But chelation treatments must be carefully scheduled and need to be medically supervised.

If your child's problem is linked to a toxic metal exposure, read on and consult your paediatrician or a physician knowledgeable in clinical metal toxicology about patient care. If you don't find one in your area, contact us. We will find you a good doctor.

GENERAL INFORMATION ABOUT TOXIC METALS

All metals are toxic if present in excess, but certain metals are strongly linked to the development of neurological disorders. Metals such as lead or mercury are known to cross the placental barrier. Research has documented that a fetus can get significant exposure to toxic substances through maternal blood and across the placenta, with fetal levels of toxic metals often being higher than that of maternal blood.^{1 2}

Exposure to neurotoxins can occur prenatally, and depending on the time and amount of exposure, results can be severe and in some cases devastating. The human brain forms and develops over a long period of time compared to other organs, with neuron proliferation and migration continuing in the postnatal period. The blood-brain barrier is not fully developed until the middle of the first year of life and thus, the internal protection from environmental toxins is inadequate.³

While breast-feeding is considered superior to bottle feeding of cow's milk and other substitute foods, breast-fed infants have been found to get significant exposure to toxics, such as mercury and organochlorine compounds through exposed mothers.⁴

Food is a potential source of toxins. In China, feeding of mashed fish to infants is customary among well-to-do families. Unfortunately, this highly nutritious food is nowadays often loaded with toxic metals. Acute symptoms of mercury or arsenic exposure caused by contaminated fish are no longer unusual in Asian pediatric clinics. In addition, unsafe drinking water can be a source of exposure for the nursing mother and the nursed infant.⁵

Considering all this, it is unlikely that an infant reaches 2 years of age -the time when the blood brain barrier is fully developed- without accumulating some toxins in his/her body and brain.

While booklet Nr. 1 concerned itself with the genetic pathway relating to the body's ability to naturally detoxify, this booklet Nr. 2 covers the health effects of the neurotoxic elements, which are known to influence brain health. Also listed are those elements known to act as a defense against metal intoxication.

It is important to realize that the human body needs to be in balance. Through homeostasis, our system is able to maintain a relatively stable internal condition that is necessary for health.

All metals need to in balance. If one metal is deficient, another potentially toxic one is able to upset the tilted balance even more by finding its way into cells. For instance,

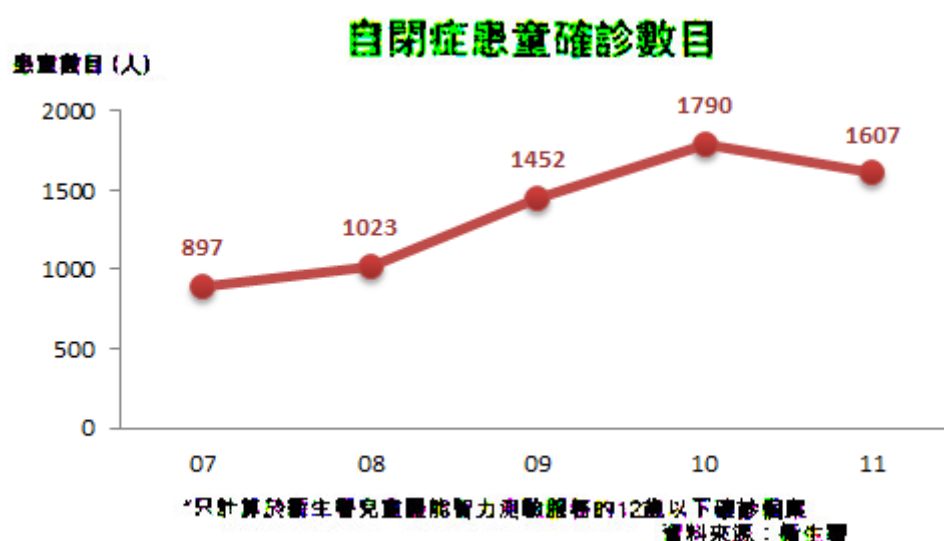
too much iron imbalances zinc, copper or manganese and vice versa. Too much lead disturbs the iron metabolism, resulting in anemia. When an iron-anemia is present, lead and other toxins can take over more easily. This vicious cycle must be interrupted, and the sooner we act, the quicker healing can take place.

Much research has concerned itself with mercury and selenium. These metals are interactively linked, and an insufficient supply of selenium can increase the mercury uptake. Once again, this indicates how important it is to keep a healthy balance.

Human biochemistry is complicated and simple at the same time. If we supply missing nutrients, toxins can be replaced. This takes knowledge and patience. Most importantly, it does not have to be expensive.

Human beings have slightly individual biochemistries, and while we all need essential minerals and trace elements for good health, no one has a need for neurotoxins. Furthermore, people have different tolerance levels and a nutritionally deprived body is more sensitive and reactive towards environmental toxins. Unfortunately, industrial and environmental changes have dramatically increased human exposure to toxins while nutritional inadequacies affect an increasing population.

Dr. Paul Lam of Hong Kong reports a tremendous increase in heavy metal intoxication among infants and sees 'astronomical toxic levels in the urine of children and adults.' According to the Chinese government, Autism has doubled in a span of 7 years as can be seen from this chart, submitted by Dr. Lam.



Starting in 2007, a sharp increase was noted until 2010. The trend did not continue in 2011.

Toxins affect children the most, simply because their metabolism is much more active greater than that of adults. As a result, metal uptake is greater in children than adults, which also means that we need to support the young body's biochemistry with important vital nutrients. If we are be able to provide nutritional balance, we support

the child physically and mentally. As the renowned biochemist and psychiatrist Dr. Carl C Pfeiffer stated, elemental balance creates mental balance.⁶

RESEARCH CORRELATING METALS AND ASD:

HAIR ANALYSIS, TOXIC METALS AND SEVERITY OF ASD SYMPTOMS

In cooperation with researchers of Cairo University, Egypt, Beni-Suef University, Egypt and the National Research Center of Egypt, Associate Professor Dr. Omnia Raffat and E.Blaurock-Busch compared the toxic metal content of hair of autistic vs. nonautistic children. The autistic group showed elevated hair levels for aluminum, antimony, arsenic, cadmium, nickel and lead. Psychiatric evaluation showed a significant positive correlation between lead and verbal communication and general impression. In addition, there was a significant negative correlation between zinc and fear and nervousness.

The researchers concluded that heavy metals play a role in the development of ASD. In combination with an inadequate nutritional status, the toxic metal effects increase along with the severity of symptoms.⁷

HAIR AND URINE ANALYSIS, PAST AND IMMEDIATE TOXIC METAL EXPOSURE AND SEVERITY OF ASD SYMPTOMS

Through laboratory diagnostics, the same group of researchers examined past and present environmental exposures. By assessing a spectrum of trace elements and heavy metals in hair and urine of both autistic and control groups, various environmental factors known to contribute to the genesis of autistic spectrum disorder were evaluated. By comparing the ASD Group to the Control Group, the researchers found a statistically significant difference in the hair and urine levels of the neurotoxic elements aluminum, mercury and lead.⁸

TOXINS IN HAIR AND URINE OF INDIAN CHILDREN WITH PHYSICAL AND MENTAL DISORDERS

Prof. Chris Busby and researchers at the University of Ulster, UK in cooperation with E.Blaurock-Busch evaluated if the increase in congenital birth anomalies and cancer seen in Fallujah, Iraq could be correlated with exposure to depleted uranium and other potentially toxic metals. Excessively high levels of aluminium and mercury were found in the hair of mothers along with elevated uranium hair levels. Interestingly, the hair of mothers showed higher levels than the fathers. Soil and water samples showed the presence of enriched uranium, raising the question about the characteristics and composition of weapons employed in that area. Results also documented that hair and urine mineral analysis results are supportive of each other, and are thus both useful diagnostic tools in chelation therapy.⁹

TOXINS IN HAIR AND URINE OF PUNJAB CHILDREN WITH PHYSICAL AND MENTAL DISORDERS

This research documented high levels of toxic metals in the hair and urine of Indian children with physical and mental disorders. Of 115 children aged 12 and younger, 88% showed uranium levels that exceeded the reference range for hair. High

manganese was found in 87% of the children, and lead levels exceeded reference ranges for children in 55% of the test group. This indicates past exposure. The test results of urine before chelation were supportive of hair. The researchers also confirmed the long term exposure with a DMSA challenge. The chelating agent DMSA (Dimercapto succinic acid) was well tolerated by the test group, and urine concentration after chelation supported the lead overexposure as previously found in the hair and the unchallenged urine.¹⁰

<http://www.la-press.com/metal-exposure-in-the-children-of-punjab-india-article-a2156>

Our Punjab study alerted university and governmental researchers. In 2011, the Bhabha Atomic Research Centre and other research faculties tested uranium in soil and water. Reported groundwater levels, measured at 644mcg/L far exceeded the EPA guideline of 30mcg/L. For details, read:

<http://www.tribuneindia.com/2011/20111017/punjab.htm#4>

ALUMINUM (AL) - TOXIC OR HARMLESS?

Chemically speaking, aluminum is a light metal. It occurs naturally in foods and the amount found in plants is generally higher than that in animal foods. In the case of plants, the level of aluminium is related to local soil and atmospheric conditions.

Aluminum is used to make beverage cans, pots and pans, airplanes, siding and roofing, and foil. Powdered aluminum metal is often used in explosives and fireworks. Aluminum is found in consumer products including antacids, astringents, buffered aspirin, food additives, antiperspirants and a number of cosmetics.

Antacids contain about 300–600 mg aluminum hydroxide (which is approximately 104–208 mg of elemental aluminum) per tablet, capsule, or 5 milliliter (mL) liquid dose. Some of this is taken up into the bloodstream.

Buffered aspirin may contain 10–20 mg of aluminum per tablet, and Vaccines may contain about 0.85 mg/dose.¹¹

ALUMINUM IN FOOD

In the 1960s and 1970s, estimates of the daily intake of aluminium ranged in the published literature from 1.53 to 160 mg/person/day (Sorensen et al., 1974). In 1966, Tipton analysed aluminium intake and excretion of two subjects for 30 days and found that the mean balances were 0.000gm and minus 0.024 g, meaning aluminium is easily excreted.

The major contributors of dietary aluminum are grains and grain products, dairy products (i.e. milk, cheese and yoghurt), desserts and beverages. Consumption of other foods containing elevated aluminum levels (e.g. spices and herbs, pickled cucumbers) can also dramatically increase dietary aluminum intakes.¹²

Aluminum Concentration in Foods

Fresh vegetables 5-9.5 ppm (=mg/kg or mcg/g)

Cow's milk 0.4-0.8 mg/l

Muscle meat and organ meat 0.2-0.6 ppm

The Al content of daily food intake can vary considerably and the daily intake may fluctuate from 2 mg to over 100 mg per day. Aluminum cooking utensils, salts, food additives, antacids, anti-diarrhea medication, cosmetics, and a multitude of pharmaceutical preparations are blamed for the increase in Al exposure.

Finally it is important to recognize that use of certain aluminum-containing non prescription drugs (e.g. Antacids) can increase daily aluminum intakes by a factor of 10 to 100 (Havas & Jaworski, 1986).

ALUMINUM AND HEALTH

Aluminum is found in small quantities in human and animal tissues, in blood and urine, yet there is no evidence that this element is essential for any metabolic function in humans or animals

Because intestinal absorption was considered to be poor, Al was not considered a health problem for a long time. Recent research increasingly points to the danger of Al overload and modern habits contribute to this problem. Dr. Henry Schroeder, a well known American researcher, stated that the tissue of modern man contains considerably more Al than previous generations, largely because Al compounds are commonly used in the food processing industry.

Animal experiments done in 1942 indicated that small quantities of Al cause electrical stimulation of the brain, and can induce epileptic seizures. The injection of Al salts caused senile dementia in animals, and exacerbated symptoms of Alzheimer's disease. Animal studies from the University of Toronto, Canada, showed that injections of Aluminum salts caused learning disabilities in cats. Dr. David Shore, medical researcher at Elizabeth Hospital, Washington, DC, reported, that the brain cells of Alzheimer's patient contained 4 to 6 times the amount of Al normally found in healthy brains.

Despite the fact that the major part of Al is excreted by the body, medical research reveals that excess Al is deposited in lungs, kidneys, thyroid, and brain. Laboratory tests found that when cerebral tissue comes into contact with Al salts, symptoms of poisoning occur. Tests done on a worker in the Al industry who suffered from advanced encephalopathy, produced Al concentration 20 times above normal.

The European Food Safety Authority (EFSA) states that aluminum is accumulative in human tissue and that aluminum has shown neurotoxicity in patients undergoing dialysis which chronically exposed them to high concentrations of aluminum. The EFSA has established a Tolerable Weekly Intake (TWI) of 1mg/kg body weight per week for aluminum. However, assessments of the daily dietary exposure to aluminum in the general population of several European countries showed that the TWI of 1mg/kg bw/week is no longer realistic. The assessment showed that an average TWI

of 2.3mg/kg bw/week for most European countries, indicating that the dietary intake of aluminum intake has increased more than twofold.

While the human body stores between 30 mg and 150 mg, experiments with rats have not produced any deficiency symptoms when fed an aluminum-free diet.

Approximately 50% of the body burden is in the skeleton and 25% in the lungs. With age, aluminum levels increase, possibly due to the inhalation of al-containing air and dust. Aluminum levels in bone tissue range from 5 to 10mg/kg. Since Al is easily eliminated by the digestive and urinary tract, it has been considered harmless, until animal experiments proved that elevated Al ingestion considerably increases the risk of sodium fluoride poisoning.

People with kidney disease have a greater tendency to store aluminum in their bodies. The kidney disease causes less aluminum to be removed through the renal system, and studies indicate that some of these people developed bone or brain diseases that may be linked to the excess intake of aluminum.¹³

Symptoms of Aluminum Overload

*Constipation, colic, nausea

*Senile dementia, senility

*Gastrointestinal irritation

*Behavioral changes

*Loss of appetite

*Ataxia

*Local numbness

*Excessive perspiration

*Loss of energy

*Slurred speech

ALUMINUM IN VACCINES

Many vaccines contain aluminum as an adjuvant. An adjuvant is a substance that boosts the ability of a vaccine to induce an immune response. It acts locally at the site of injection, as a signal to the immune system, drawing a heightened response to the injected vaccine. Ironically, without adjuvants we would need a larger dose of the vaccine to induce an immune response.

Aluminum in vaccines is handled by the body quite differently than the aluminum in intravenous solutions comes from studies looking at the intramuscular injection of aluminum-containing adjuvants into rabbits. Rather than entering the blood stream directly and accumulating in tissues, as with intravenously injected aluminum, intramuscularly injected aluminum-containing adjuvants are first dissolved by organic acids in the interstitial fluids, and are then rapidly eliminated.¹⁴

If that is the case, we don't need to worry about aluminum and vaccination. Time will tell. In the meantime and at my recommendation and risk, my granddaughter, at age 4 ½ has not been vaccinated- and I do understand the risk and responsibility I carry.

ALUMINUM AND CHILDREN

We do not know if aluminum will cause birth defects in animals or people. However, very young animals appeared weaker and less active in their cages and some

movements appeared less coordinated when their mothers were exposed to large amounts of aluminum during pregnancy and while nursing. In addition, aluminum also affected the animal's memory. These effects are similar to those that have been seen in humans.

It is estimated that the daily dietary intake ranges from about 2 to 6 mg/day for children and from about 6 to 14 mg/day for teenagers and adults.¹⁵ Most aluminum ingested with food, water, and medicines leaves the body quickly in the feces, and much of the aluminum that does enter the bloodstream will be excreted in the urine.

In the presence of leaky gut syndrome, Aluminum will more readily find its way into the blood and when the renal system is impaired, aluminum will be retained.

The German Environmental Protection Agency has recommended a urine reference value of 15mcg/l, but higher levels are seen after ingestion of aluminum-rich food and drink such as tea or acidic fruit juices in aluminum cans or aluminum-lined containers, however high excretion levels may only be due to the recent aluminum ingestion and thus only be present temporarily,¹⁶ not reflection a tissue overload.

In 2009, the author statistically evaluated the aluminum concentration of 1935 unchallenged urine samples i.e. no chelation agent was used on this 1935 urine samples. The mean concentration was 20mcg/l.

At the same time, the evaluation of 266 unchallenged urine sample of children <12 years of age, showed a mean aluminum concentration of 35mcg/l, greatly exceeding the mean concentration of urine samples from adults. This suggests that the daily aluminum intake of children is greater than that of adults. We do not know how a long term exposure of relatively low amounts affects a child's physical and intellectual development.

Brain and bone disease caused by high levels of aluminum in the body have been seen in children with kidney disease. Bone disease has also been seen in children taking some medicines containing aluminum. In these children, the bone damage is caused by aluminum in the stomach preventing the absorption of phosphate, a chemical compound required for healthy bones.

Aluminum is found in breast milk, but only a small amount of this aluminum will enter the infant's body through breastfeeding. Typical aluminum concentrations in human breast milk range from 0.0092 to 0.049 mg/L. Aluminum is also found in soy-based infant formula (0.46–0.93 mg/L) and milk-based infant formula (0.058–0.15 mg/L).

Studies indicate that infants who were given IV solutions containing aluminum showed impaired neurological and mental developments.¹⁷ Infants who had received IV solutions, containing an average of 50mcg of aluminum per day were subjected to a total of 500mcg over a period of 10 days. Babies who received a nearly aluminum-free IV solution with only about 10mcg/day showed no neurological or mental impairment.¹⁸ Studies also indicate that hospitalized premature infants are also exposed to aluminum through parenteral nutritional feeding, and bags, burettes, and syringes contaminated with aluminum. Researchers concluded that 'manipulation, containers, and administration sets increased aluminum levels by about 40%.' FDA established that the daily aluminum intake should not exceed 5mcg/kg BW.¹⁹

REDUCING EXPOSURE

It is impossible to avoid exposure to aluminum because it is so common and widespread in the environment.

Make sure drinking water is not high in aluminum. Water processing plants may use aluminum salts for water treatment, and aluminum levels should not exceed 0.1 mg/L. Several U.S. cities have reported concentrations as high as 0.4–1 mg/L of aluminum in their drinking water.

Avoid food and drinks in aluminum cans. Fruit and vegetable juices can be acidic, lemonades and colas are generally acidic, potentially leaching aluminum from the can into the drink.

Avoid eating large amounts of processed food containing aluminum additives.

Avoid cooking acidic foods in aluminum.

Avoid antacids and other aluminum-rich medications. IV feeding solutions or Total Parenteral Nutrition (TNP) contains aluminum, and the FDA (USA Food and Drug Association) requires a liter solution contains no more than 25mcg of aluminum (a requirement for adults!).

Avoid nutritional supplements that may contain aluminum such as Dolomite. Healing clay contain high amounts of aluminum.

Zeolites are microporous aluminosilicates often promoted for 'natural detoxification.' Because they are tiny particles, they easily pass the mucous membranes, finding their way into the bloodstream.

DIAGNOSING (OVER)EXPOSURE

Urine and blood aluminum measurements can tell you whether you are exposed to larger-than-normal amounts of aluminum. If blood or urine concentrations exceed existing reference ranges, avoid or reduce aluminum exposure for three days. For a repeat analysis metal-free containers and tubes should be used, and utmost care must be taken to avoid environmental exposure through dust or other sources. If such care is taken in the medical practice during sample taking and in the analytical laboratory, the follow-up test most likely shows an aluminum concentration within the normal range.

Measuring bone aluminum can also indicate exposure to high levels of aluminum, but this requires a bone biopsy.²⁰ The metal composition of bone is similar to hair, and a hair analysis is less traumatic (and less costly) than a bone biopsy.

SIGNIFICANCE OF HAIR ALUMINUM LEVELS

Hair evaluates long term exposure, but increased aluminum levels must be carefully evaluated. While very high Al levels potentially reflect a chronic exposure, environmental influences must always be suspected and investigated. An Al overload is often found in conjunction with a disturbed calcium metabolism.

Clinical studies using HMA, have established a link between Al overload and disturbances of the nervous system. Hair concentrations of Aluminum, Antimony,

Lead, and Manganese were found to be significantly ($P < 0.05$) higher in a group of spastic children than in the 'normal group'.²¹

TREATMENT

Since the oral intake of aluminum is constantly rising, we need to make sure that we limit the intake of this common element as much as possible. We also need to make sure that the natural process of elimination is not inhibited. This includes a healthy digestive and renal tract.

We can support digestion by supporting the microbiological environment, which in turn improves gut permeability. The intake of acidophilus lactobacillus improves the intestinal flora, thus aiding normal elimination of toxins. Foods such as yoghurt can help. Healthy oils such as linseed oil improve digestion, which in turn supports natural elimination.

Avoid aluminum-rich drinks is an important means to reduce aluminum exposure in children. Drinking water should be low in aluminum, but higher in calcium (which reduces the aluminum uptake of the body). If renal function is sluggish, adding moderate amounts of vitamin B6 can help.

Aluminum overexposure through oral intake does rarely, if ever warrant chelation. It is wise to change dietary habits first. If industrial exposure is the source of high aluminum concentration in blood and urine, consult a physician trained in metal detoxification. (see www.ibcmt.com)

Conclusion

Aluminum is ubiquitous in our environment, in food, water, medicine including natural medicines and cosmetics. Therefore, overexposure is becoming more reality than the exception and while we cannot completely avoid it, we can limit intake and exposure.

The link between overexposure and neurological problems has been established. Laboratory diagnostics have improved considerably during the past decade. We are greatly aware of contamination- and are constantly challenged when it comes to analyzing human and environmental samples for elements such as aluminum.

Analytical precision depends to a great deal on proper sampling and physicians and their assistance need to be cautious when collecting specimen. When we are sure that all sampling and analytical requirements have been met, we will be able to substantiate claims regarding aluminum and its influence on neurological developments.

At present, we need to be aware. And when one test indicates an excessive aluminum load, we need to confirm it through additional testing. Furthermore, additional studies are needed to support existing evidence that aluminum is a danger to the neurological development of our children.

ARSENIC (AS)

GENERAL INFORMATION

Arsenic is a semi-metal element in the periodic table, and considered highly toxic to animals and man. It is one of the oldest poisons known to man. Its applications throughout history are wide and varied: murder used it because it is odorless and tasteless. Only one tenth of one gram can lead to death.

Chronic arsenic toxicity is a global environmental health problem, affecting millions of people worldwide. Arsenic is released into the environment by smelting of various metals, combustion of fossil fuels, as herbicides, pesticides and fungicides in agricultural products. The drinking water in many countries, which is tapped from natural geological resources, is often contaminated as a result of the high level of arsenic in groundwater.

Arsenic exists in both organic and inorganic form, and long-term health effects can be severe and highly variable: skin and lung cancer, neurological effects, hypertension and cardiovascular diseases.

Neurological effects of arsenic may develop within a few hours after ingestion, but usually are seen in 2—8 weeks after exposure. It is usually a symmetrical sensorimotor neuropathy, often resembling the Guillain-Barré syndrome where the predominant clinical features of neuropathy are paresthesias, numbness and pain, particularly in the soles of the feet.

Most of the adverse effects of arsenic are caused by inactivated enzymes in the cellular energy pathway, whereby arsenic reacts with the thiol groups of proteins and enzymes and inhibits their catalytic activity. Furthermore, As-induced neurotoxicity, like many other neurodegenerative diseases, causes changes in cytoskeletal protein composition and hyperphosphorylation. These changes may lead to disorganization of the cytoskeletal framework, which is a potential mechanism of As-induced neurotoxicity.²²

Arsenic exposure can easily be detected, especially in hair - even after many years. In the past, arsenic was ascribed miraculous properties, and it was prescribed to enhance absorption of nutrients and help gaining weight. It was also given to prevent skeletal problems and to treat anemia. Not too many years ago, it was suggested that small doses increase energy levels. In the Tyrolean region of Austria, the well known 'arsenic-eaters' were reported to ingest small doses of arsenic at specific intervals to increase physical strength.

Interestingly, the body can build up a resistance to the toxic effect after small doses are ingested over a long time. In fact, some of the arsenic-eaters were known to tolerate up to four times the lethal dose. History does not tell us much about those arsenic-eaters who had a lower tolerance and succumbed. However, one of the documented manifestations included a decreased iodine absorption by the thyroid and reduced thyroid hormone production, which is known to cause cretinism.

COMMON SOURCES

In addition to arsenic from air, water and food, tobacco treated with arsenate sprays may also be a route of exposure. Soil can be a source of exposure. Children love to play with dirt, and studies indicate that children living near smelting areas showed signs of high cadmium, lead and arsenic exposure, all due to soil.^{23 24} Water can be a source of arsenic contamination, and while WHO (World Health Organisation) recommends setting national standards, not all are the same. In 2006, the EPA (US Environmental Protection Agency) has reduced its previous standard of 50mcg/L to a limit of 10mcg/L,²⁵ though the American Council on Science and Health (ACSH) reported in 2002 that there are no adverse health effects (in the United States) from arsenic in drinking water at or below the limit of 50µg/L. This is curious, because governments generally do not lower standards unless research indicates the need.

Table 1 Currently accepted national standards for arsenic in drinking water²⁶

Standard	Countries
Countries whose standard is lower than 10 mcg/L	Australia (7 mcg/L, 1996)
Countries whose standard is 10 mcg/L	European Union (1998), Japan (1993), Jordan (1991), Laos (1999), Laos, Mongolia (1998), Namibia, Syria(1994)
Countries whose standard is lower than 50 mcg/l but higher than 10 mcg/l	Canada (1999) 0.025 mg/l
Countries considering to lower the standard from 50 mcg/L	Mexico(1994)
Countries whose standard is 50 mcg/l	Bahrain, Bangladesh (unknown), Bolivia (1997), China (unknown), Egypt(1995), India (unknown), Indonesia (1990), Oman, Philippines (1978), Saudi Arabia, Sri Lanka (1983), Viet Nam(1989),

The toxicity of arsenic to [insects](#), [bacteria](#) and [fungi](#) led to its use as a wood preservative.²⁷ Arsenic was found in herbicides and pesticides (and still is in some countries), and it was not uncommon for children to show symptoms of poisoning after touching Fly traps or coils.

ROXARSONE – ARSENIC SUPPLEMENT FOR ANIMALS

Arsenic was added to animal food, as a method of disease prevention and growth stimulation.^{28, 29} One example is [roxarsone](#), a controversial arsenic compound, which was approved in 1944 and has been largely used as a nutritional supplement for chicken. About 70% of the US chicken farmers have used it since 1995.³⁰ In 2009, the Poison-Free Poultry Act proposed to ban the use of roxarsone in industrial swine and poultry production.³¹ In 2011, Pfizer, the manufacturer of roxarsone voluntarily withdrew the product from the US market, but continues to sell it internationally.³²

The dietary arsenic intake of humans varies widely, and is estimated to range from less than 10 µg/day to 200 µg/day. In the UK and elsewhere, fish is the main

contributor of arsenic in the diet of humans. With the exception of fish, most foods contain less than 0.25 µg/g arsenic. Many species of fish contain between 1 and 10 g/g. Arsenic levels at or above 100µg/g have been found in bottom feeders and shellfish.³³

Arsenic intakes by high fish consumers can reach several thousand µg per day.³⁴ The levels of inorganic arsenic are generally higher in shellfish. However, there are no reports of acute toxicities in man resulting from the consumption of organoarsenicals in seafood.

IS THERE A SAFE ARSENIC INTAKE?

One approach to determining safe levels of As in food is by comparing safety standards for drinking water. This comparison is made on the basis of inorganic As species as these are considerably more toxic than organic As species.

Several countries, including the UK and Australia currently use a 1 ppm limit for arsenic in food. In 1989, the FAO and WHO jointly established a provisional tolerable dietary intake of 0.015 mg inorganic As/kg body weight/week, or 130 µg/day for a 60 kg adult. This level is already exceeded by the intake of 200 µg/day from drinking 4 L of water containing 50ppb (=mcg/L) arsenic.

Rice can be a source of arsenic overexposure, especially if it is grown in water containing more than 10mcg/L of arsenic, as is the case in Bangladesh and other rice-growing countries.³⁵

SYMPTOMS OF TOXICITY

Patients exposed to arsenic will frequently have a garlic smell to their breath and to tissue fluids. In trivalent arsenic poisoning the clinical effects depend on the chronicity of the exposure. Acute exposures generally present with gastrointestinal symptoms that mimic y y cholera: vomiting and severe diarrhea (which may be rice-watery in character, often bloody). The acutely intoxicated patient will be in acute distress, often dehydrated and in hypovolemic shock.

Chronic toxicity is more insidious and may present as a classical dermatitis: hyperkeratosis with a classical dew drops on a dusty road appearance or peripheral neuropathy: classically a painful paresthesia which is symmetrical and stocking-glove in distribution. Also, whitish lines (Mees lines) which look very much like traumatic injuries are found on the fingernails.

Arsenic intoxication is known to produce symptoms such as dark gray skin color, wart-like keratosis on palms and soles, Mees bands, acne-like skin eruptions, skin cancer, liver and kidney disease, and cerebral changes. Symptoms of a severe acute poisoning are nausea, vomiting, gastrointestinal inflammation with severe diarrhea, shock due to severe loss of fluid and electrolytes, kidney failure, respiratory failure, and coma.

A chronic arsenic exposure or overload has been associated with alopecia, dermatitis, myalgia, lethargy, exhaustion, mental confusion, diarrhea, headache,

burning sensation of extremities, constipation, stomatitis, epilepsy and convulsions, slow wound healing, edema due to electrolyte imbalance, and neuropathy.

Inorganic arsenic crosses the placenta and may cause neonatal death.

DIAGNOSING ARSENIC EXPOSURE

BLOOD: Due to rapid excretion through the kidneys, serum and whole blood **arsenic** levels are often not helpful in diagnosing acute arsenic poisoning, unless samples are obtained soon after exposure. Moderately elevated blood levels may only be an indication of an excessive arsenic intake due to diet or other sources. Avoid arsenic-containing food such as fish and chlorella, plus other potentially high arsenic sources for three days, before repeating the test. Repeat results should be within the expected range. If not, a serious and immediate exposure may be present. Evaluate potential sources.

URIN: Mildly to moderately elevated urinary arsenic excretion levels may be due to an increased intake of dietary arsenic. Evaluate potential sources and if you suspect a dietary involvement, avoid arsenic-containing food and other potentially high arsenic sources for three days, before repeating the test. Collect urine for 24hrs. If the urine concentration is above 50mcg/L, check with a physician trained in clinical metal toxicology (see www.ibcmt.com)

HAIR/NAILS: hair and nails are good diagnostic indicators of a chronic arsenic exposure. Both of these tests are known to locate long term arsenic exposure long before symptoms of intoxication are obvious. This fact was known in forensic medicine for quite some time.

TREATMENT OF ARSENIC INTOXICATION

The chelating agent BAL (British Anti Lewisite) was been developed as an emergency treatment for chemical warfare-based arsenic poisoning during World War II. BAL (chemical name: dimercaprol; 2,3-dimercaptopropanol) has been in use in the medical community for over 60 years, but since it causes serious side effects, it has now been replaced by equally effective chelating agents such as DMPS, which causes few side effects and DMSA, which is well tolerated even among children.

(For more information about chelating agents, see the IBCMT Textbook on Clinical Metal Toxicology by P.J. Van der Schaar or Toxic Metals and Antidotes by Blaurock-Busch)

DMPS AND DMSA

DMPS is considered a stronger chelating agent than DMSA, but side effects may be more prominent. DMPS is administered intravenously and orally, but for children DMSA is considered a safer choice.

DMPS has a strong affinity to bind copper and zinc, and continued administration can interfere with the copper and zinc metabolism. When DMPS is used for long term treatment, the copper and zinc status must be carefully observed and supplementation between treatments is recommended. Treatments should be spaced carefully.

Both medications have a strong odor, not unlike rotten eggs. To cover up some of the nasty odor, wrap the capsules into bread or other food and take as directed by a physician. It is best to take oral chelators on an empty stomach with 1-2 cups of water. The urine collection should be 4 hours after intake. After the urine collection is completed, patients are advised to drink sufficient water for better renal clearance.

Side Effects to DMSA or DMPS: Nausea, vomiting, diarrhea or loose stools, metallic taste in mouth, stomach and abdominal cramps (these happen more likely when the digestive tract is highly toxic), flu like symptoms, headache and a temporarily impaired vision. The latter symptoms are often reported by patients suffering neurological problems, possibly due to heavy metal intoxication. If any of these symptoms appear, consult a physician.

Clinical cases provide strong evidence that DMSA side effects lessen considerably when the toxic load is reduced. It is not unusual that initially an adult strongly reacts to a relatively low dose of DMSA (500mg or less), but report no side effects after successful treatment. It is not unusual that such a patient tolerates 3times the initial amount without noticing any problem. We do not know of comparable reports involving children.

It is often stated that one of the advantages of using DMSA is its ability to pass the blood brain barrier. Unfortunately, there is only one animal study that supports that claim. No human study has yet proven it. However, studies indicate that symptoms and behaviour improved after chelation.

There may be other explanations in support of using either one of the chelating substances for detoxifying the brain and the central nervous system.

Both chelating agents have similar chemical properties. Both are hydrophilic, meaning water soluble, meaning DMPS and DMSA do not easily move into fatty tissue. Brain and nerves consist of fatty tissue.

BLOOD BRAIN BARRIER

While the Blood Brain Barrier prevents toxins from passing, the hypotheses is discussed that magnetic fields such as the ones emitted from mobile phones, microwaves, even radiation exposure temporarily open the BBB, allowing passage of foreign substances such as toxins or chelating agents. Fever and infections, trauma to the brain, hypertension, hyperosmolarity (i.e. the presence of a high concentration of a substance in the blood) can open the BBB, or developmental problems prevented the full development at birth.³⁶

SPACING TREATMENTS AND HOMEOSTASIS

There may be another reason why detoxification improves neurological problems. Homeostasis may take place, attempting to bring order to a highly challenged system. In other words, after a chelating agent has removed toxic and vital metals from the body, homeostasis may rebalance the body's biochemistry.

The author sees an indication that this might be the case, and it seems wise to space chelation treatments weeks apart instead of attempting too many treatments in quick succession. More is not necessarily better, and it might be wise to allow the body to

adjust and rearrange its internal biochemistry. This redistribution of toxic and vital metals may, in fact, cause metals to be released from organs that are otherwise difficult to detoxify.

THERAPEUTIC CONSIDERATION

When a chronic arsenic overload has been diagnosed through hair or nail analysis, and when an immediate exposure has been ruled out, nutritional detoxification may be sufficient. Supplement the sulfur-containing amino acids (cysteine, methionine), along with B-vitamins, increase the vitamin E intake (of all tocopherols), and check the selenium status. Arsenic suppresses iodine and selenium, and adequate selenium intake can support the body's natural elimination of arsenic.

Check thyroid function (especially T3 and TSH) and the iodine status through blood, urine or hair testing. A low blood and/or urine level indicates an inadequate nutritional supply, whereas a low hair concentration reflects a chronically low intake. An excess iodine intake (through iodine-rich supplements such as chlorella and algae) may also disrupt the thyroid metabolism. Algae products can be high in arsenic.³⁷

RESEARCH

The relationship between cognitive functions and hair mineral concentrations of lead, arsenic, cadmium, and aluminum was tested on a random selection of 69 children. The data obtained showed a significant correlation between reading and writing skills and elevated arsenic levels, as well as the interaction between arsenic and Pb. Children with reduced visual-motor skills had clearly elevated Al and Pb levels.

Moon C. et al: Main and interactive effects of metallic pollutants on cognitive function. J. Learning Disabilities (18(4):217-21. 1985

LEAD (PB)

Lead is a naturally occurring bluish-gray metal found in small amounts in the earth's crust. Lead can be found in all parts of our environment, but much of our exposure comes from human activities including burning fossil fuels, mining, and manufacturing.

Lead has many different uses. It is used in the production of batteries, ammunition, metal products (solder and pipes), and devices to shield X-rays. Due to health concerns, lead from paints and ceramic products, caulking, and pipe solder has been dramatically reduced in recent years. The use of lead as an additive to gasoline was banned in 1996 in the United States, in Europe after 2000.

SOURCES OF EXPOSURE

Exposure to lead can happen from breathing workplace air or dust, eating contaminated foods, or drinking contaminated water. Work or hobbies such as making stained glass or increase lead exposure. Some health care products or folk remedies may contain lead. Children can be exposed from eating lead-based paint chips or playing in contaminated soil. Lead can damage the nervous system, kidneys, and reproductive system. The Environmental Protection Agency (EPA) limits lead in

drinking water to 15µg per liter. WHO recommends a limit of 10mcg/l and this level will be enforced by European countries starting in 2013.

REDUCING EXPOSURE

If a water lead problem is suspected, run or flush water that has been standing overnight before drinking or cooking with it.

Do not allow children to chew or mouth surfaces that may have been painted with lead-based paint. Some types of paints and pigments that are used as make-up or hair coloring contain lead. Keep these kinds of products away from children.

If a home contains lead-based paint or you live in an area contaminated with lead, wash children's hands and faces often to remove lead dusts and soil, and regularly clean the house of dust and tracked in soil.

TOXICITY

Lead can affect almost every organ and body system. This toxic metal is a known cause of various anemias. Lead affects the nervous system, both in adults and children. Long-term exposure of adults can result in decreased performance in some tests that measure functions of the nervous system. It may also cause weakness in fingers, wrists, or ankles. Lead exposure may cause increases in blood pressure, particularly in middle-aged and older people. Exposure to high lead levels can severely damage the brain and kidneys in adults or children and ultimately cause death. In pregnant women, high levels of exposure to lead may cause miscarriage. High level exposure in men negatively affects sperm production.

Department of Health and Human Services (DHHS) has determined that lead and lead compounds are reasonably anticipated to be human carcinogens and the EPA has determined that lead is a probable human carcinogen. The International Agency for Research on Cancer (IARC) has determined that inorganic lead is probably carcinogenic to humans and that there is insufficient information to determine whether organic lead compounds will cause cancer in humans.

CHILDREN AND LEAD OVEREXPOSURE

Exposure to lead is more dangerous for young and unborn children. Unborn children can be exposed to lead through their mothers. Harmful effects include premature births, smaller babies, a decrease in mental ability in infants, learning difficulties, and reduced growth in young children. These effects are more common if the mother or baby was exposed to high levels of lead. Some of these effects may persist beyond childhood.

Small children can be exposed by eating lead-based paint chips, chewing on objects painted with lead-based paint or swallowing house dust or soil that contains lead.

Children are more vulnerable to lead poisoning than adults. A child who swallows large amounts of lead may develop blood anemia, severe stomach ache, muscle weakness, and brain damage. If a child swallows smaller amounts of lead, much less severe effects on blood and brain function may occur. Even at much lower levels of exposure, lead can affect a child's mental and physical growth.

DIAGNOSIS

Lead in the human body is easily measured in blood, urine, bones, teeth, or hair. Water or soil a source of exposure, and can be tested reliably.

When we know the source of exposure, we can avoid it or remove it altogether.

BLOOD:

Slightly elevated blood levels may be an indication of an excessive intake due to diet, water or other sources. Second-hand smoke is a cause of metal exposure in children. Inhaling smoke can lead to elevated concentration of lead, nickel and cadmium in blood. Avoid lead-containing sources for three days, before repeating the blood test. Repeat results should now be within the expected range. If not, consult a physician and check for sources of the immediate exposure.

By measuring an individual's blood lead level (BLL), we can detect lead poisoning in adults or children. When blood lead is high, an increase in erythrocyte protoporphyrin (EP) follows.²

- The standard elevated blood lead level (BLL) for adults' set by the Center for Disease Control is 25 micrograms per deciliter (25 $\mu\text{g}/\text{dl}$) of whole blood. This level recognizes that every adult has accumulated some lead contamination.
- The level for a child is lower; currently it is 10 micrograms per deciliter (10 $\mu\text{g}/\text{dl}$) of blood.²

The Centers for Disease Control and Prevention (CDC) states that a blood lead level above 10 $\mu\text{g}/\text{dL}$ is a cause for concern. It also states that lead can impair development even at BLLs below 10 $\mu\text{g}/\text{dL}$.³⁸

The German Environmental Agency's BLLs are lower than those set by US agencies. In Australia, the acceptable level of lead in blood was lowered from 25 $\mu\text{g}/\text{dL}$ to 10 $\mu\text{g}/\text{dL}$ in 1992. In 1993 the National Health and Medical Research Council (NH&MRC) set a national target for 1998 for all Australian to have a BLL less than 15 $\mu\text{g}/\text{dL}$ (except for workers employed in the lead industry), and strategies were put in place whereby 90% of pre-school children would have BLLs below 15 $\mu\text{g}/\text{dL}$. In 1996 the National Blood Lead Survey (the Donovan Survey) found 7.7% of children aged one to four were above 10 $\mu\text{g}/\text{dL}$, and 1.7% were above 15 $\mu\text{g}/\text{dL}$.⁴

Biomonitoring Ranges for a normal i.e. nonexposed population. Blood levels above the given range indicate need for action.

Children (USA)	< 100 $\mu\text{g}/\text{L}$ = 10 $\mu\text{g}/\text{dl}$
Adults (USA)	<250 $\mu\text{g}/\text{L}$
Children and adults (Germany)	<50
Females (18-69yrs) (Germany)	<70
Males (18-69yrs) (Germany)	<90

- The US Center for Disease Control (CDC) recommends that all children be screened for lead poisoning yearly. This is especially important for children between 6 months and 6 years of age.

- Children with an erythrocyte protoporphyrin level (EP) of 35 micrograms per deciliter ($=350\mu\text{g/l}$) should be tested for a blood lead level.
- Children with a BLL of 20 micrograms per deciliter ($=200\mu\text{g/L}$) or higher should be screened by their doctor for lead poisoning.
- Medical treatment is necessary if the BLL is higher than 45 micrograms per decilitre ($=450\mu\text{g/l}$).
- Exposure to lead also can be evaluated by measuring erythrocyte protoporphyrin (EP) in blood samples. However, the EP level is not sensitive enough to identify children with elevated blood lead levels below 250 micrograms per liter ($\mu\text{g/L}$).

URIN

Mildly to moderately elevated lead excretion levels may be due to an increased intake. Check your water, and make sure the child is not exposed to lead-paint.

HAIR/NAILS

Hair and nails are similar to bone tissue. Lead is easily absorbed in bone and when it has moved into bone marrow, it easily disrupts the iron metabolism, leading to anemias. Since hair and nail closely resemble bone tissue, high lead concentration in hair or nail may allow early intervention of lead-induced anemias.¹ Lead hair analysis has been indicated as a useful test for children when evaluating chronic exposure and mineral imbalances. The researchers Wilhelm M et al found through hair analyses that Children < 5 years of age are especially prone to higher cadmium and lead, exposure and their zinc status is lower compared with older children.³⁹

LEAD IN TEETH OR BONES

can be measured by X-ray techniques, but these methods are not widely available.

LEAD CONCENTRATION IN BREAST MILK OF NURSING MOTHERS

Breast milk feeding with high lead concentration is one of the first sources of lead exposure in neonates. Researchers from the King Saud University of Riyadh and the King Khalid University Hospital found a wide range of lead in the breast milk of nursing mothers. The lead concentration ranged from $0.318\mu\text{g/dL}$ to a high of $2.5\mu\text{g/dL}$ with an average of $0.768 \pm 0.42\mu\text{g/dL}$. Mothers residing near industrial areas or highways showed higher concentrations than those living in remote areas. (Ann Saudi Med 1995;15(3):249-251).

LEAD IN WATER

The mineral and trace element content of water varies, and is greatly influenced by the environment, geographical location, water treatment and the pipes in which the water flows.

The mineral content of City water is less influenced by weather conditions such as prolonged heat or rain than the ground water found in wells and cisterns.

Lead is rarely found in city water, but enters tap water through corrosion of plumbing materials. Homes built before 1986 are more likely to have lead pipes, fixtures and solder. However, new homes are also at risk: even legally “lead-free” plumbing may contain up to 8 percent lead. The most common problem is with brass or chrome-plated brass faucets and fixtures which can leach significant amounts of lead into the water, especially hot water.

To have the lead content checked, 10ml of water are needed for testing.

- **Checking your cistern or city water:**

Turn on your kitchen faucet and let the water run for 10 minutes. After that time, you are drawing water deep from the well or from the city pipes. Open the plastic tube provided from the laboratory, rinse it three times and then fill. Do not fill totally to the top. Leave about one centimeter space unfilled.

- **Checking your water pipes**

Old water pipes are a source of metals and bacteria. When water stands over several hours in the pipes, depending on its acidity or alkalinity, it may cause mild corrosion. Old solder can release toxic metals into your drinking water. Copper may be released from copper pipes.

To see how your drinking water is affected, you must take the water sample first thing in the morning. Open the faucet and rinse the plastic tube or bottle three times, then fill. Do not fill totally to the top. Leave about one centimeter space unfilled.

LEAD IN PAINT

If you live in an older home and your child has a habit of scratching and licking paint from walls or painted objects, you may want to check if a hazard exists. About one half to one teaspoon of paint is needed to do a risk assessment test. If a hazard exists, contact a trained health professional.

TREATMENT OPTIONS

- All forms of EDTA (NaEDTA, NaMgEDTA, CaEDTA) have a high lead binding capacity. CaEDTA has been approved by the FDA to chelate lead, *but intravenous administration of EDTA is not an option for children - unless an acute intoxication has been diagnosed and the administering physician is a toxicologist or a trained in clinical metal toxicology. If EDTA has been prescribed for treatment, only CaEDTA should be administered to a child, and never at a young age.*

EDTA suppositories are on the market, but they only detoxify the colon, hence are not useful for the treatment of systemic lead intoxication.

- Oral EDTA is often recommended, but it is not an effective means of detoxifying. Only 5% of EDTA are absorbed in the gastrointestinal tract, too little to cause any significant metal binding.

DMSA has been approved by the FDA for the treatment of lead intoxication in children. The recommended dose is 10mg/kg body weight. It is also listed in the official European Antidota list as published and utilized by poison control centers.

For more information on antidotes for lead poisoning, call the local poison center or check www.ibcmt.com for clinical metal toxicologists. Members are listed by country.

Alternatives for reducing a mild to moderate chronic lead exposure are vitamin C, Glutathion, L-Cysteine and L-Methionine. Check with a nutritionally oriented physician or a nutritionist for the appropriate treatment needed.

Have the child's zinc status checked. Autistic or hyperactive boys often show a disturbed zinc metabolism. Substituting zinc only may not be the answer. Often, vitamin B6 needs to be added to enhance zinc absorption. While we can check blood levels of Vitamin B6, the test is rarely needed. Start with supplementing low doses of a vitamin B complex, containing B6 (Pyridoxin) or supplement pyridoxin by itself. Vitamin B6 stimulates dream recall and deficient patients never dream. As soon as B6 is adequately supplemented, dream recall starts. If vitamin B6 is overdosed, patients have bad dreams, even hallucinations.⁴⁰

MANGANESE (MN)-ESSENTIAL AND POTENTIALLY NEUROTOXIC

The human body contains approximately 10 mg of manganese, most of which is found in the liver, bones, and kidneys. This trace element is a cofactor for a number of important enzymes, including arginase, cholinesterase, phosphoglucomutase, pyruvate carboxylase, mitochondrial superoxide dismutase and several phosphates, peptidases and glycosyltransferases. Manganese functions with vitamin K in the formation of prothrombin and is part of the Phase1 detoxification enzyme MnSOD, needed for its antioxidant properties.

In certain instances, Mn^{2+} may be replaced by Co^{2+} or Mg^{2+} . It is therefore important to keep all metals in balance.

IMPORTANT HEALTH FUNCTIONS:

- Essential for glucose utilization
- Lipid synthesis and lipid metabolism
- Cholesterol metabolism
- Pancreatic function and development
- Prevention of sterility
- Normal skeletal growth and development
- Important for protein and nucleic acid metabolism
- Activates enzyme functions
- Involved in thyroid hormone synthesis

Required Daily Amount (in mg)

Infants, 0-5 months: 0.5-0.7

Infants, 5-12 mo. 0.7-1.0

Children, 1-3 yrs 1.0-1.5

4-6 1.5-2.0

7-10 2.0-3.0

11+ 2.5-5.0

Adults, all genders 2.5-5.0

ABSORPTION AND EXCRETION:

The manganese metabolism is similar to that of iron. It is absorbed in the small intestines and while the absorption process is slow, the total absorption rate is exceptionally high, about 40%. Excess manganese is excreted in bile and pancreatic secretion. Only a small amount is excreted in the urine.

Calcium can suppress the body's ability to absorb manganese.

SOURCES:

Liver and kidney are the primary meat source of manganese. Wheat germ, legumes, nuts, and black tea are good plant sources.

Manganese content of foods (mg/100g)

<u>Plant foods</u>		<u>Animal foods</u>	
Wheat germ	9	Oyster	0.6
Rolled oats	5	Liver	0.25-0.36
Wheat bran	4	Cheese	0.017-0.19
Cereals	2.4-4	Fish	0.012-0.12
Soybeans	3	Kidneys	0.6-0.1
Whole wheat bread	2.3	Meat	0.2-0.8
Parsley	3	Chicken	0.02
Legumes	1.3-2	Turkey	0.03-0.05
Sorghum	1.9		
Rye bread	1		
Rice	1		

A healthy person excretes approximately 4 mg/day, which is the minimum daily amount that should be consumed.

POTENTIAL DEFICIENCY SYMPTOMS:

Manganese deficiency has never been reported in humans, meaning the clinical significance of a true deficiency is unknown. However, manganese deficiencies have been produced in animals. For examples, rats fed a manganese-deficient diet develop sterility. Males show testicular degeneration while females demonstrate an inability to suckle the young. In chicks, manganese-deficient diets cause bone growth disorders. It is assumed that these symptoms may have paralleled those seen in humans.

- Ataxia
- Fainting
- Hearing loss
- Weak tendons and ligaments
- Possible cause of diabetes. Medical studies indicate that manganese deficiency impairs glucose metabolism and reduced insulin production
- Manganese deficiency has been linked to myasthenia gravis. Manganese activates several enzyme systems and supports the utilization of vitamin C, E, choline, and other B-vitamins. Inadequate choline utilization reduces the acetylcholine synthesis, causing conditions such as myasthenia gravis (loss of muscle strength).

TOXICITY:

Manganese overload is generally due to industrial pollution. Manganese poisoning has been found among workers in the battery manufacturing industry. Symptoms of toxicity mimic those of Parkinson's disease (tremors, stiff muscles). Excessive manganese has been linked to hypertension in patients 40 years old and older.

If well-water is rich in manganese, bacterial growth becomes a problem especially if the iron concentration is also high.

Excess manganese interferes with the absorption of dietary iron. Long-term exposure to excess manganese levels may result in iron-deficiency anemia. Increased manganese intake may also impair the activity of copper metallo-enzymes, including the CoZnSOD detoxification enzyme.

SYMPTOMS OF MANGANESE OVEREXPOSURE

- Psychiatric illnesses
- Mental confusion
- Impaired memory
- Loss of appetite
- Mask-like facial expression and monotonous voice
- Spastic gait
- Neurological problems

Other manifestations include:

- Impaired thiamin (B1) metabolism
- Fe deficiency
- Increased demand for vitamin C and Copper.

- Manganese toxicity can cause kidney failure, hallucinations, as well as diseases of the CNS. High hair manganese levels indicate problems with calcium and/or iron metabolism.

LABORATORY DIAGNOSIS:

Manganese influences the copper and iron metabolism and estrogen therapy may raise serum manganese concentration, whereas glucosteroids alter the manganese distribution in the body.

BLOOD ANALYSIS:

If a blood analysis is scheduled, advise patient to avoid all tea for at least one day prior to sampling. Herbal, black and green tea may contain high concentrations of manganese.

MTM evaluated the blood manganese concentration of 595 nonexposed test persons. 95Percent of the tested population showed values within the reference range of 7.10 to 20mcg/l. The mean range for the total population was 12.8mcg/L, compared to a mean range of 7.4mcg/L for a US population (342 test persons). This suggests that the average manganese intake is lower for the American population. The mean value for 26 Asian children age 3-12 was 17.5mcg/L

URINE ANALYSIS

If the baseline urine analysis indicated a marginal elevation, the exposure is, most likely, dietary. Serious manganese overexposure or intoxication is rare.

MTM evaluated the manganese concentration of baseline urine samples from nonexposed adults. Of the 1935 test persons the 95 percentile was 6.5mcg/l, which is outside the range of <4.5mcg/l. The mean value was 2.6mcg/l.

In comparison, 95percentile of 588 children, <12 years of age was 12mcg/l, nearly double that of the adults. The mean range of 4mcg/l was also considerable higher than that of the adults, suggesting that manganese exposure is more of a problem among children.

If whole blood and/or baseline urine levels exceed reference ranges, evaluate potential source and check hair manganese levels to evaluate if a potential long term exposure is present as it can potentially imbalance the mineral metabolism, affecting enzyme and detoxification systems.

HAIR ANALYSIS

To evaluate hair manganese levels, it is important that the hair sample to be tested is is not colored. Dark, especially black hair dyes can contain manganese, meaning results would not be reliable. If the head hair is colored or chemically treated, use pubic hair or nails.

MTM evaluated hair manganese levels of adults and children. The 95percentile for the 525 adults was 0.82mg/kg (=mcg/g). The mean value was 0.22mcg/g. Both values were well within the expected range.

The 95percentile for 114 children <12years of age was 1.19mcg/g, outside the expected range of 0.5mcg/g; the mean value was 0.38mcg/g manganese, well within the expected range. This suggests that manganese absorption and tissue storage over time is higher in children than in adults.

These evaluations suggest that long term manganese overexposure is not prevalent among adults, and not common among children.

TREATMENT

If manganese overexposure or intoxication has been diagnosed, an increase in Vitamin C improves cellular exchange. Manganese poisoning can be treated successfully with chelation therapy. While the chelator of choice for adults is EDTA, this chelating substance should not be given to children. Dietary or nutritional changes are to be considered, because DMSA is not very effective in removing manganese.

RESEARCH

MANGANESE AND LEARNING DISABILITIES

The concentration of Mn in the hair of normal newborn infants increased significantly from 0.19µg/g at birth to 0.965µg/g at 6 weeks of age and 0.685ug/g at 4 months when they were fed infant formula. There was an insignificant increase to 0.330µg/g at 4 months in breast-fed infants. After this age there was a slow decline in hair Mn to 0.268µg/g in normal children at age 8years, and 0.434 in learning disabled (hyperactive) children. This is the 3rd study reporting elevated hair Mn in learning disabled children.

Collipp, P.J., et al. Manganese in infant formulas and learning disability. Ann. Nutr. Metab. 27(6):488-494, 1983.

THE MERCURY CONNECTION (HG)

Mercury (Hg), one of the most toxic elements, easily passes the blood brain barrier. Research from the University of Calgary has documented that mercury, unlike other toxic metals, is toxic to nerve cells in minute concentrations. In 1997, Prof. Lorscheider and colleagues at the University of Calgary, Canada found that mercury vapour caused "brain molecular lesions. For the first time in medical history, the scientists were able to demonstrate that tiny amounts of mercury initiate and cause neurodegeneration."⁴¹

ELEMENTAL MERCURY AND METHYLMERCURY

Mercury (Hg) is a heavy metal that is liquid at standard temperature and pressure. It is found naturally in the Earth's crust. The richest mercury ores contain up to 2.5% mercury by mass. Rich mercury ores are often found in volcanic regions such as Spain and Peru. Mercury mining began in 1558 and became an essential resource in the economy of Spain and its American colonies. Because of its special features, mercury and its compounds have been used widely in medicine (for thermometers

and as preservatives such as thiomersal in vaccines, eye drops and nasal sprays and in topical antiseptics. It is still used in some diuretics.

In the late 20th century, mercury was largely used in the chlorine production and in spite of its toxicity mercury is still widely used in cosmetics, particularly the manufacture of mascara. Energy-saving light bulbs are filled with gaseous mercury, and the disposal or breakage of bulb can be hazardous.⁴² Also in the 20th century, mercury was frequently administered to children as a laxative and dewormer, and was used in teething powders for infants.⁴³

MERCURY IN DRUGS AND MEDICINE

Some years ago, the author met a multiple sclerosis patient who received mercury rubs as a medical treatment! This was in the 1980s, and he did end up in a wheel chair. It shows how medical judgement can err.

A number of medications are on the market, containing mercury. These include eye drops, nasal sprays, antibiotic lotions and solutions, Neosporin and lotions for the treatment of fungal problems, haemorrhoid relief ointments and a number of topical solutions or ointments. Mercury can be found in antibiotic ear suspension and testosterone injection suspension. Products containing mercury are listed under <http://www.scribd.com/doc/8080205/Medicines-That-Contain-Mercury>

ENVIRONMENTAL INTOXICATION

Mercury can cause acute and chronic poisoning. The author was part of a scientific committee invited to Buyat Bay, Indonesia where an entire village suffered from acute mercury poisoning as a result of gold mining. In Asian countries mining companies still wash gold with mercury, and dump the heavily contaminated water into the ocean, unfiltered. Not only did the Buyat Bay people engage in legal and illegal gold washing with mercury, they also lived off the fish found in this contaminated water. Severe skin ailments, birth defects and neurological disorders affected nearly every inhabitant of that poor village.

Mercury (Hg) and its compounds are extremely toxic and must be handled with care.

Methylmercury (CH₃Hg), also referred to as MeHg is an organic form of mercury. It deserves attention because it is in a form that is easily bio-accumulated in organism. It easily builds up in predatory fish and accumulates in food as it travels up the food chain. Consumption of contaminated fish is a major source of human exposure to MeHg (National Research Council, 2000).

THE TOXICITY OF MERCURY

Because MeHg is the form most readily incorporated into biological tissue, it is most toxic to humans. Exposure to this highly toxic substance is known to cause adverse health effects in humans and in animal. Most extensive are the data on neurotoxicity, particularly in developing organisms. The nervous system is considered to be the most sensitive target organ.

Observation indicate that hazardous amounts of methylmercury can enter the fetus in utero, as well as the infant that consumes milk of a mother who has eaten contaminated food. A total of 43 paired samples of maternal blood and milk were collected from 20 lactating mothers. The concentration of organic mercury in milk was proportional to the concentration of organic mercury in maternal blood up.⁴⁴

There is more to MeHg. The human system can produce it internally. If we swallow inorganic mercury (as it happens when we grind teeth with amalgam fillings, or release minute amounts of mercury during chewing), microscopic organisms convert the inorganic mercury (Hg) into the more toxic methylmercury (CH₃Hg). These microscopic organisms are bacteria such as the Escherichia and Enterobacter strain found in our digestive tract.⁴⁵ Researchers suggest that bacteria use this methylation process as a resistance/detoxification mechanism.⁴⁶

Because MeHg is considered a neurotoxin, a Reference Dose (RfD 2001) for methylmercury was calculated to protect children's developing nervous system. Currently, the U.S. EPA uses a RfD of 0.1mcg/kg body weight per day. This is considered the maximum daily dose without recognized adverse effects.⁴⁷

MERCURY IN FOOD

Following is a list from the Natural Resource Defence Council (NRDC). It lists fish caught and sold commercially.⁴⁸ For information about fish in your country or state, check with your state officials.

Sources for NRDC's guide: The data for this guide to mercury in fish comes from two U.S. federal agencies: the Food and Drug Administration, which tests fish for mercury, and the Environmental Protection Agency, which determines mercury levels that it considers safe for women of childbearing age.

About the mercury-level categories: The categories on the list (least mercury to highest mercury) are determined according to the following mercury levels in the flesh of tested fish.

- Least mercury: Less than 0.09 parts per million
- Moderate mercury: From 0.09 to 0.29 parts per million
- High mercury: From 0.3 to 0.49 parts per million
- Highest mercury: More than .5 parts per million

LEAST MERCURY

Enjoy these fish:

Anchovies

Butterfish

Catfish

Clam

Crab (Domestic)

Crawfish/Crayfish

Croaker (Atlantic)

Flounder*

Haddock (Atlantic)*
 Hake
 Herring
 Mackerel (N. Atlantic, Chub)
 Mullet
 Oyster
 Perch (Ocean)
 Plaice
 Pollock
 Salmon (Canned)**
 Salmon (Fresh)**
 Sardine
 Scallop*
 Shad (American)
 Shrimp*
 Sole (Pacific)
 Squid (Calamari)
 Tilapia
 Trout (Freshwater)
 Whitefish
 Whiting

MODERATE MERCURY

Eat six servings or less per month:

Bass (Striped, Black)
 Carp
 Cod (Alaskan)*
 Croaker (White Pacific)
 Halibut (Atlantic)*
 Halibut (Pacific)
 Jacksmelt
 (Silverside)
 Lobster
 Mahi Mahi
 Monkfish*
 Perch (Freshwater)
 Sablefish
 Skate*
 Snapper*
 Tuna (Canned
 chunk light)
 Tuna (Skipjack)*
 Weakfish (Sea Trout)

HIGH MERCURY

It is recommended that you do not eat more than three servings per month:

Bluefish

Grouper*

Mackerel (Spanish, Gulf)

Sea Bass (Chilean)*

Tuna (Canned Albacore)

Tuna (Yellowfin)*

HIGHEST MERCURY (*avoid eating*):

Mackerel (King)

Marlin*

Orange Roughy*

Shark*

Swordfish*

Tilefish*

Tuna (Bigeye, Ahi)*

- **Fish in Trouble! Avoid eating** these fish. They are perilously low in numbers or are caught using environmentally destructive methods.
- **** Farmed Salmon** may contain PCB's, chemicals with serious long-term health effects.

THIOMERSAL AND THE VACCINE CONNECTION

Chemical synonyms for thiomersal ($C_9H_9HgNaO_2S$) are Ethylmercurithiosalicylic acid sodium salt, Mercury-([*o*-carboxyphenyl]thio)ethyl sodium salt, Sodium ethylmercurithiosalicylate. Biochemically and physiologically it is a sulfhydryl (thiol) oxidizing reagent capable of inhibiting a wide range of sulfhydryl-dependent enzymes and proteins such as PI3-kinase-dependent methionine synthase, glutamate transport receptors, and $Na^{++}K^{+}$ dependent ATPases. It also kills harmful microbes, and for this reason, thiomersal has been widely used as a preservative in a number of biological and drug products, including vaccines.

Here's a curious "coincidence." In the late 1930s, thiomersal, this mercury-containing organic compound (an organomercurial) was introduced into vaccines. In 1943, The Austrian paediatrician Leo Kanner identified autism as a new type of mental disorder, labelling it infantile autism.⁴⁹ In 1944, one year after Kanner's publication, Hans Asperger described children that he also called 'autistic', but who seemed to have high non-verbal intelligence quotients and who used a large vocabulary appropriately. Confusion remains about the distinction between Asperger syndrome and high-functioning autism.⁵⁰

The debate about thiomersal-containing vaccines causing autism resulted in studies, most of which could not find a strong link between thiomersal-containing vaccines and ASD. It was also concluded that the pharmacokinetics of ethylmercury make such an association less likely. Apparently, epidemiologic studies that support a link demonstrated significant design flaws that invalidate their conclusions.⁵¹

Because of an increasing awareness of the theoretical potential for neurotoxicity of even low levels of organomercurials and because of the increased number of thiomersal containing vaccines that had been added to the infant immunization

schedule, concerns about the use of thiomersal in vaccines and other products continued to be raised.

In 1997, Frank Pallone, a U.S. congressman from New Jersey, attached a simple, 133-word amendment to a Food and Drug Administration (FDA) reauthorization bill. This amendment gave the FDA 2 years to “compile a list of drugs and foods that contain intentionally introduced mercury compounds and [to] provide a quantitative and qualitative analysis of the mercury compounds in the list. The bill — the FDA Modernization Act of 1997 — was signed into law on November 21, 1997. Vaccine manufacturers had to reduce or eliminate thiomersal from vaccines routinely recommended for children 6 years of age and younger, with the exception of inactivated influenza vaccine. After this law was signed, low-dose thiomersal vaccines became available. These childhood vaccines contained 1 microgram or less of mercury per dose.⁵²

In 2012, the American CDC states that ‘no convincing evidence of harm (is) caused by the low doses of thiomersal in vaccines, except for minor reactions like redness and swelling at the injection site. In spite of this official approval, the Public Health Service agencies, the American Academy of Pediatrics, and vaccine manufacturers agreed in July 1999 that thiomersal should be reduced or eliminated from childhood vaccines as a precautionary measure. Since 2001, with the exception of some influenza (flu) vaccines, thiomersal is not used as a preservative in routinely recommended childhood vaccines.⁵³ That manufacturer of pharmaceuticals freely withdrew vaccines with higher thiomersal-content from the market, is interesting, leading to speculation.

In 2010, a study by the Centers for Disease Control and Prevention (CDC) has shown that prenatal and infant exposure to vaccines and immunoglobulins that contain thiomersal does not increase risk for autism spectrum disorder (ASD). This case-control study was conducted in 3 managed care organizations (MCOs) of 256 children with ASD and 752 controls matched by birth year, gender, and MCO. Prenatal and early-life exposure to ethylmercury from thiomersal-containing vaccines and immunoglobulin preparations was not related to increased risk of ASDs. The researches concluded that prenatal and early-life exposure to ethylmercury from thiomersal-containing vaccines and immunoglobulin preparations was not related to increased risk of ASDs.⁵⁴

In a similar study, governmental researchers from the US National Center for Immunizations and Respiratory Diseases, Influenza Division, Centers for Disease Control and Prevention in Atlanta, Georgia enrolled 1047 children between the ages of 7 and 10 years and administered standardized tests assessing 42 neuropsychological outcomes (but did not assess autism-spectrum disorders). Exposure to mercury from thiomersal was determined from computerized immunization records, medical records, personal immunization records, and parent interviews. Information on potential confounding factors was obtained from the interviews and medical charts. The researchers assessed the association between current neuropsychological performance and exposure to mercury during the prenatal period, the neonatal period (birth to 28 days), and the first 7 months of life. Among the 42 neuropsychological outcomes, the researchers could detect a few significant associations with exposure to mercury from thiomersal.⁵⁵

Similarly, the author participated in a study on autism, conducted in Saudi Arabia with the cooperation of the University of Cairo. The researchers identified multiple toxic metal exposure in the autistic group. While vaccination could not be identified as a cause of autism, autistic children participating in the study showed considerably higher levels of toxic metals in hair and urine than the children of the control group. Maternal second-hand smoke exposure was higher in the autistic group as was maternal and infantile seafood consumption.⁵⁶ We also noted that nutritional deficiencies were more prevalent in the autistic group, an observation also reported by Priya et al, Goyer and others.^{57, 58 59 60}

What have those studies in common? They are based on vaccines containing low amounts of thiomersal, 1 microgram or less of mercury per dose. But prior to May 1999, the FDA found that by 6 months of age, infants could have received as much as

75 µg of mercury from three doses of the diphtheria–tetanus–pertussis vaccine

75 µg from three doses of the Haemophilus influenzae type b vaccine,

37.5 µg from three doses of the hepatitis B vaccine

- **a total of 187.5 µg of mercury.**

Prior to the enactment of the 2001 law, an American child age two had received normal childhood vaccination per common pediatric programs had been exposed to 237 micrograms of mercury through vaccination alone!

Three days in particular may have been singled out as spectacularly toxic for infants vaccinated prior to 2001:

Day of birth: hepatitis B vaccine contains 12 mcg mercury

At 4 months: DTaP and HiB vaccines are given on the same day, providing a mercury dose of 50 mcg

At 6 months: Hep B, Polio vaccines are given, providing 62.5 mcg mercury

At 15 months the child receives another 50 mcg

This is in sharp contrast to vaccination programs involving low-dose thiomersal vaccines. Currently, U.S. EPA uses a RfD (Reference Dose) for mercury of 0.1mcg/kg body weight per day as an exposure without recognized adverse effects.

Another, not commonly known fact is that the law allowed the continued use of high-thiomersal vaccines that were stored in clinics and pharmacies prior to the enactment of the 2001 law, and we have no idea how much was stored. Parents of a child whose immunization program started in 2001 do not know if the child received low or high-dose thiomersal vaccines. As a matter of fact, the paediatrician who administered the vaccines may not know either. He or she may have acted in good faith, believing in injecting a low-mercury vaccine when in fact the child received one of the 'older' supplies.

DIAGNOSTIC TESTS TO EVALUATE THE MERCURY STATUS

Improved instrumentation allow the detection of minute amounts in blood, hair, saliva or urine. In hair, we determine past exposure and that exposure may have happened before birth.

Today, we can detect mercury levels greater than 0.1mcg/g and since microwave digestion of hair is completed in closed vessels, we no longer have the problem of escaping mercury fumes, as we did some years ago. We know see what has been stored over time.

In blood or urine, the detection limit is even lower. Only minute amounts of mercury find its way into the bloodstream via food or medication, and only small amounts are excreted via urine or stool. We can analyse for mercury in mother's milk and other foods.

Environmental agencies are recognizing that a low burden of mercury exposure can cause harm. As a result, reference ranges have been lowered consistently over the past decades. We are now able to diagnose and treat mercury exposure before severe health problems appear.

TREATMENT

High mercury concentration in blood:

Rule out that the patient ate fish prior to testing. If that was the case, ask the patient to avoid eating fish for 3 days and have a repeat mercury blood analysis done. Results should now be within the expected range.

Evaluate any potential cause of exposure, and remove it, if possible. Nutritional detoxification methods may suffice, such as

- oral intake of sulfur-containing amino acids such as cysteine, increased vitamin E intake, glutathion may be added and selenium. The following program may be suitable for children, age 3 and older. Adjust according to age and weight.
 - 1 capsule of amino acid complex
 - 1 capsule cysteine
 - 100 IE Vitamin E
 - 50mcg Selenium
 - 1 B-complex to aid the amino acid metabolism
- Nutrients may be given intravenously. To avoid reactions such as an intolerance or allergy to any of the ingredients, check with your physician.
- Nutrient infusions are generally not given to young children, unless hospitalization requires such medical intervention.

- For patients with elevated blood mercury levels, chelation may be the treatment of choice. The chelating agents DMSA (oral) or DMPS (oral or i.v.) bind mercury most effectively. Oral DMSA or DMPS are generally well tolerated; however allergic reactions or intolerance to either one chelating agent have been reported (see Chelation). Check with a doctor.

High mercury concentration in morning urine or randomly collected urine. No detoxication treatment has been given!:

Rule out that the patient eat fish prior to testing. If that was the case, avoid eating fish for 3 days and have a repeat mercury urine analysis done. Results should now be within the expected range. If they are not, check for sources of immediate exposure and seek medical help.

High mercury concentration in hair represents a chronic exposure. Blood and urine testing is usually negative since metals are deposited in tissue.

If the hair mercury level is elevated, evaluate the potential cause of exposure. It may have happened long ago, even prenatally. Rule out the possibility of an additional, immediate exposure. Remove it and avoid all sources of mercury, such as eating large fish, avoid thiomersal-containing vaccines and medications. If the patient has amalgam fillings, a saliva test can tell if metals are released. If that is the case, check with a dentist trained in alternative dentistry.

Carefully evaluate amalgam removal. The removal of amalgam fillings by overly zealous dentists may cause more immediate harm than good. If amalgam fillings are removed, consider chelation. IBCMT recommends that dentists and medical physicians cooperate to prevent additional mercury exposure during amalgam removal (which releases mercury as fumes and particles that are inhaled or swallowed, contributing to existing exposures.)

Start a nutritional detoxification program as outlined above. It will aid the body to naturally detoxify and ask a physician trained in clinical metal toxicology about additional chelation treatments.

CONCLUSION:

Mercury and its compounds are wide spread in today's commercial world. A child may have been exposed to mercury and other toxins before birth, and we would not even know it. We don't test infants for mercury exposure and thus do not know how many infants enter this world with a metal load, and how much of a load it is!

Not all burdened newborns show symptoms, but as they say, if an already filled glass receives a few additional drops, it will eventually run over.

Said differently, if, during the first two years, more neurotoxins are added to an already burdened system, neurological disorders can be expected to show sooner or later.

Parents should ask themselves the following questions:

- has the mother received vaccination before or during pregnancy?

- did the mother receive dental amalgam treatment during pregnancy?
- has the mother smoked prior to, or during pregnancy?
- has she eaten fish regularly during pregnancy and nursing?
- did vaccination cause a noticeable change in behavior?

If any of these questions are answered with Yes, we can expect the child to show a metal burden, and it may or may not yet be significant.

Extra care should be taken that an existing burden is not increased through the addition of mercury-containing foods, medicines or other sources. An already fragile system may not be able to tolerate this. In fact, it is not unusual that a child 'suddenly' turns autistic, not after the first immunization but after successive vaccination treatments.

MINERALS AND TRACE ELEMENTS AFFECTING NEUROFUNCTION

INFORMATION ABOUT RECOMMENDED INTAKE LEVELS

Recommendations for nutrients are provided in the Dietary Reference Intakes (DRIs) developed by the Institute of Medicine of the National Academy of Sciences. *Dietary Reference Intakes* is the general term for a set of reference values used for planning and assessing nutrient intake for healthy people.

Three important types of reference values included in the DRIs are *Recommended Dietary Allowances* (RDA), *Adequate Intakes* (AI), and *Tolerable Upper Intake Levels* (UL).

The RDA recommends the average daily intake that is sufficient to meet the nutrient requirements of nearly all (97%-98%) healthy people. An AI is set when there is insufficient scientific data available to establish a RDA for specific age/gender groups. AIs meet or exceed the amount needed to maintain a nutritional state of adequacy in nearly all members of a specific age and gender group. The UL, on the other hand, is the *maximum* daily intake unlikely to result in adverse health effects.⁶¹

COPPER (CU)

USES AND FUNCTION

Copper is an essential element in biological systems. A 70 kg adult human body contains approximately 80mg of copper, one third in muscle and the remainder in other tissues and fluids. The importance of copper in the efficient use of iron makes it essential in hemoglobin synthesis.

In the divalent state, Cu^{2+} has the capacity to form complexes with many proteins. In these cuproproteins, copper is part of the molecule and is present as a fixed proportion of the molecular structure. Metalloproteins form an important group of

oxidase enzymes, including ceruloplasmin, superoxide dismutase, cytochrome oxidase and others.

Copper is found in four different forms in the human body:

- 1) bound to albumin
- 2) bound to amino-acids (especially histidine, threonine, and glutamine)
- 3) ceruloplasmin
- 4) erythrocuprein, only found in erythrocytes

COPPER IS NEEDED FOR

- iron absorption
- protein synthesis
- vitamin C absorption
- the production of RNA
- the production of myelin
- for the synthesis of TSH (thyroid stimulating hormone). Copper and Zinc containing metallo-enzymes are essential for thyroxin metabolism.
-

ABSORPTION AND EXCRETION:

Copper readily binds with L-amino acids, which facilitate its absorption from the stomach and duodenum. Adults absorb approximately 56% of the dietary copper. About 30% of dietary Copper is absorbed in the upper gastrointestinal tract and the main route of excretion is through bile. Less than 50 mg/day of copper are lost in urine. The liver is the main organ for storage and excretion.

Animal tests have shown that cadmium interferes with copper absorption.

Required Daily Amount (in mg)

Infants, 0-5 months: 0.5-0.7

Infants, 5-12 mo. 0.7-1.0

Children, 1-3 yrs 1.0-1.5

4-6 1.5-2.0

7+ 2.0-2.5

Adults, all genders 2.0-3.0

DEFICIENCY SYMPTOMS:

Particularly in infants, Copper deficiency produces three distinct symptoms:

- 1) Anemia, hypoproteinemia, and low serum and copper levels, which are corrected by combined iron and copper supplementation.

Pronounced neutropenia, anemia, diarrhea, bone changes, and hypocupremia can be found in malnourished infants receiving high-calorie, low copper diets, usually through hyperalimentation. These infants respond to copper therapy.

Known as Menke's or kinky hair syndrome, this problem is caused by X-linked genetic defect in copper absorption from the intestinal mucosa that results in low blood, liver, and hair copper levels. Progressive mental deterioration and defective keratinization of hair result.

Symptoms of Copper Deficiency in young people and adults:

- Reduced hemoglobin synthesis
- Impaired Fe metabolism, and reduced Fe in the tissues
- Hypochromia
- Microcytic anemia
- Kwashiorkor (esp. protein and amino acid deficiency)
- Heart disease
- Infectious hepatitis
- Poor growth and development
- Cirrhosis
- Infertility
- Pancreatic dysfunctions
- Diarrhea

Problems associated with copper deficiency

- Reduced vitamin A levels in the liver
- Impaired phospholipid synthesis
- Reduced production of melanin, causing hair loss, albinism, etc.
- Impaired Zinc metabolism
- High Molybdenum levels (disturbed Cu/Mo ratio increases Mo. levels and depresses Copper metabolism).
- Increased Cadmium levels (Cadmium depresses Copper levels)
- Increased cholesterol levels

THE RECOMMENDED DIETARY ALLOWANCE (RDA)

A variety of indicators were used to establish the recommended dietary allowance (RDA) for copper, including plasma copper concentration, serum ceruloplasmin activity, superoxide dismutase activity in red blood cells, and platelet copper concentration. The RDA for copper is based on the prevention of deficiency.

Recommended Dietary Allowance (RDA) for Copper			
Life Stage	Age	Males (mcg/day)	Females (mcg/day)
Infants	0-6 months	200 (AI)	200 (AI)
Infants	7-12 months	220 (AI)	220 (AI)
Children	1-3 years	340	340

Children	4-8 years	440	440
Children	9-13 years	700	700
Adolescents	14-18 years	890	890
Adults	19 years and older	900	900
Pregnancy	all ages	-	1,000
Breastfeeding	all ages	-	1,300

TOXICITY:

Copper toxicity is a potential complication in long-term hemodialysis patients. An excess dietary intake through copper-rich foods or water, combined with a reduced ability to excrete copper can also cause elevated blood and hair copper levels.

Copper is considered to be a brain stimulant. Above average intelligent students have shown to have slightly elevated Copper and Zinc hair levels. Hyperactive children often display elevated hair Copper and low Zinc levels, and respond well to Zinc supplementation. Elevated hair copper levels have also been linked to emotional instability.

The administration of estrogens can increase Copper blood and hair levels, causing emotional instability and depression. Postpartum depression has been linked to elevated copper hair and blood levels. During pregnancy, especially during the first trimester, copper levels increase steadily. At conception the mean Copper level is approximately 115 mcg%, and at delivery around 260 mcg%, and continuing high post-partum levels have been linked to depression and mood disorders. Drs. Pfeiffer and Iliev reported that compared to the rise in copper levels during pregnancy, oral intake of estrogen raises the copper levels of schizophrenics even more.

Copper overload can result from drinking copper-rich drinking water, as well as copper-rich diet, the use of copper IUDs or long-term copper therapy.

SOURCES OF COPPER

Copper is found in many foods. Liver, cocoa, oysters, nuts, shellfish, liver, kidney, egg yolk, and Brewer's yeast are particularly rich sources.

Copper content of foods (mg/100g)

Plant foods

Cocoa powder	3.9
Nuts	0.3-3.7
Brewer's yeast (dry)	3.3

Animal foods

Liver	3.6-7.6
Oyster	1.2-3.7
Mussels	3.2

Chocolate	1.1-2.7	Cheese	0.01-1.17
Wheat germ	1.55	Meat	0.04-0.6
Mushrooms	0.2-1.0	Fish	0.01-0.55
Wheat bran	0.95	Fowl	0.1-0.45

SIGNIFICANCE OF LABORATORY TESTS

Approximately 90% of the total plasma copper is firmly bound to the α_2 -globulin ceruloplasmin, which is an oxidase involved in the binding of iron to transferrin in the plasma and also in the utilization of iron. Of the remaining 10% of plasma copper, most is loosely bound to albumin, which acts as the plasma carrier of copper and a very small fraction is complexed with amino acids or present in other copper enzymes.

It is generally agreed that there is a gender difference in serum copper levels.

Low serum copper levels are found in patients with:

- Wilson's disease
- Menke's disease or kinky hair syndrome
- Some iron-deficiency anemias
- Protein malnutrition
- Chronic ischemic heart disease
- Burn patients

Elevated blood and hair copper levels have been found

- after the use of oral contraceptives and estrogen therapy
- in patients undergoing renal dialysis
- during the third trimester of pregnancy, which may be considered normal.
- postpartum depression has been linked to elevated copper levels
- in many chronic and acute disease states, including
 - Hodgkin's disease
 - Leukemia and other malignancies
 - Megaloblastic and aplastic anemia
 - Hemochromatosis
 - Liver disease
 - Rheumatic fever
 - Major and minor thalassemia
 - Trauma
 - Psychiatric disease states, including schizophrenia
 - Collagen diseases
 - Depression

Environmental Factors influencing hair levels

Frequent swimming in pools, treated with copper-containing algacides can falsely elevate hair copper levels.

THERAPEUTIC CONSIDERATION:

To normalize copper levels, it is important to pay attention to related trace elements such as iron, manganese, zinc and molybdenum. Vitamin C increases the copper mobilization and excretion, especially when supplemented with L-amino acids and vitamin B6.

Copper-deficiency anemia in children can be caused by chronic diarrhea that is relatively common in infants allergic to cow's milk. Chronic diarrhea can cause Copper deficiency.

Copper overload is often found in histapenic patients (patients with histamine deficiency), as well as patients suffering from depression and psychoses, together with insomnia. High hair Copper levels are often found in patients with migraines, arthritis, cancer, as well as after long-term estrogen therapy. Hair Copper levels are a reliable indicator for liver storage.

Tyramine rich foods such as cheese, yeast, herring, and chicken liver are migraine triggers. It has been suggested that tyramine-rich foods influence the absorption of Copper. Note: Foods such as chocolate, nuts, and crustaceans are very low in tyramine, but are high in Copper, and are generally considered to be migraine triggers. Citrus fruit further increases the absorption of Copper in the small intestine. Glutamate (after being transformed into glutamine), increases Copper transport to the tissues.

WILSON'S DISEASE

Wilson's disease is an inborn error of copper metabolism inherited as an autosomal recessive characteristic in humans of both sexes. The disease is distinguished by excessive accumulation of copper in the liver, brain, cornea and kidneys, with low levels of ceruloplasmin copper in serum. The effectiveness of chelation as a treatment can be monitored by urinary copper measurements.

The chelating agent DMPS effectively removes copper.⁶²

RESEARCH***COPPER AND IDIOPATHIC SCOLIOSIS***

In the 1980's Pratt and Phippen published their results on research done on Copper levels in patients with idiopathic scoliosis (IS). The study was undertaken at the Elizabethtown Hospital for Children, Elizabethtown, Pennsylvania, and included 74 IS children and 25 healthy controls. The authors reported that the overloads or deficiencies of Copper, Zinc and Manganese presented an important factor in the treatment of IS. Our own research on 12-year old twins suffering from IS, confirmed their findings. The treatment comprising diet and mineral therapy, as well as physiotherapy according to Lehnert-Schroth, resulted in correction of the scoliotic curvature.

COPPER AND MIGRAINES

Tyramine-rich foods such as cheese, yeast, chicken liver, wine, pickled herring, etc. can cause migraines. This does not mean, however, that foods free of tyramine do not trigger migraine attacks. Harrison suggests that migraines are more likely triggered by foods which influence the absorption and utilization of Copper. Chocolate, nuts, shellfish, and wheat germ are rich in Copper, whereas citrus fruit contain citrate, which increases the intestinal absorption of copper. Migraine sufferers should, therefore, reduce dietary Copper and its constituents, which enhance the cellular Copper uptake.

Harrison, D.P, COPPER AS A FACTOR IN THE DIETARY PRECIPITATION OF MIGRAINE, Headache 26:248-250, May 1986

IMMUNE DEPRESSION AND ALLERGIC REACTIONS

Copper deficiency is associated with increased susceptibility to infections. The functions of the reticulo-endothelial system, granulocyte activity, and antibody function, as well as thymus hormone activity, are considerably reduced in the presence of copper deficiency.

Chandra, R.K., TRACE ELEMENT REGULATION OF IMMUNITY AND INFECTION, J. Am. Coll. Nutr. 4 (1985) 5-16.

IRON (FE)

GENERAL INFORMATION

The average adult male contains approximately 4 grams of body iron. About 65 to 70% is found in hemoglobin, 4% in myoglobin, and less than 1% in other iron-containing enzymes and proteins. The remaining 25-30% represents the storage pool of iron. By comparison, women have a much smaller iron reserves with the adult female body containing about 3grams of iron. Women also have a slightly lower hemoglobin concentration in blood than males.

METABOLISM AND REQUIREMENT

Daily requirements for iron vary depending on sex, age, and physiological status. Although iron is not excreted in the conventional sense, there is a daily loss of about 1mg due to the normal shedding of intestinal mucosal cells and skin epithelial cells and the loss of small numbers of erythrocytes in urine and feces. As a result, an iron intake of 1mg/day is sufficient for men and postmenopausal women; however, menstruating females need about 1.5 to 2mg of iron per day to offset the loss of about 20 to 40mg of iron during each menstrual cycle. Pregnancy, blood loss at delivery, and subsequent breast feeding increases the iron requirement.

DAILY REQUIREMENT

Healthy full term infants are born with a supply of iron that lasts for 4 to 6 months. There is not enough evidence available to establish a RDA for iron for infants from birth through 6 months of age. Recommended iron intake for this age group is based on an Adequate Intake (AI) that reflects the average iron intake of healthy infants fed breast milk.⁶³

Recommended Dietary Allowances (RDA) for Iron⁶⁴

Age	Males (mg/day)	Females (mg/day)	Pregnancy (mg/day)	Lactation (mg/day)
7 to 12 months	11	11	N/A	N/A
1 to 3 years	7	7	N/A	N/A
4 to 8 years	10	10	N/A	N/A
9 to 13 years	8	8	N/A	N/A
14 to 18 years	11	15	27	10
19 to 50 years	8	18	27	9
51+ years	8	8	N/A	N/A

N/A= not applicable

Nutrient requirements increase during pregnancy to support fetal growth and maternal health. Iron requirements of pregnant women are approximately double that of non-pregnant women because of increased blood volume during pregnancy, increased needs of the fetus, and blood losses that occur during delivery.⁶⁵ If iron intake does not meet increased requirements, iron deficiency anemia can occur. Iron deficiency anemia of pregnancy is responsible for significant morbidity, such as premature deliveries and giving birth to infants with low birth weight.

IRON AND HEALTHFUL DIETS

The federal government's 2010 *Dietary Guidelines for Americans* notes that "nutrients should come primarily from foods.

Meat such as lean beef and turkey are good sources of heme iron. Beans, lentils, and soybeans contain non-heme iron.

The absorption of heme iron vs. non-heme iron varies considerable. Iron from animals sources is more easily absorbed. Research indicates that 37% of heme iron was absorbed. None-heme iron absorption was 5%.⁶⁶

ABSORPTION AND STORAGE

The average North American diet supplies between 10 and 20mg of iron per day. Only 5 to 10% of this amount is absorbed, mainly in the duodenum and upper small intestine. Most dietary iron is in the ferric (Fe^{3+}) state, which is poorly absorbed. Gastric secretion and hydrochloric acid reduce ferric iron to the absorbable ferrous (Fe^{2+}) form. Ascorbic acid, sugars, amino acids and other compounds that form soluble iron chelates enhance the iron absorption, but substances such as phosphates (found in eggs, milk and cheese), oxalates (found in spinach and rhubarb), phytates (found in vegetables and grains) and tannates (found in tea), reduce iron absorption.

About one third of body iron is stored in the liver, one third in the bone marrow, and the remainder in the spleen and other tissues. It is bound in tissues in two forms: ferritin and hemosiderin.

FACTORS SUPPORTING IRON ABSORPTION:

- Vitamin C
- Digestive support to improve gastrointestinal function

- Amino acids. especially cysteine. cystine. and methionine
- Adequate protein consumption

TRANSPORT MECHANISM

Transferrin, a single-chain polypeptide, is the transport protein for iron in blood. Each transferrin molecule has two binding sites for ferric iron, and these sites are normally 20%-50% saturated. The need for a specific carrier protein derives from the toxicity and relative insolubility of free iron. Virtually all of the plasma iron is protein bound and at any given moment, plasma transferrin carries about 3 to 4mg of iron.

SOURCE

Iron Content of Foods (mg/100 g)

<u>Plant Foods</u>		<u>Animal Foods</u>	
Brewer's yeast	17.5	Pig's liver	20
Sesame seeds	10	Beef liver	10
Soy beans. millet	9	Pig's kidneys	10
Wheat germ	8	Beef pancreas	9
Sunflower seeds	6.3	Calves liver	8
Parsley leaf	6	Beef liver	7
Lentils	7	Oysters	5.8
Beans (white). Oats	6	Liverwurst	5.3
Oat meal	5	Lungs. Heart	5
Rye	4.6	Ocean fish	0.5-2.4
Wheat bran	4	Brain	2.5-3
Spinach	3-4	Ham	2.3
Wheat flour	4.4	Egg	2
Rye bread	3	Meat	1-2
Wheat	3	Duck. chicken	1.8-2
Rice (unpolished)	2.6	Shrimps	1.8
Corn	0.5-2.4	Cheese	0.2-1
Rye flour	2.1	Freshwater fish	0.6-1
Noodles. carrots	2	Cottage cheese	0.4
Whole wheat bread	2	Whey	0.1

Cabbage	2	Full cream milk	0.045
Salads	1.1-2	Breast milk	0.1

While breast milk does not contain much iron, a Finish study demonstrated that breast-fed babies had a far superior dietary iron intake than bottle-fed infants. Apparently, the small intestines of babies are capable of utilizing up to 50% of the iron found in breast milk, but absorb only 20% of the iron found in cow's milk.

IRON DEFICIENCY

Since iron is necessary for cell function and oxygen utilization, fatigue is one of the most common symptoms. Poor attention & cognition, generally a result of low energy are also common. Other deficiency symptoms are difficulty swallowing pills and a sallow complexion. Patients exposed to excessive copper, manganese or lead are prone to iron deficiency, because these trace elements are physiologically antagonistic to each other.

Deficiency is relatively common and blood loss is the most common cause. The high prevalence of iron deficiency among women is due to menstrual blood loss. Causes of iron deficiency esp. in men are bleeding from the intestinal tract (i.e. peptic ulcer, diverticulosis) or malignancy. People who eat junk food or place a heavy emphasis on milk and cereals are easily affected by iron. Frequent diarrhea or partial or total gastrectomy cause malabsorption problems, leading to iron deficiency.

Iron deficiency anemias are caused by an insufficient dietary intake or are the result of absorption problems. Strict vegans are prone to iron deficiency anemias, as are people suffering from intestinal bleeding. A poor iron absorption may also be caused by an inadequate intake of vitamin C or B12. Before iron supplementation is attempted, supplementing these vitamins may solve the problem.⁶⁷

IRON DEFICIENCY DURING DEVELOPMENT

Sufficient iron intake is of particular importance during pregnancy. Anemia reportedly causes a higher rate of premature birth:

Women with severe anemia	42%
Women with average anemia	14%
Women with no clinical anemia	8%

A significant cause of iron-deficiency anemia is [parasitic worms](#): [hookworms](#), [whipworms](#), and [roundworms](#).⁶⁸ Worms cause intestinal bleeding which isn't always noticeable in feces and is especially damaging to growing children. In underdeveloped countries, malaria, hookworms and vitamin A deficiency contribute to anemia during pregnancy.⁶⁹

Iron deficiency during pregnancy can affect the newborn. Infants, affected in their earlier stages of development may suffer greater consequences than adults as iron-deficiency anemia affects neurological development by decreasing learning ability, altering motor functions, and permanently reducing the number of [dopamine](#) receptors and [serotonin](#) levels. Iron deficiency during development can lead to

reduced [myelination](#) of the [spinal cord](#) as well as a change in myelin composition. Additionally, iron-deficiency anemia has a negative effect on physical growth. [Growth hormone](#) secretion is related to serum [transferrin](#) levels, suggesting a positive correlation between iron-transferrin levels and an increase in height and weight. Iron deficiency is also linked to [pica](#), a problem characterized by an [appetite](#) for substances largely non-nutritive such as clay, dirt or chalk.⁷⁰ Other common symptoms are shortness of breath and a poor appetite.

SYMPTOMS ASSOCIATED WITH IRON DEFICIENCY:

- Anorexia
- Growth problems
- Sore tongue
- Lethargy
- Irritability
- Poor concentration
- Impaired protein metabolism

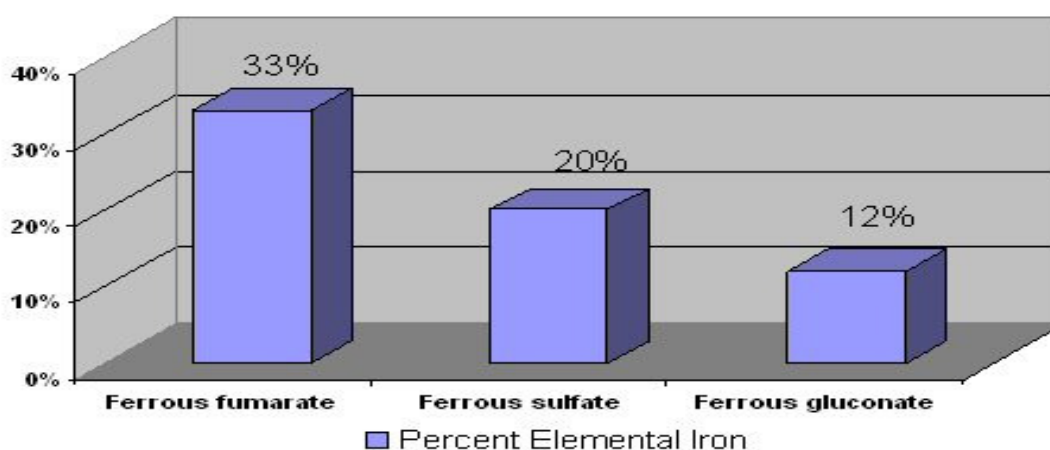
FACTORS INFLUENCING IRON-DEFICIENCY ANEMIA:

- Pyridoxin (B6) deficiency can mimic iron deficiency anemia. In the case of a B6 deficiency, serum iron levels and bone marrow hemosiderin are often elevated.
- Pernicious anemia is a B12 deficiency, caused by the lack of intrinsic factors.
- Folic acid deficiency anemia is mostly found in alcoholics. but can also be the result of faulty diet or malabsorption problems (disease of the intestine) or cirrhosis of the liver. Anticonvulsant drugs can cause folate deficiency. Low serum folate levels confirm folic acid deficiency anemia

THERAPEUTIC CONSIDERATIONS

Supplemental iron is available in two forms: ferrous and ferric. Ferrous iron salts (ferrous fumarate, ferrous sulfate, and ferrous gluconate) are the best absorbed forms of iron supplements [64]. Elemental iron is the amount of iron in a supplement that is available for absorption.

The following table shows that there is a significant difference in elemental iron found in iron supplements.



In case of an acute deficiency, the body's absorption rate is slightly higher than normal. The average diet provides between 5 and 7 mg of iron per 1000 calories, and anemia is often the result of an insufficient dietary supply, especially in children and juveniles. Before iron supplementation is implemented, the individual iron requirements must be based on laboratory tests to distinguish iron deficiency from other causes and pay attention to the following factors.

IRON AND MINERAL INTERACTIONS

Some researchers have raised concerns about interactions between iron, zinc, and calcium. When iron and zinc supplements are given together in a water solution and without food, greater doses of iron may decrease zinc absorption. However, the effect of supplemental iron on zinc absorption does not appear to be significant when supplements are consumed with food.⁷¹ There is evidence that calcium from supplements and dairy foods may inhibit iron absorption, but it has been very difficult to distinguish between the effects of calcium on iron absorption versus other inhibitory factors such as phytate.⁷²

- Age and sex
- Blood loss (menstruation, hemorrhage)
- Pregnancy
- Copper and manganese levels should be checked (high levels can block iron absorption)

Lead levels should be checked (lead intoxication causes iron-deficiency anemia) and hair analysis is a useful test for evaluating a chronic lead exposure, sampling is easy and painless.

THE RISK OF IRON TOXICITY

There is potential for iron toxicity because very little iron is excreted from the body. As a result, iron can accumulate in body tissues and organs when normal storage sites are full. People with hemochromatosis are at risk of developing iron toxicity because of their high ability to store iron.

In children, death has occurred from ingesting 200 mg of iron.⁷³ **It is important to keep iron supplements tightly capped and away from children's reach.**

Any time excessive iron intake is suspected, **immediately** call your physician or Poison Control Center, or visit your local emergency room. Doses of iron prescribed for iron deficiency anemia in adults are associated with constipation, nausea, vomiting, and diarrhea, especially when the supplements are taken on an empty stomach.

In 2001, the Institute of Medicine of the National Academy of Sciences set a tolerable upper intake level (UL) for iron for healthy people. At times, a physician may prescribe an intake higher than the upper limit for an individual with a defined iron deficiency to replenish their iron stores. Before this medical supplementation takes place, the diagnosis has to confirm that a low iron storage is, indeed, the underlying problem.

Tolerable Upper Intake Levels for Iron ⁷⁴

Age	Males (mg/day)	Females (mg/day)	Pregnancy (mg/day)	Lactation (mg/day)
7 to 12 months	40	40	N/A	N/A
1 to 13 years	40	40	N/A	N/A
14 to 18 years	45	45	45	45
19+ years	45	45	45	45

N/A = not applicable

LABORATORY DIAGNOSIS

There are three iron compartments. accounting for more than 90% of the total body iron, hemoglobin, serum ferritin levels and circulating iron.

A complete blood count gives the number of erythrocytes per liter, hemoglobin concentration, hematocrit. and red blood cell indices.

In defined iron-deficiency anemia, cell size (MCV) and hemoglobin content (MCH) are reduced and the concentration of hemoglobin per cell (MCHC) is also down. At an early stage of iron depletion, both hemoglobin concentration and red cell indices are normal. A HMA usually indicates a low iron status. Red blood cell parameters define the presence of absence of anemia and its morphological character. but other tests are required to identify the cause and type of anemia.

Serum concentration are

- decreased in iron-deficiency anemia, in chronic anemias, in malignancies, in inflammation and infections. myocardial infarction and after surgery
- increased in red cell disorders such as megaloblastic anemias, thalassemia. and sideroblastic anemia, bone marrow hypoplasia, viral hepatitis, acute iron poisoning, and hemochromatosis.
- Serum iron values must be confirmed with Total iron-binding capacity (TIBC) and transferrin saturation. TIBC measures the maximum amount of iron that serum protein can bind and is an indirect way of assessing Transferrin Levels.

Significance of HMA Iron levels

Iron levels in hair represent the iron status of tissues and have been reported to reflect cytochrome changes. HMA, in conjunction with blood analysis, can be an early indication of an inadequate iron intake or of a disturbed iron metabolism.

When the HMA shows low Fe levels, low tissue storage and anemic tendency must be suspected. An inadequate iron intake or absorption problems may be present. Before iron therapy is implemented, other laboratory analytes should be evaluated.

High HMA levels can be present in conjunction with low serum iron levels and symptoms of anemia, signifying a mobilization problem. Ascorbic acid depletion may be the cause.

RESEARCH:

Iron deficiency results in poor immunity and reduces the bactericidal capacity of neutrophils and lymphocyte response.

Chandler. R.K.: Nutrition and immunity-basic consideration. Part I. Contemp.Nutr. 11 (1986)

Chandra. R.K.: Trace element regulation of immunity and infection. J.Am.Coll.Nutr. 4 (1985) 5-16.

Immuno-suppression can already occur at a 10% reduction of iron intake.

Levy. J.A.: Nutrition and the immune system. in: Sites. D.P. et.al.: Basic and clinical immunology. 4th Edition. Lange Med.Pub. Los Altos. CA. (1982) pp. 297-305.

Acute ulcerative colitis was treated with a low-fat diet (6.5% of daily calorie intake). vitamin E and ferrous gluconate. Corticosteroids were discontinued after a short time. Before the nutrient therapy, colonoscopies and biopsies showed severe acute inflammation. Shortly after beginning of the therapy. the inflammation reduced considerably. When the nutrient therapy was stopped, the symptoms reappeared. Supplementation of vitamin E and Fe only was not successful.

Bennet. J.D.: Use of a-Tocopherylquinone in the treatment of ulcerative colitis. GUT 27 (1986) 695-697.

MAGNESIUM (MG)

Magnesium is the fourth most abundant mineral in the body and is essential to good health. Approximately 50% of total body magnesium is found in bone. The other half is found predominantly inside cells of body tissues and organs. Only 1% of magnesium is found in blood, but the body works very hard to keep blood levels of magnesium constant.⁷⁵

Magnesium is needed for more than 300 biochemical reactions in the body. It helps maintain normal muscle and nerve function, keeps heart rhythm steady, supports a healthy immune system, and keeps bones strong. Magnesium also helps regulate blood sugar levels, promotes normal blood pressure, and is known to be involved in energy metabolism and protein synthesis]. There is an increased interest in the role of magnesium in preventing and managing disorders such as hypertension, cardiovascular disease, and diabetes. Dietary magnesium is absorbed in the small intestines. Magnesium is excreted through the kidneys.^{76 77}

WHAT IS A SAFE MAGNESIUM INTAKE?

The RDA recommends the average daily intake that is sufficient to meet the nutrient requirements of nearly all (97%-98%) healthy people. The following table lists the RDAs for magnesium, in milligrams, for children and adults.⁷⁸

Recommended Dietary Allowances for magnesium for children and adults

Age (years)	Males (mg/day)	Females (mg/day)	Pregnancy (mg/day)	Lactation (mg/day)
1–3	80	80	N/A	N/A
4–8	130	130	N/A	N/A
9–13	240	240	N/A	N/A
14–18	410	360	400	360
19–30	400	310	350	310
31+	420	320	360	320

There is insufficient information on magnesium to establish a RDA for infants. For infants 0 to 12 months, the DRI is in the form of an Adequate Intake (AI), which is the mean intake of magnesium in healthy, breastfed infants. The following table lists the AIs for infants in milligrams (mg)

Age (months)	Males and Females (mg/day)
0 to 6	30
7 to 12	75

An inadequate magnesium intake is common in patients suffering from neurological disease. Magnesium deficiency is associated with anxiety, sleep disturbance (problems staying asleep), clumsiness (dyspraxia), depression, muscle cramping or tension, blood pressure changes and bladder enuresis. Magnesium is needed for the sugar and protein metabolism and energy production. Generally, people with an inadequate magnesium intake complain about constipation. Many autistic children don't have bowel movements for days- until they receive adequate magnesium.

FOOD SOURCES

Eating a wide variety of legumes, nuts, whole grains, and vegetables will help meet the daily dietary need for magnesium. Green vegetables such as spinach are good sources of magnesium. Some legumes (beans and peas), nuts and seeds, and whole, unrefined grains are also good sources of magnesium. Refined grains are generally low in magnesium. When white flour is refined and processed, the magnesium-rich germ and bran are removed. Bread made from whole grain wheat flour provides more magnesium than bread made from white refined flour. Tap water can be a source of magnesium, but the amount varies according to the water supply. Water that naturally contains more minerals is described as "hard". "Hard" water contains more magnesium than "soft" water.⁷⁹

Selected food sources of magnesium⁸⁰

Food	Milligrams (mg)	% DV*
Wheat Bran, crude, ¼ cup	89	22
Almonds, dry roasted, 1 ounce	80	20
Spinach, frozen, cooked, ½ cup	78	20
Raisin bran cereal, 1 cup	77	19
Cashews, dry roasted, 1 ounce	74	19
Soybeans, mature, cooked, ½ cup	74	19
Wheat germ, crude, ¼ cup	69	17
Nuts, mixed, dry roasted, 1 ounce	64	16
Bran flakes cereal, ¾ cup	64	16
Shredded wheat cereal, 2 rectangular biscuits	61	15
Oatmeal, instant, fortified, prepared w/ water, 1 cup	61	15
Peanuts, dry roasted, 1 ounce	50	13
Peanut butter, smooth, 2 Tablespoons	49	12
Potato, baked with skin, 1 medium	48	12
Blackeye peas, cooked, ½ cup	46	12
Pinto beans, cooked, ½ cup	43	11
Rice, brown, long-grained, cooked, ½ cup	42	11
Lentils, mature seeds, cooked, ½ cup	36	9
Vegetarian baked beans, ½ cup	35	9
Kidney beans, canned, ½ cup	35	9
Chocolate milk, lowfat, 1 cup	33	8
Banana, raw, 1 medium	32	8
Yogurt, fruit, low fat, 8 fluid ounces	32	8
Milk chocolate candy bar, 1.5 ounce bar	28	7
Milk, lowfat or nonfat, 1 cup	27	7
Raisins, seedless, ½ cup packed	26	7

Selected food sources of magnesium⁸⁰

Food	Milligrams (mg)	%DV*
Halibut, cooked, 3 ounces	24	6
Bread, whole-wheat, commercially prepared, 1 slice	23	6
Avocado, cubes, ½ cup	22	6
Chocolate pudding, ready-to-eat, 4 ounces	19	5

*DV = Daily Value. DVs are reference numbers developed by the Food and Drug Administration (FDA) to help consumers determine if a food contains a lot or a little of a specific nutrient. The DV for magnesium is 400 milligrams (mg). Most food labels do not list a food's magnesium content. The percent DV (%DV) listed on the table above indicates the percentage of the DV provided in one serving. A food providing 5% of the DV or less per serving is a low source while a food that provides 10–19% of the DV is a good source. A food that provides 20% or more of the DV is high in that nutrient. It is important to remember that foods that provide lower percentages of the DV also contribute to a healthful diet.

THE BIOAVAILABILITY OF MAGNESIUM

is influenced by dietary factors. Eating too much fiber (containing phytates) and not enough vegetables can deplete the system. People living in industrialized countries have a daily magnesium intake of 250-300mg of magnesium, but the daily need is approximately 400mg/day. Through stress, health problems such as diabetes etc may increase that need, depending on age and symptom.

There are many magnesium supplements on the market (Magnesium chloride, oxide, gluconate, malate, orotate, glycinate and citrate etc), containing various amounts of elemental magnesium. All work similarly, but the amount of elemental magnesium in a compound and its bioavailability influence the effectiveness of the magnesium supplement. Bioavailability refers to the amount of magnesium in food, medications, and supplements that is absorbed in the intestines and ultimately available for biological activity in cells and tissues. Enteric coating (the outer layer of a tablet or capsule that allows it to pass through the stomach and be dissolved in the small intestine) of a magnesium compound can decrease bioavailability.⁸¹ [In a study that compared four forms of magnesium preparations, results suggested lower bioavailability of magnesium oxide, with significantly higher and equal absorption and bioavailability of magnesium chloride and magnesium lactate.⁸²]. The following table as provided by the National Institute of Health is a good indication.⁸³

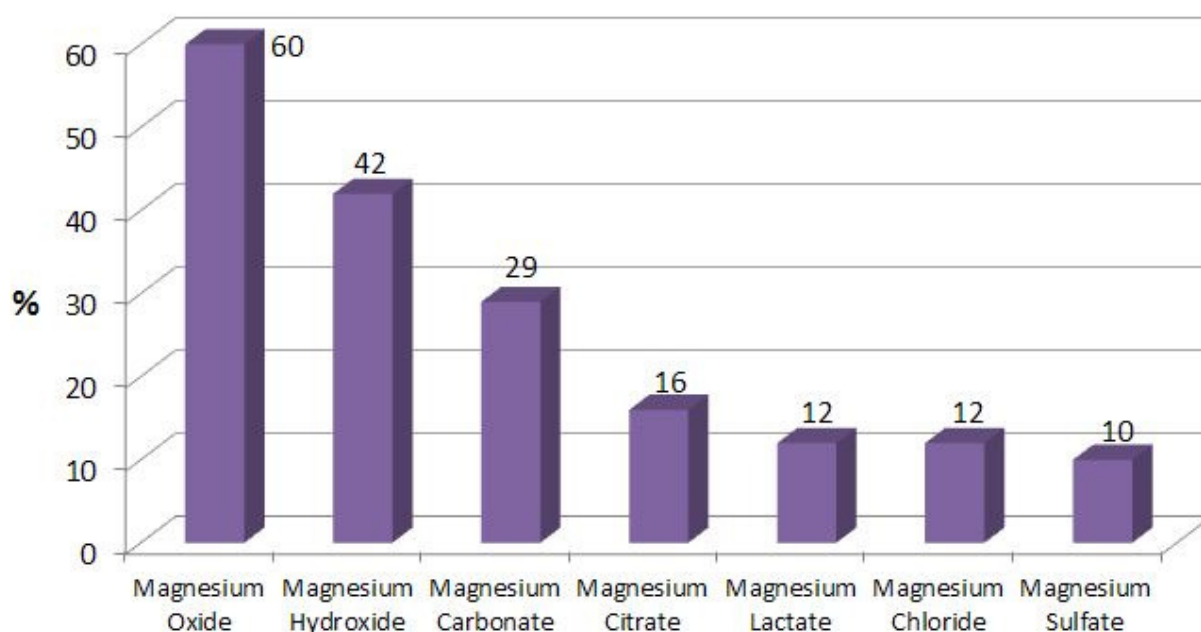


Figure 1: ■ Percent Magnesium content of oral supplements

This supports the belief that both the magnesium content of a dietary supplement and its bioavailability contribute to its ability to restore deficient levels of magnesium.

WHAT WE NEED TO KNOW ABOUT MAGNESIUM SUPPLEMENTATION

If taken in excess, magnesium will cause diarrhea. In that case, stop magnesium supplementation until bowel movements calmed down. Pause for a day or more and continue with a lesser dose.

Vitamin B6 improves magnesium absorption.

Side effects i.e. negative reactions to a magnesium supplement may be caused by additives such as the filler lactose. Switching products may eliminate the problem. Consult with your physician and pharmacist.

SELENIUM (SE)

GENERAL INFORMATION

Selenium in humans serves as an essential constituent of the enzyme glutathione peroxidase. This trace element is covalently linked to cysteine residues in the protein as selenocysteine, an enzyme that is found in the cytoplasm and mitochondria of liver, erythrocytes, platelets, and other tissues. Selenium-glutathione and vitamin E are strong antioxidants, protecting lipids in the cell membranes from the destructive effects of peroxide (H_2O_2) generated by excess oxygen. Because the antioxidant role of selenium parallels that of vitamin E, the nutritional amount of selenium needed is inversely proportional to the dietary supply of vitamin E. Selenium-deficiency diseases will respond to vitamin E treatment.

The selenium content of the human body amounts to 10-15 mcg, the main portion being found in reproductive glands, kidneys, thyroid, and plasma.

FUNCTION AND REQUIREMENT

Selenium prevents chromosomal damage and protects cellular functions. Selenium deficiency in animals can lead to brain dysfunction, cardiovascular, liver and muscle problems and can affect fetal development. Epidemiologically, selenium deficiency has been associated with certain types of cancer, whereas a selenium intake that is higher than the RDA and lower than levels that produce toxicity have shown to inhibit carcinogenesis in experimental cases. Animal studies with rats proved that sufficient Selenium supply prevents tumor formation. Selenium deficient control animals that did not receive supplemental selenium all developed cancer. Statistically, the occurrence of cancer is considerably higher in areas with a low selenium content of the soil. Dr. Steven Levine, founder of the Allergy Research Group, California, reported that selenium counteracts the effects of chemical allergies and sensitivities.

Chronic selenium deficiency has been associated with cardiovascular disease and endemic cardiomyopathy as has been seen in certain rural areas of China, where it is known as Keshan's disease. Severely low blood levels have been found in this population.

Men usually have a higher requirement for selenium than women, and one quarter of the yearly infant mortality in America has been directly linked to selenium deficiency, and/or low vitamin E levels. Clinical data indicates that the majority of infants were male, and almost none had been breast fed. Mother's milk contains over six times more selenium than cow's milk. Australian studies suggested that the apparently inexplicable infant mortality is most likely linked to selenium deficiency.

SYMPTOMS OF SELENIUM DEFICIENCY

Three specific diseases are strongly associated with selenium deficiency:

- Keshan Disease, which results in an enlarged heart and poor heart function, occurs in selenium deficient children.
- Kashin-Beck Disease, which results in osteoarthropathy
- Myxedematous Endemic Cretinism, which results in mental retardation

Other symptoms are:

- Poor resistance to infections
- Growth impairment
- Calcium deposits in muscle tissue (dystrophia musculorum progressiva)
- Elevated cholesterol levels
- Reduced tissue levels of coenzyme Q10
- Increased susceptibility to cadmium and mercury poisoning
- Necrotic changes in the liver
- Cataracts
- Increased susceptibility to cancer

In humans, selenium deficiency can contribute to a form of hemolytic anemia in premature infants and a cardiomyopathy syndrome.⁸⁴

SOURCE:

Plant foods are the major dietary sources of selenium in most countries throughout the world. The content of selenium in food depends on the selenium content of the soil where plants are grown or animals are raised. For example, researchers know that soils in the high plains of northern Nebraska and the Dakotas have very high levels of selenium. People living in those regions generally have the highest selenium intakes in the United States.⁸⁵ Soils in some parts of China and Russia have very low amounts of selenium. Selenium deficiency is often reported in those regions because most food in those areas is grown and eaten locally.

Selected Food Sources of Selenium⁸⁶

Food	Micrograms (mcg)	Percent DV*
Brazil nuts, dried, unblanched, 1 ounce	544	777
Tuna, light, canned in water, drained, 3 ounces	68	97
Cod, cooked, 3 ounces	32	46
Turkey, light meat, roasted, 3 ounces	27	39
Bagel, egg, 4 inch	27	39
Chicken breast, meat only, roasted, 3 ounces	24	34
Beef chuck roast, lean only, roasted, 3 ounces	23	33
Sunflower seed kernels, dry roasted, 1 ounce	23	33
Egg noodles, enriched, boiled, ½ cup	19	27
Macaroni, enriched, boiled, ½ cup	19	27
Ground beef, cooked, broiled, 3 ounces	18	26
Egg, whole, hard-boiled, 1 large	15	21
Oatmeal, instant, fortified, cooked, 1 cup	12	17
Cottage cheese, low fat 2%, ½ cup	11	16
Bread, whole-wheat, commercially prepared, 1 slice	11	16
Rice, brown, long-grain, cooked, ½ cup	10	14
Rice, white, enriched, long-grain, cooked, ½ cup	6	9
Bread, white, commercially prepared, 1 slice	6	9
Walnuts, black, dried, 1 ounce	5	7
Cheddar cheese, 1 ounce	4	6

*DV = Daily Value. DVs are reference numbers developed by the Food and Drug Administration (FDA) to help consumers determine if a food contains a lot or a little of a specific nutrient. The DV for selenium is 70 micrograms (mcg). Most food labels do not list a food's selenium content. The percent DV (%DV) listed on the table indicates the percentage of the DV provided in one serving. A food providing 5% of the DV or less is a low source while a food that provides 10–19% of the DV is a good source. A food that provides 20% or more of the DV is high in that nutrient. It is important to remember that foods that provide lower percentages of the DV also contribute to a healthful diet. For foods not listed in this table, please refer to the U.S. Department of Agriculture's [Nutrient Database Web site](#).

RECOMMENDED INTAKE

Recommended Dietary Allowances (RDA) for Selenium for Children and Adults^{87]}

Age (years)	Males (mcg/day)	and	Females Pregnancy (mcg/day)	Lactation (mcg/day)
1–3	20		N/A	N/A
4–8	30		N/A	N/A
9–13	40		N/A	N/A
14–18	55		60	70
19+	55		60	70

There is insufficient information on selenium to establish a RDA for infants. An Adequate Intake (AI) has been established that is based on the amount of selenium consumed by healthy infants who are fed breast milk. See table below.

Table 3: Adequate Intake for Selenium for Infants^{88]}

Age (months)	Males and Females(mcg/day)
0–6 months	15
7–12 months	20

Results of the National Health and Nutrition Examination Survey (NHANES III—1988–94) indicated that diets of most Americans provide recommended amounts of selenium.⁸⁹

WHY SUPPLEMENTATION?

In the U.S., most cases of selenium depletion or deficiency are associated with severe gastrointestinal problems, such as Crohn's disease, or with surgical removal of part of the stomach. These and other gastrointestinal disorders can impair selenium absorption [24-26]. People with acute severe illness who develop inflammation and widespread infection often have decreased levels of selenium in their blood.⁹⁰

People with iodine deficiency may also benefit from selenium supplementation. Iodine deficiency is rare in the U.S., but is still common in developing countries where

access to iodine is limited [28]. Research suggests that selenium deficiency may worsen the effects of iodine deficiency on thyroid function, and that an adequate selenium nutritional status may help protect against some of the neurological effects of iodine deficiency.⁹¹

Selenium supplements may be protective against goiter.⁹²

SELENIUM SUPPLEMENTS

Selenium occurs in staple foods such as corn, wheat, and soybean as selenomethionine, the organic selenium analogue of the amino acid methionine.⁹³ Selenomethionine can be incorporated into body proteins in place of methionine, and serves as a vehicle for selenium storage in organs and tissues. Selenium supplements may also contain sodium selenite and sodium selenate, two inorganic forms of selenium. Selenomethionine is generally considered to be the best absorbed and utilized form of selenium.

Selenium is also available in 'high selenium yeasts', which may contain as much as 1,000 to 2,000 micrograms of selenium per gram.⁹⁴ Most of the selenium in these yeasts is in the form of selenomethionine. However, some yeasts may contain inorganic forms of selenium, which are not utilized as well as selenomethionine.

A study conducted in 1995 suggested that the organic forms of selenium increased blood selenium concentration to a greater extent than inorganic forms. However, it did not significantly improve the activity of the selenium-dependent enzyme, glutathione peroxidase.⁹⁵ Researchers are continuing to examine the effects of different chemical forms of selenium, but the organic form currently appears to be the best choice.

SELENIUM TOXICITY

High blood levels of selenium (greater than 100 mcg/dL) can result in a condition called selenosis.⁹⁶ Symptoms of selenosis include gastrointestinal upsets, hair loss, white blotchy nails, garlic breath odor, fatigue, irritability, and mild nerve damage.⁹⁷

Selenium toxicity is rare in the U.S. The few reported cases have been associated with industrial accidents and a manufacturing error that led to an excessively high dose of selenium in a supplement.⁹⁸ The Institute of Medicine of the National Academy of Sciences has set a tolerable upper intake level (UL) for selenium, in micrograms per day, for infants, children, and adults. See below

Tolerable Upper Intake Levels for Selenium for Infants, Children, and Adults⁹⁹

Age	Males (mcg/day)	and	Females
0–6 months	45		
7–12 months	60		
1–3 years	90		
4–8 years	150		
9–13 years	280		
14–18 years	400		
19+ years	400		

Toxic symptoms, due to excessive ingestion of Selenium include loss of hair, nails, and teeth, dermatitis, fatigue, garlic breath, yellow skin, irritability, and in rare cases, paralysis. Acute Selenium poisoning manifests itself with high fever, rapid breathing, gastroenteritis, myelitis, and anorexia. Selenium poisoning can be fatal in extreme cases.

Symptoms of Selenium Toxicity

- Chronic arthritis
- Yellow skin Mottled and damaged teeth
- Hair loss
- Irritability
- Skin eruption
- Diabetes
- Liver and kidney damage
- Metallic taste
- Loss of finger nails

THERAPEUTIC CONSIDERATION:

Selenium supplementation should only be temporary. Diagnostic checks (serum or whole blood) should be considered after 1 to 3 months of supplementation. Long term supplementation is not recommended.

Too much Selenium can cause dental caries in children up to 10 years.

Vitamin E supports Selenium therapy.

Sulfates reduce selenium absorption and the possibility of selenium poisoning.

Methionine detoxifies excess amounts of selenium.

LABORATORY ANALYSIS:

BLOOD SELENIUM

Serum, plasma or whole blood tests are used to detect nutritional deficiencies and toxicities.¹⁰⁰

Reference levels for serum or plasma in mcg/L: Adults: 50-120

A serum or plasma concentration of <50mcg/L for adults is considered suboptimal.

Children 0-1yr: 33-71

2-5yrs: 32-84

...5-10yrs: 41-74

10-16yrs 40-82

Reference levels for whole blood in mcg/L:

Males 79-130

Females 60-120

URINE LEVELS:

Urinary selenium measurements are considered secondary indicators for selenium toxicity. The greatest selenium concentration found in body fluids was 4900mcg/L, and it was found in selenium workers who had inhaled selenium dust. It is suggested that selenium urinary levels should be below 100mcg/L.

HAIR SELENIUM LEVELS

Selenium containing anti-dandruff shampoos can falsely elevate hair levels. In such a case, high hair selenium levels should be confirmed with blood and urine analysis.

The exact level representing acute Selenium deficiency has not been established, but low tissue levels indicate a chronically low dietary intake.

RESEARCH

Hair Mineral Analysis results obtained from 120 school children showed that elevated hair Selenium levels were found in children with behavioral problems.

Marlowe, M. et al. Hair selenium levels and children's classroom behavior. J.Orthom.Med. 1(2):91-96, 1986.

A study from 1981 by the US-Environmental Protection Agency researched hair selenium levels of 400 so-called normal and intellectually disabled school children. The results showed that significantly elevated selenium levels were found in intellectually disabled children

Ely, D.L. et al. Aerometric and hair trace metal content in learning disabled. Environ.Res. 25:325-39, 1981.

ZINC (ZN)

GENERAL INFORMATION

Zinc is involved in numerous aspects of cellular metabolism. It is required for the catalytic activity of approximately 100 enzymes¹⁰¹ and it plays a role in immune function, protein synthesis¹⁰² wound healing, DNA synthesis and cell division.¹⁰³¹⁰⁴ Zinc also supports normal growth and development during pregnancy, childhood, and adolescence [and is required for proper sense of taste and smell.¹⁰⁵ A daily intake of zinc is required to maintain a steady state because the body has no specialized zinc storage system.¹⁰⁶

Zinc is probably the most important mineral for brain function as it is involved in many enzyme pathways. Without adequate B6 and zinc, neurotransmitter synthesis is compromised. Vitamin B6 and zinc are involved in basic protein manufacturing processes of transamination and transcription, respectively. Signs and symptoms of a vitamin B6 and zinc deficiency are acne, white spots on nails, joint problems, poor dream recall, and stress intolerance.

ZINC AND PYROLURIA

In the late 1960's Dr. Abram Hoffer, Dr. Carl Pfeiffer M.D., Ph.D. and others discovered a common psychiatric imbalance – **pyroluria** - that depleted vitamin B6 and zinc. Pyroluria results from a genetic difference in hemoglobin metabolism that creates a substance that binds with Vitamin B-6. This biproduct is called kryptopyrrole.

Pyroluria is a metabolic disorder, also referred to as the Pyrrole Disorder or Mauve Factor. It is associated with elevated pyrroles in urine and severe deficiencies of zinc and pyridoxine (Vitamin B-6). Hoffer and Osmond had suggested that the syndrome be called malvaria since at that time its structure was unknown. Pyroluria is considered a better term.

Zinc deficiency symptoms such as poor wound healing, white spots on fingernails, poor growth and skin problems are common among the affected. Most persons with pyrrole disorder exhibit symptoms of anxiety, mood swings, irritability, poor immune function, poor short-term memory and poor stress control. In many cases these symptoms can be mild and not interfere with daily living. However, nearly 30% of mentally-ill persons exhibit this imbalance and report improvement following aggressive therapy with zinc and B-6.

PYROLURIA- DIAGNOSIS AND TREATMENT

Elevated kryptopyrrole levels result from an abnormality in hemoglobin (the protein that holds iron in red blood cells). Kryptopyrrole has no known function in the body, but it is excreted in urine. It was originally discovered in a urine test in Saskatchewan about 1960 in a patient exhibiting schizophrenic symptoms.

Kryptopyrrole is measured in urine. KP combines with vitamin B6 and zinc to produce symptoms of B6 and zinc deficiency. The specific treatment therefore must be Pyridoxine (vitamin B6) and zinc. If supplementation discontinued, a rapid return of serious symptoms is noted.

SOURCES OF ZINC

A wide variety of foods contain zinc. Oysters contain more zinc per serving than any other food, but they are known to contain toxins. Luckily, most children are not fond of shellfish and should not be forced to eat them. Red meat and poultry provide the majority of zinc in the American and Western diet. Other food sources include beans, nuts, certain types of seafood (such as crab and lobster), whole grains, fortified breakfast cereals, and dairy products. See table below.¹⁰⁷

Phytates—which are present in whole-grain breads, cereals, legumes, and other foods—bind zinc and inhibit its absorption. Thus, the bioavailability of zinc from grains and plant foods is considerably lower than that from animal foods, although many grain- and plant-based foods are still good sources of zinc.¹⁰⁸

Selected Food Sources of Zinc

Food	Milligrams (mg) per serving	Percent DV*
Oysters, cooked, breaded and fried, 3 ounces	74.0	493
Beef chuck roast, braised, 3 ounces	7.0	47
Crab, Alaska king, cooked, 3 ounces	6.5	43
Beef patty, broiled, 3 ounces	5.3	35
Breakfast cereal, fortified with 25% of the DV for zinc, $\frac{3}{4}$ cup serving	3.8	25
Lobster, cooked, 3 ounces	3.4	23
Pork chop, loin, cooked, 3 ounces	2.9	19
Baked beans, canned, plain or vegetarian, $\frac{1}{2}$ cup	2.9	19
Chicken, dark meat, cooked, 3 ounces	2.4	16
Yogurt, fruit, low fat, 8 ounces	1.7	11
Cashews, dry roasted, 1 ounce	1.6	11
Chickpeas, cooked, $\frac{1}{2}$ cup	1.3	9
Cheese, Swiss, 1 ounce	1.2	8
Oatmeal, instant, plain, prepared with water, 1 packet	1.1	7
Milk, low-fat or non fat, 1 cup	1.0	7
Almonds, dry roasted, 1 ounce	0.9	6

Selected Food Sources of Zinc

Food	Milligrams (mg) per serving	Percent DV*
Kidney beans, cooked, ½ cup	0.9	6
Chicken breast, roasted, skin removed, ½ breast	0.9	6
Cheese, cheddar or mozzarella, 1 ounce	0.9	6
Peas, green, frozen, cooked, ½ cup	0.5	3
Flounder or sole, cooked, 3 ounces	0.3	2

* DV = Daily Value. DVs were developed by the U.S. Food and Drug Administration to help consumers compare the nutrient contents of products within the context of a total diet. The DV for zinc is 15 mg for adults and children age 4 and older. Food labels, however, are not required to list zinc content unless a food has been fortified with this nutrient. Foods providing 20% or more of the DV are considered to be high sources of a nutrient.

RECOMMENDED INTAKES

Intake recommendations for zinc and other nutrients are provided in the Dietary Reference Intakes (DRIs) developed by the Food and Nutrition Board (FNB) at the Institute of Medicine of the National Academies (formerly National Academy of Sciences). DRI is the general term for a set of reference values used for planning and assessing nutrient intakes of healthy people.¹⁰⁹ These values, which vary by age and gender, include the following:

The Recommended Dietary Allowance (RDA) as listed below is the average daily level of intake that is considered sufficient to meet the nutrient requirements of nearly all (97%–98%) healthy individuals.

For infants less than 6 month of age, an adequate intake* has been set, which is equivalent to the mean intake of zinc in healthy, breastfed infants.

Table 1: Recommended Dietary Allowances (RDAs) for Zinc

Age	Male	Female	Pregnancy	Lactation
0–6 months	2 mg*	2 mg*		
7–12 months	3 mg	3 mg		
1–3 years	3 mg	3 mg		
4–8 years	5 mg	5 mg		
9–13 years	8 mg	8 mg		
14–18 years	11 mg	9 mg	12 mg	13 mg
19+ years	11 mg	8 mg	11 mg	12 mg

ZINC DEFICIENCY

Zinc deficiency symptoms are growth retardation, loss of appetite, and impaired immune function. In severe cases, zinc deficiency causes hair loss, diarrhea, delayed sexual maturation, impotence, hypogonadism in males, and eye and skin lesions. Weight loss and anorexia, delayed healing of wounds, taste abnormalities, and mental lethargy has been associated with zinc deficiency.¹¹⁰ Many of these symptoms are non-specific and often associated with other health conditions; therefore, a medical examination and appropriate laboratory tests are necessary to confirm a zinc deficiency.¹¹¹

DIETARY SUPPLEMENTS

Common and easily available forms of zinc include zinc gluconate, zinc sulfate, and zinc acetate. The percentage of elemental zinc varies by form. For example, zinc sulfate contains approximately 23% of elemental zinc; thus, 220 mg of zinc sulfate contain 50 mg of elemental zinc. Although manufacturers of nutritional supplements have a tendency to market more exotic (and more expensive) products, research has not determined whether differences exist among forms of zinc in absorption, bioavailability, or tolerability. The more expensive zinc supplements are often combined with nutrients enhancing absorption (such as vitamin B6). It may be more cost-efficient to buy them separately, but take them in combination i.e. zinc gluconate plus a B-complex.

In addition to standard tablets and capsules, some zinc-containing cold lozenges are labeled as dietary supplements. The benefit of taking a zinc lozenge is its local action. An inflamed throat does respond to zinc, especially if the lozenge is sucked on slowly, rather than swallowed. The use of lozenges should be controlled, especially for children, preventing abuse or overexposure.

HEALTH RISKS FROM EXCESSIVE ZINC

Zinc toxicity can occur in both acute and chronic forms. Acute adverse effects of high zinc intake include nausea, vomiting, loss of appetite, abdominal cramps, diarrhea, and headaches.¹¹² One case report cited severe nausea and vomiting within 30 minutes of ingesting 4 g of zinc gluconate (570 mg elemental zinc).¹¹³ Intakes of 150–450 mg of zinc per day have been associated with such chronic effects as low copper status, altered iron function, reduced immune function, and reduced levels of high-density lipoproteins.¹¹⁴ Reductions in a copper-containing enzyme, a marker of copper status, have been reported with even moderately high zinc intakes of approximately 60 mg/day for up to 10 weeks.¹¹⁵

Supplementation of high doses of zinc for prolonged periods can aggravate brain function, because zinc can initiate heavy metal release. A zinc overexposure- just like a deficiency causes immune deficiency problems. A good percentage of patients suffering from neurological disorders show signs of overexposure with copper, mercury, lead, aluminium, or cadmium.

Because zinc is present in several products, many of which are sold over the counter for the treatment and prevention of colds. Numerous case reports of anosmia (loss of the sense of smell), in some cases long-lasting or permanent, have been associated

with the use of zinc-containing nasal gels or sprays.^{116 117} In June 2009, the FDA warned consumers to stop using zinc-containing intranasal products because they might cause anosmia.¹¹⁸

High amounts of zinc can be present in denture adhesive creams (ranging from 17–34 mg/g).¹¹⁹ While the use of these products as directed (0.5–1.5 g/day) is not of concern, excessive and long term use can lead to zinc toxicity, resulting in copper deficiency and neurologic disease. Toxicity has been reported in individuals who used 2 or more standard 2.4 oz tubes of denture cream per week!¹²⁰ As a result, denture creams have been reformulated to eliminate zinc.

Zinc excess can deplete copper. Excessive zinc taken over a prolonged period, can cause **copper deficiency** symptoms. Copper is needed for catecholamine neurotransmitter production. Other common copper deficiency symptoms include frequent bacterial infections, bleeding gums, and easy bruising.

INTERACTIONS WITH MEDICATIONS

Zinc supplements have the potential to interact with several types of medications. A few examples are provided below. Individuals taking these medications on a regular basis should discuss their zinc intakes with their healthcare providers.

Antibiotics

Both quinolone antibiotics (such as Cipro®) and tetracycline antibiotics and Achromycin® and Sumycin®) interact with zinc in the gastrointestinal tract, inhibiting the absorption of both zinc and the antibiotic.¹²¹ Taking the antibiotic at least 2 hours before or 4–6 hours after taking a zinc supplement minimizes this interaction.¹²²

Penicillamine

Zinc can reduce the absorption and action of penicillamine, a drug used to treat rheumatoid arthritis.¹²³ To minimize this interaction, individuals should take zinc supplements at least 2 hours before or after taking penicillamine.

Diuretics

Thiazide diuretics such as chlorthalidone (Hygroton®) and hydrochlorothiazide (Esidrix® and HydroDIURIL®) increase urinary zinc excretion by as much as 60%. Prolonged use of thiazide diuretics could deplete zinc tissue levels, so clinicians should monitor zinc status in patients taking these medications.¹²⁴

CHILDREN (AND MOTHERS) AT RISK

Those at risk of zinc deficiency or inadequacy need to include good sources of zinc in their daily diets. Supplemental zinc might be appropriate but should be supervised by a nutritionally educated physician.

Gastrointestinal and other diseases

Gastrointestinal surgery and digestive disorders (such as ulcerative colitis, Crohn's disease, and short bowel syndrome) can decrease zinc absorption and increase endogenous zinc losses primarily from the gastrointestinal tract and, to a lesser extent, from the kidney.¹²⁵ Other diseases associated with zinc deficiency include malabsorption syndrome, chronic liver disease, chronic renal disease, sickle cell

disease, diabetes, malignancy, and other chronic illnesses.¹²⁶ Chronic diarrhea also leads to excessive loss of zinc.¹²⁷

Vegetarians

The bioavailability of zinc from vegetarian diets is lower than from non-vegetarian diets because vegetarians do not eat meat, which is high in bioavailable zinc and may enhance zinc absorption. In addition, vegetarians typically eat high levels of legumes and whole grains, which contain phytates that bind zinc and inhibit its absorption.

Vegetarians may require as much as 50% more of the RDA for zinc than non-vegetarians. In addition, they might benefit from using certain food preparation techniques that reduce the binding of zinc by phytates and increase its bioavailability. Techniques to increase zinc bioavailability include soaking beans, grains, and seeds in water for several hours before cooking them and allowing them to sit after soaking until sprouts form.¹²⁸ Vegetarians can also increase their zinc intake by consuming more leavened grain products (such as bread) than unleavened products (such as crackers) because leavening partially breaks down the phytate; thus, the body absorbs more zinc from leavened grains than unleavened grains.

Pregnant and lactating women

Pregnant women, particularly those starting their pregnancy with marginal zinc status, are at increased risk of becoming zinc insufficient due, in part, to high fetal requirements for zinc.¹²⁹ Lactation can also deplete maternal zinc stores.¹³⁰ For these reasons, the RDA for zinc is higher for pregnant and lactating women than for other women.

Older infants who are exclusively breastfed

Breast milk provides sufficient zinc (2 mg/day) for the first 4–6 months of life but does not provide recommended amounts of zinc for infants aged 7–12 months, who need 3 mg/day.¹³¹ In addition to breast milk, infants aged 7–12 months should consume age-appropriate foods or formula containing zinc. Zinc supplementation has improved the growth rate in some children who demonstrate mild-to-moderate growth failure and who have a zinc deficiency.¹³²

People with sickle cell disease

Results from a large cross-sectional survey suggest that 44% of children with sickle cell disease have a low plasma zinc concentration,¹³³ possibly due to increased nutrient requirements and/or poor nutritional status. Zinc deficiency also affects approximately 60%–70% of adults with sickle cell disease.¹³⁴ Zinc supplementation has been shown to improve growth in children with sickle cell disease.¹³⁵

ZINC AND HEALTH

Immune function

Severe zinc deficiency depresses immune function, and even mild to moderate degrees of zinc deficiency can impair macrophage and neutrophil functions, natural killer cell activity, and complement activity.¹³⁶ The body requires zinc to develop and

activate T-lymphocytes. Individuals with low zinc levels have shown reduced lymphocyte proliferation response to mitogens and other adverse alterations in immunity that can be corrected by zinc supplementation.¹³⁷ These alterations in immune function might explain why low zinc status has been associated with increased susceptibility to pneumonia and other infections in children in developing countries and the elderly.

Wound healing

Zinc helps maintain the integrity of skin and mucosal membranes. Patients with chronic leg ulcers have abnormal zinc metabolism and low serum zinc levels. Clinicians frequently treat skin ulcers or burn patients with zinc supplements.¹³⁸

Diarrhea

Acute diarrhea is associated with high rates of mortality among children in developing countries.¹³⁹ Zinc deficiency causes alterations in immune response that probably contribute to increased susceptibility to infections, such as those that cause diarrhea, especially in children.¹⁴⁰

Studies show that malnourished children in India, Africa, South America, and Southeast Asia experience shorter courses of infectious diarrhea after taking zinc supplements. The children in these studies received 4–40 mg of zinc a day in the form of zinc acetate, zinc gluconate, or zinc sulfate.¹⁴¹ Results from another study suggest that zinc supplementation in developing countries help reduce the duration and severity of diarrhea in zinc-deficient or otherwise malnourished children.¹⁴²

The World Health Organization and UNICEF now recommend short-term zinc supplementation (20 mg of zinc per day, or 10 mg for infants under 6 months, for 10–14 days) to treat acute childhood diarrhea.¹⁴³

The common cold

Recently, a Cochrane review concluded that "zinc (lozenges or syrup) is beneficial in reducing the duration and severity of the common cold in healthy people, when taken within 24 hours of onset of symptoms", however no recommendation regarding the dose needed was made.¹⁴⁴ Another review completed in 2004 also concluded that zinc can reduce the duration and severity of cold symptoms.¹⁴⁵

ZINC INTAKES AND LABORATORY DIAGNOSIS

The nutritional status for zinc is difficult to assess¹⁴⁶ due to its distribution throughout the body as a component of various proteins and nucleic acids.¹⁴⁷ Hair mineral analysis can provide information about the long term zinc intake and absorption, but care must be taken that zinc-containing shampoos and lotions are not used frequently. While healthy hair does not easily absorb metals, brittle hair or split ends do.

Plasma or serum zinc levels are used for evaluating the immediate zinc status. Blood is used to diagnose an acute zinc deficiency, but blood levels do not necessarily reflect the cellular zinc status due to tight homeostatic control mechanisms. Because clinical effects of zinc deficiency can be present in the absence of abnormal blood or

hair analysis results, it is important to carefully evaluate patient symptom and history.¹⁴⁸

Risk factors (such as inadequate caloric intake, alcoholism, and digestive diseases) must be taken into account. In infants and children, impaired growth is a common symptoms of zinc deficiency. Most infants (especially those who are formula fed), children, and adults in the United States consume recommended amounts of zinc according to two national surveys, the 1988–1991 National Health and Nutrition Examination Survey (NHANES III)¹⁴⁹ and the 1994 Continuing Survey of Food Intakes of Individuals (CSFII).¹⁵⁰ Metabolic factors such as poor absorption and high excretion (pyroluria) can be the cause of a zinc deficiency, even in the presence of an adequate intake. Heavy metal exposure upsets the balance of minerals and trace elements.

Zinc intakes might be low in older adults from the 2%–4% of U.S. households that are food insufficient (sometimes or often not having enough food).¹⁵¹ Data from NHANES III indicate that adults aged 60 years or older from food-insufficient families had lower intakes of zinc and several other nutrients and were more likely to have zinc intakes below 50% of the RDA on a given day than those from food-sufficient families.¹⁵² Again, an adequate nutritional intake does not rule out zinc deficiency.

Low zinc levels in a baseline urine are not a reflection of a zinc deficiency, but do indicate that the zinc intake is below normal. Zinc absorption may be normal. When, the zinc absorption is poor, the urine excretion of zinc is high. Combining zinc with an increased intake of vitamin B6 can solve the absorption problem.

WHAT YOU NEED TO KNOW ABOUT METAL TESTING

BLOOD METAL TESTING

When a child displays deficiency symptoms, the doctor may decide to have blood metals checked. Acute deficiencies are rare. In most cases, a child displaying early signs of a deficiency is placed on appropriate supplementation before acute symptoms appear.

When a child displays symptoms of metal intoxication, a blood test may be needed.

A blood test for toxic metals is important when a patient has been acutely exposed to a toxin within the last 72hrs. The blood test will aid in evaluating the type and severity of the exposure, which in turn provides important information about the type of treatment needed and how aggressive the treatment approach must be for the acutely intoxicated. Most of these cases involve life-threatening situations. Chances are such children are seen in an hospital emergency room, rather than in a routine paediatric practice.

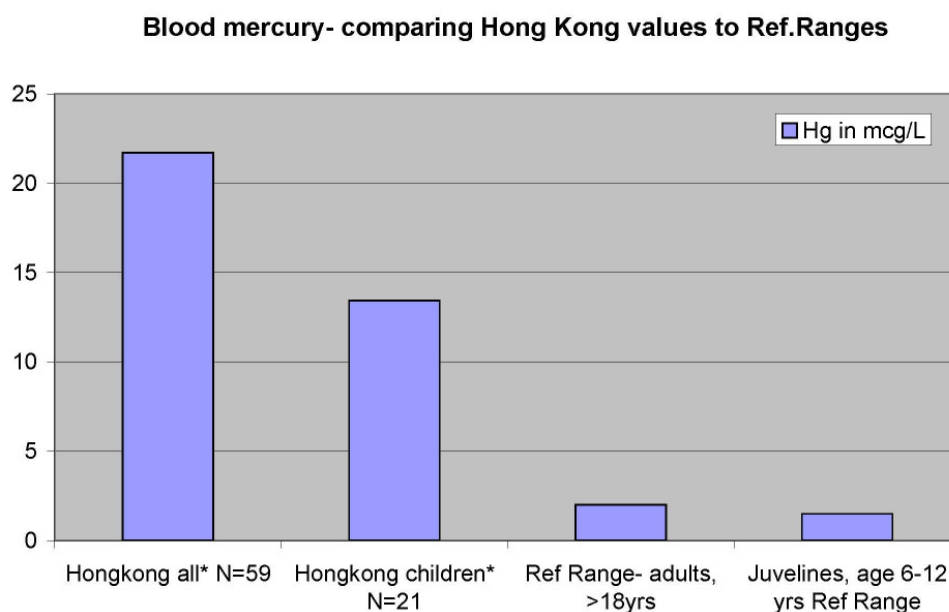
A blood sample is NOT needed for cases of chronic intoxication. An autistic child displaying symptoms of a *chronic* mercury exposure, rarely needs his blood checked for toxic metals. Such a child has been slowly exposed over a long time, and the

amount of the toxin circulating in the blood stream is usually inconspicuous. Test results will be within the expected reference range.

If we would take a blood sample right after a person has been immunized with a thiomersal-containing vaccine, we would notice mercury in blood. Results would indicate an exposure within the past 72 hours. If the vaccine was administered 2 weeks ago, mercury levels would, most likely be, within range. Reason: the toxic metal has since been stored in organ tissue, or has been excreted.

High metal exposure is on the rise, just as environmentally-caused diseases are. Our data base demonstrates that nearly 100% of Hong Kong the mercury blood values from Hong Kong are far above the safe levels as recommended by the WHO (World Health Organisation or the CDC (Center for Disease Control).

Our laboratory evaluations also indicate that the mercury level in blood of Hong Kong children is alarmingly high. We consider it no longer unusual to find mercury levels in the blood of Hong Kong children that exceed allowed blood levels more than five times. A comparison of mercury blood levels of Hong Kong children and reference ranges demonstrates this noticeable difference.



A 2008 Hong Kong study now reported an ASD incidence rate similar to those reported in Australia and North America. The most recent estimate for the U.S. states that up to 1 out of every 88 children, or 11.3 per 1,000, have some form of ASD,¹⁵³ a dramatic increase since early 2000. The environmental connection seems obvious.

CASE REPORT EVALUATION:

The following blood report shows extreme mercury blood levels of a young Hong Kong child suffering from autism. Such high blood levels reflect a direct mercury exposure, which in this case stems from a combination of eating mercury-rich fish on a daily basis and receiving thiomersal-containing vaccinations.
























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MINERAL ANALYSIS				Whole Blood - Child		
		Lab Number		1WK120000		
Doctor	Sample Doctor		Test Date		7/30/2012	
Patient Name	ADAM		Sex	m	Age	5
Clinical Information		AUTISM		Page		1/4
Acceptable Range			Test Value			
Essential Trace Elements in mcg/l						
Chromium		n.n.				
Cobalt	< 1.50	0.15				
Iodine		279.10				
Manganese	7.10 --- 20.00	9.58				
Molybdenum	0.50 --- 1.80	0.85				
Selenium	40.00 --- 130.00	89.66				
Vanadium	< 0.80	< 0.98				
Essential Macro- & Trace elements (mg/l)						
Copper	0.60 --- 1.36	1.03				
Magnesium	25.00 --- 48.50	29.05				
Zinc	4.00 --- 7.50	7.50				
Potentially Toxic Elements in mcg/l						
Aluminum	< 30.00	12.26				
Antimony	< 3.50	< 1.16				
Arsenic-total	< 10.00	< 4.30				
Beryllium	< 4.00	n.n.				
Bismuth	< 1.00	0.04				
Cadmium	< 0.30	< 0.76				
Lead	< 35.00	55.67				
Mercury	< 0.80	< 7.41				
Nickel	< 2.00	2.75				
Platinum	< 0.50	0.17				

n.n. = not detected

These 95percentile Reference Ranges listed above are representative for a healthy population. All elements are tested quantitatively.

Accreditation: DIN EN ISO 17025; Quality control: Dipl. Ing. Friedle, Ing. J. Merz, Dr. Rauland; Validation: Dr. E.Blaurock-Busch PhD, Laboratory physician: Dr. med. A. Schönberger

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MINERAL ANALYSIS			Whole Blood - Child			
Patient Name	ADAM		Lab Number	1WK120000	Page	2/4
Acceptable Range		Test Value				
Potentially Toxic Elements in mcg/l						
Silver	< 1.00	< 0.42			<div><div></div><div></div></div>	
Thallium	< 0.60	< 0.24			<div><div></div><div></div></div>	
Tin	< 2.00	< 1.30			<div><div></div><div></div></div>	
Uranium	< 1.00	< 0.25			<div><div></div><div></div></div>	
Zirconium	< 55.00	< 1.63			<div><div></div><div></div></div>	

n.n. = not detected

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MINERAL ANALYSIS		Whole Blood - Child			
Patient Name	ADAM	Lab Number	1WK120000	Page	3/4
<p>Blood is a transport medium and the concentrations of essential elements found in blood reflect the body's immediate nutritional status, and factors influencing uptake and distribution. The presence of toxic metals in blood suggests immediate exposure and indicates the need for medical attention. The information contained in this elemental analysis report is designed as an interpretive adjunct to normally conducted diagnostic procedures. The findings are best viewed in the context of a medical examination and history.</p> <p>Reference ranges listed are obtained, if available, from the CDC (Center for Disease Control), the WHO (World Health Organisation) and Environmental Agencies and are updated accordingly. If a reference range is not given by those agencies, general laboratory procedures are utilized to obtain a statistical reference range in the 95percentile. For more information, please contact us: service@microtrace.de or www.microtrace.de</p>					
<p>CADMIUM (Cd) is toxic to virtually every system of the body. It has been implicated in renal disease, prostatic carcinoma and other cancers, hypertension, anemia, itai-itai disease and anemias. It inhibits enzyme and nutrient utilization, and is readily stored in the kidney where it competes with zinc for binding sites in various enzymes and other proteins. Zinc, vitamin C, iron and/or calcium intake can partially protect against cadmium overload. Smoke increases the susceptible to toxicity, and tissue levels are known to increase with age. The blood levels of smokers are about 50% higher than those of nonsmokers. Acute poisoning causes severe pulmonary and bronchial irritation. SOURCE: pollution, smoking. THERAPEUTIC CONSIDERATION: Antioxidant therapy with emphasis on vitamin C. Zinc and vitamin B6; increased amino acid intake. Water contamination is a recognized source of cadmium toxicity. Chelation therapy may be considered.</p>					
<p>MERCURY (Hg): Elemental mercury is easily converted to organic mercury by living systems. Symptoms of poisoning include inactivation of enzyme function, birth defects, brain damage and other central nervous system disorders. Early symptoms of mercury overexposure include insomnia, dizziness, fatigue, drowsiness, weakness, depression, tremors loss of appetite, loss of memory, nervousness, headache, dermatitis, numbness, and tingling of lips and feet, emotional instability and kidney damage. Symptoms of acute toxicity: loss of teeth, extreme tremor, mental and emotional disorders, kidney failure. Neurological ailments may be linked to chronic mercury exposure, even before birth. SPECIFICS: Mercury remains in the blood stream for 24 to a maximum of 72 hours and high levels confirm immediate and acute exposure. SOURCES: overexposure may stem from paints, explosives, electrical apparatus, batteries, mercurial diuretics, fungicides, fluorescent lamps, cosmetics, hair dyes, amalgams in dentistry, contaminated seafood, petroleum products, and vaccines containing thiomersal. Improper disposal of broken mercury thermometers and other apparatuses that use mercury including button cells and tube lights may also result in mercury exposure. NUTRITIONAL RECOMMENDATION: increase intake of cysteine and antioxidant intake, esp selenium and vitamin E and cysteine. CHELATION INFORMATION: Chelating agents such as DMPS, DMSA and ZnDTPA are known to bind mercury, resulting in increased urinary excretion. A comparison of pre and post urine Hg levels, allows observation of the patient's response to provocation treatment. Hair mercury levels reflect on longterm exposure.</p>					
<p>NICKEL (Ni): the function of nickel is not totally clear, however nickel contact allergies are well known, generally resulting in skin reactions and exzemas. Exposure has been associated with dermatitis and an increased cancer risk. COMMON SOURCES: Nickel-cadmium batteries, jewelry, cold wave permanents, welding, and smoke. Nickel carbonyl found in cigarette and cigar smoke is a strong carcinogen. Smokers and children of smokers often exhibit higher nickel tissue levels than nonsmokers. Other sources are chromium/nickel/steel cookware (Chromargan), unglazed pottery, and dental braces. Burning fossil materials (coal, oil) releases nickel and other toxic metals into the air. SYMPTOMS OF NICKEL OVEREXPOSURE: Early symptoms are apathy, diarrhea, skin problems, insomnia, vertigo, injury to cerebral blood vessels, and vomiting. Toxicity symptoms include frontal headaches, gastroenteritis, eczema, cancer of the lung and nasal cavity. THERAPEUTIC CONSIDERATION: sulfur-bearing amino acids, pectin and antioxidants support natural elimination of nickel; in more severe cases of overexposure, chelation therapy may be recommended.</p>					

n.n. = not detected

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MINERAL ANALYSIS		Whole Blood - Child			
Patient Name	ADAM	Lab Number	1WK120000	Page	4/4
<p>LEAD (Pb): Occupational and environmental exposure are the common causes of exposure. Lead reduces the body's ability to utilize calcium, magnesium, zinc, iron and other important nutrients. This heavy metal greatly affects health. It is a known cause of anemia, and children are easily affected by lead exposure. TOXICITY SYMPTOMS include abdominal pain, anorexia, anxiety, constipation, fatigue, headaches, impaired coordination, indigestion, irritability, muscle pains, learning and neurological disorders, incl. tremors, severe anemias and immune deficiencies, learning disabilities, hyperactivity and violent behavior. SOURCES: leaded gasoline, canned goods, lead paint, newsprint, tobacco smoke, air pollution, and contaminated water. THERAPEUTIC CONSIDERATION: Vitamin C, sulfur-bearing amino acids and other oral chelating agents can increase the urinary excretion. In acute cases of exposure, chelation treatments using chelating agents such as EDTA, dimercaprol, and penicillamine are recommended.</p>					
<p>ZINC (Zn) is an important metalloenzyme that is needed for enzyme function and insulin synthesis. It is a co-factor in the absorption and metabolism of many vitamins, is needed for the production of sex and growth hormones, wound and burn healing, and DNA and RNA synthesis. Absorption of dietary zinc occurs mainly in the small intestine, and zinc uptake can be competitive with that of iron and copper. Zinc is excreted in feces, urine and sweat. Copper or iron deficiency, anemia, bone and joint pathology, loss of hair color may be present. The RDA is 3-30mg/day, depending on age and status. Zinkvergiftungen sind sehr selten. Longterm use of oral zinc supplementation or environmental exposure near smelter sites can contribute to zinc overload. THERAPEUTIC CONSIDERATION: Haemolysis raises zinc levels. Symptoms of zinc overload are similar to zinc deficiency symptoms, causing immune dysfunction. Check iron, copper and manganese levels. Due to the circadian rhythm, zinc levels are higher in the morning and lower in the evening.</p>					

n.n. = not detected

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Children who live in big cities are exposed to air pollution, and it is not unusual for those children to show elevated results of multiple toxins in blood as is the case here.

Overexposed children are generally undersupplied with important nutrients. This child does not show a great demand for nutrients. Most autistic children show far greater nutritional demands than this one. It would be beneficial to pay greater attention to magnesium-rich foods or supplementation, and a hair analysis report would indicate if this mild under supplementation has resulted in tissue depletion.

Also unusual are the borderline high zinc levels. In consultation with the parents it was found that this child received zinc supplements on a daily basis for 3 months. According to the blood test results, it would be beneficial to stop zinc supplementation and concentrate on a detoxification treatment. Oral DMSA might be the chelator of choice, and treatment should be supervised by a physician knowledgeable in oral chelation.

HAIR MINERAL ANALYSIS (HMA)

Hair mineral analysis reflects how efficiently the root was nourished (or intoxicated) via the blood stream. As long as metals circulate, hair tissue will receive them. This feeding and storing mechanism continues over time. Therefore, hair mineral levels indicate how well or poorly the hair tissue was supplied over time. HMA values do NOT reflect present variations as seen in blood or urine.

A 'normal' hair level of mercury or lead does not necessarily exclude a metal burden. If a metal such as mercury (Hg) has fully crossed the blood brain barrier and no additional exposure exists, the metal will no longer be detected in the circulating blood stream. Since the metal is no longer circulating, it cannot supply the hair root and hair shaft. As a result, the metal can no longer be detected in the outgrowing hair shaft. This principle applies to all metals capable of crossing the blood brain barrier.

Hair tissue storage depends on the body's protein-metal binding ability, which decreases with age. Light-haired children have a lower protein-metal-binding capacity, and again, elevated levels of any toxin are a sign of concern.

Method development and increased instrument sensitivity have improved the accuracy of hair testing. Unfortunately, misinterpretation of hair mineral analysis results abound. Often wild claims are made. The accuracy of the analytical work is often questioned, when in fact quality control proves that testing is highly accurate. The submission of bad samples, such as colored, bleached or permed hair is the biggest problem with hair mineral analysis, and cannot be overcome by the best of instrumentation or the best analytical chemist.

In spite of all attacks, hair mineral analysis continues to be favorably mentioned in universities studies, even governmental ones. Solid research exists. The U.S. Environmental Protection Agency concluded in a 1980 report that "human hair can be used effectively for the biological monitoring of the highest priority toxic metals - lead, cadmium, mercury and arsenic," and "For toxic exposure..... (testing) hair appears to be superior to (testing) blood and urine."

HAIR SAMPLING PROCEDURE:

Taking a hair sample is a painless procedure. Less than one half gram of head hair is needed for testing.

Long Hair

- Part the hair in the middle of the back of the head, and pull it out and up.
- Cut a small 1.5 to 2 inch (4.5 to 5.5 cm.) strand of hair close to the head. Discard ends of long strands and KEEP less than 2 inches (less than 5.5 cm) closest to the scalp.
- Place hair in sampling envelope, fill out the Sampling Instructions Form with the appropriate information and send to MTM.

Short hair

- Trim 0.3 grams (300mg) of hair from the back of the head. Use thinning scissors, if possible.
- Place hair in paper envelope, fill out the Sampling Instructions Form with the appropriate information and send to MTM.

Pubic hair

- Trim pubic hair with normal scissors.
- Place hair in paper envelope, fill out the Sampling Instructions Form with the appropriate information and send to laboratory

Note: since hair samples undergo a special washing procedure with de-ionized solutions, washing of hair is not needed prior to sampling. For the same reason, any type of comb or scissor may be used.

STANDARD HAIR MINERAL REPORT

The hair analysis of an autistic child, age 1 ½ shows that metal overexposure often go hand in hand with an increased need for nutrients needed for neurofunction: magnesium and zinc.

Micro Trace Minerals Laboratory

environmental & clinical laboratory

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MINERAL ANALYSIS			Childs' Hair			
Doctor		Dr Well	Lab Number		1KH120000	
Patient Name		Mark M	Sex	m	Test Date	1/31/2012
Clinical Information		Autistic since age 1 1/2			Age	3
					Page	1/6
Acceptable Range		Test Value				
Essential Macroelements (ppm = mg/kg = mcg/g)						
Calcium	200.00 --- 850.00	585.97				
Magnesium	20.00 --- 115.00	14.50	↓			
Essential Trace Elements (ppm = mg/kg = mcg/g)						
Chromium	0.02 --- 0.15	0.20	↑			
Cobalt	< 0.15	0.02				
Copper	6.70 --- 37.00	22.01				
Iodine	0.15 --- 3.50	1.15				
Iron	7.70 --- 15.00	11.57				
Manganese	0.07 --- 0.50	0.19				
Molybdenum	0.02 --- 1.00	0.10				
Selenium	0.40 --- 1.40	1.45	↑			
Vanadium	0.01 --- 0.15	0.07				
Zinc	110.00 --- 227.00	109.86	↓			
Nonessential Trace Elements (ppm = mg/kg)						
Boron	< 2.00	1.08				
Germanium	< 0.50	0.03				
Lithium	< 0.20	0.01				
Strontium	0.11 --- 4.28	1.15				
Tungsten	< 0.02	0.01				
Potentially Toxic Elements (ppm = mg/kg = mcg/g)						
Aluminum	< 8.00	20.10	↑			
Antimony	< 0.20	0.27	↑			

n.n. = not detected

These 95percentile Reference Ranges listed above are representative for a healthy population. All elements are tested quantitatively.

Accreditation: DIN EN ISO 17025; Quality control: Dipl. Ing. Friedle, Ing. J. Merz, Dr. Rauland; Validation: Dr. E.Blaurock-Busch PhD, Laboratory physician: Dr. med. A. Schönberger

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MINERAL ANALYSIS			Childs' Hair			
Patient Name	Mark M	Lab Number	1KH120000	Page	2/6	
	Acceptable Range	Test Value				
Potentially Toxic Elements (ppm = mg/kg = mcg/g)						
Arsenic-total	< 0.20	0.10				
Barium	< 2.65	0.51				
Beryllium	< 0.03	0.00				
Bismuth	< 0.18	0.03				
Cadmium	< 0.20	0.14				
Lead	< 3.00	7.64	↑			
Mercury	< 0.30	2.29	↑			
Nickel	< 0.85	0.15				
Palladium	< 0.02	0.02	↑			
Platinum	< 0.07	0.00				
Silver	< 1.00	0.34				
Thallium	< 0.01	0.00				
Tin	< 0.93	1.31	↑			
Titanium	< 0.65	0.31				
Uranium 238	< 0.10	0.02				
Zirconium	< 1.47	0.23				

n.n. = not detected

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EVALUATION OF REPORT RESULTS:

Low tissue levels of Magnesium and Zinc levels are typical for autistic hyperactive or hyperactive individuals. We can assume that this patient has a low zinc or magnesium intake, but to know for certain, the dietary intake must be carefully evaluated through questioning parent and patient. A weekly diet history provides important information, not only about the actual nutrient intake but also about potential absorption problems.

MAGNESIUM:

- Is the daily intake of magnesium-rich foods adequate i.e. does this person eat good amounts of vegetables and fruit?
- Individuals with a high meat intake have a greater need for magnesium
- Caffeine (as in coffee, tea or cokes) increases the need for magnesium
- Sweets increase the need for magnesium
- Any type of stress increases the need for magnesium
- Glutamate (MSG) upsets the magnesium balance
- Does the patient have good bowel movements? Most magnesium-deprived persons suffer from constipation, poor sleeping habits and muscle spasms or twitching!
- If constipation is a problem, it might be smart to temporarily provide magnesium as a supplement before dietary adjustments are adequate- and experience suggests that it is most difficult to change the dietary habits of an autistic child. Supplementation of magnesium with a vitamin B-complex to support magnesium absorption might be needed on a daily basis. Important notice: When the stool turns loose, the amount of magnesium supplemented, can be reduced. When diarrhea starts, magnesium supplementation should be stopped for a day or more. Over supplementation of magnesium causes diarrhea!
- If the magnesium supply is adequate, sleeping habits improve and spastic tendencies improve, often significantly.

Note: supplementation of B-vitamins is important, not only to support magnesium absorption. It would also improve cobalt levels, and cobalt is part of the vitamin B12 molecule. Therefore, an increase in vitamin B-complex enhances the vitamin B12 intake and hence, the cobalt status, all of which is important for a healthy red blood cell production- preventing anemia.

ZINC:

- Meat and other animal foods are a good source of zinc.
- Is the daily intake of zinc-rich foods adequate i.e. does this person eat zinc-rich foods from animal or vegetarian sources? If most of the zinc is derived from vegetarian sources, we can safely assume that zinc absorption is inadequate.

- Is the daily intake of phytate-rich foods high? If yes, zinc absorption is blocked to some degree. Phytate-rich foods, especially whole grain intake should be limited or avoided.

Note: supplementation of B-vitamins, esp. vitamin B6, improves zinc absorption. If we see low hair zinc levels in a meat-eating individual, we can assume that diet is not the problem, absorption is. We don't really need to spend money to determine if the patient suffers from Pyrollurie. We can safely assume that absorption problems exist and take nutritional measures to solve the problem. Since the treatment for Krypopyrollurie is the same as that for a simple zinc or magnesium absorption problem, why spend more time on diagnostics than necessary!

Another important note: Phytates don't just block the absorption of zinc, they also reduce iron absorption. An increase in vitamin C supports iron absorption, somewhat blocks the action of phytates, and thus helps to prevent anemia.

SELENIUM:

long term supplementation (to block mercury) is responsible for the borderline high selenium levels. Selenium supplementation should be reduced.

ALUMINUM:

Leaky gut syndrome increases the aluminium uptake. It is therefore most logical to avoid aluminium-rich drinks such as soft drinks and support intestinal function. Eat yoghurt daily, or provide lactobacillus acidophilus supplements about 20minutes before meals, about 2-3 times daily. Avoid sugar-rich foods and drink plenty of water and hair concentrations will reduce itself over time.

ANTIMON:

Avoid medications containing antimony and PET bottles. While levels observed for bottled water are below drinking water guidelines, fruit juice concentrates (for which no guidelines are established) produced in the UK were found to contain up to 44.7 µg/L of antimony, well above the EU limits for tap water of 5 µg/L.¹⁵⁴ Medically, antimony is not considered a dangerous metal, but its chemical properties are similar to those of lead.

TIN:

Fluoride toothpaste contains stannous fluoride. Stannous is the Latin name for tin. Due to its antimicrobial function, tin is used in many toothpastes, including the stannous pyrophosphate toothpastes. Saliva studies indicate that tin ions in their organic form provide oral hygiene and gingival health benefits¹⁵⁵ Tin is not considered toxic, Children have a tendency to swallow toothpaste, but no data exists regarding the daily tin intake due to toothpaste.

Inorganic tin salts are poorly absorbed and rapidly excreted in the faeces; as a result they have a low toxicity. Only about 5 per cent is absorbed from the gastrointestinal tract, widely distributed in the body and excreted by the kidney. The WHO 1973 permissible limit for tin in tinned food is 250 micrograms per kg. The adult daily intake of tin was about 17 mg per day in 1940, but it has now decreased to about 3.5 mg, due to improvements in technique of tinning with enamel overcoat and crimped lids to minimize exposure to tin and lead solder. This level is well below the level of 5-7 mg per kg body weight shown to give rise to toxic symptoms.

Acute overexposure affects the gastrointestinal tract and kidney function, but the main results of toxicity are skin and eye irritation. Neurotoxicity has been mentioned. The role of tin in human health is multifunctional. Recent studies suggest that tin compounds exhibit some antitumour activity and may have a future role in cancer diagnosis and chemotherapy, and in controlling hyperbilirubinaemia.¹⁵⁶

LEAD AND MERCURY

The high levels in hair mineral analysis indicate long term exposure. They also indicate that these metals continue to circulate in the blood of this patient i.e. blood 'feeds' the hair root and because toxic metals are still circulating, detoxification treatments will be more readily successful, within a reasonable time.

SUMMARY

Detoxification treatments seem a logical approach and while we don't know how far this child's health improves, an improvement will be seen- because body and mind will function more optimally when toxins no longer block cellular and enzyme functions.

Hair analysis tells us that toxins accumulated over time. Experience also tells us that toxins can be safely removed over time. All we need is good therapeutic and nutritional guidance (which should not be expensive) and patience- because eliminating toxins does take time.

SALIVA AND AMALGAM METALS

Dental amalgams continue to be a subject of great controversy, but more governments are taking stand. In Norway and Sweden mercury has been banned as dental material,¹⁵⁷ and the FDA took a 'final' stand, stating that 'dental amalgams are a moderate risk' to human health.¹⁵⁸ Through court orders, the FDA was forced to withdraw previous safety claims and issue an advisory that indicated that "Dental amalgams may contain mercury, which may have neurotoxic effects on the nervous systems of developing children and fetuses."¹⁵⁹ However, in following statements, the FDA also stated that "It considers dental amalgam fillings safe for adults and children ages 6 and above."

The FDA needs to explain why evidence suggests that mercury is safe for American children and other evidence clearly indicates that it is not safe for Canadian¹⁶⁰, Swedish or Norwegian children.

Saliva testing is not useful for children who have no amalgam fillings or other dental metals in the mouth. It is a test that demonstrates how dental metals are released through chewing.

Testing is simple: Chew gum for 10 minutes and collect all saliva during the chewing period into another test tube. With this information, the physician and dentist is able to evaluate the patient's dental situation.¹⁶¹

SALIVA SAMPLE REPORT

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MINERAL ANALYSIS			Saliva		
		Lab Number		1SA120000	
Doctor	Sample Doctor			Test Date	8/16/2010
Patient Name	Sample Patient	Sex	f	D.O.B.	6/19/1997
Clinical Information				Page	1/1
Acceptable Range		Test Value			
Essential Trace Elements in mcg/l					
Chromium	< 3.00	< 1.40			
Cobalt	< 2.50	0.29			
Molybdenum	< 3.50	0.56			
Essential Macro- & Trace elements (mg/l)					
Copper	< 0.07	0.07			
Potentially Toxic Elements in mcg/l					
Cadmium	< 2.00	< 0.76			
Gallium	< 1.00	0.28			
Iridium	< 1.00	< 0.23			
Mercury	< 3.00	< 7.41			
Nickel	< 2.00	7.55	↑		
Palladium	< 1.00	< 0.62			
Platinum	< 1.00	< 0.09			
Rhodium	< 1.00	n.n.			
Silver	< 2.00	3.09	↑		
Tin	< 2.00	2.11	↑		

n.n. = not detected

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RESEARCH:
FIELD STUDY ON THE MERCURY CONTENT OF SALIVA

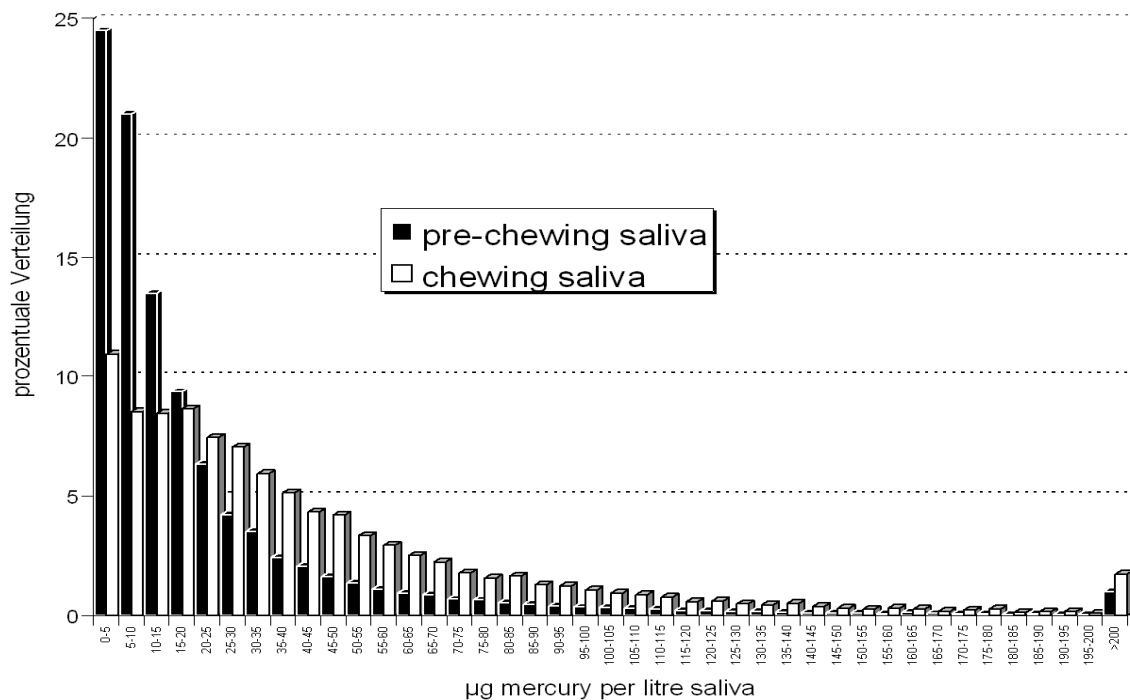


Fig. 6: Percentage distribution of the mercury concentrations in pre-chewing saliva and chewing saliva (n = 17 351)

20 000 subjects were enrolled in a large-scale field study to determine the concentration of total mercury in saliva. A statistical relationship was found between the mercury concentration in the pre-chewing saliva and chewing saliva, and the number of amalgam fillings. The mean number of amalgam fillings was 9 and the median mercury concentration was 11.6 µg/l in the pre-chewing saliva and 29.3 µg/l in the chewing saliva, which is considerably higher than reported in most previous publications. Extrapolation to the uptake of total mercury per week has shown that the provisional tolerable weekly intake (PTWI) value of the WHO is exceeded in at least 30% of the subjects.

The dependence of the number of fillings on age is very marked. The group of 6 - 9 year-olds had about 3 fillings. The group of 30 - 34 year-olds had the highest number with a mean of 11 fillings. In the older age groups the number of fillings fell continuously to about 5.¹⁶²

FECAL METALS

For many toxic metals, fecal excretion is the primary route of elimination from the body. Thus, the metal content of fecal matter is a reflection of the dietary metal intake. Certain foods such as fish are high in arsenic or mercury, and fecal testing

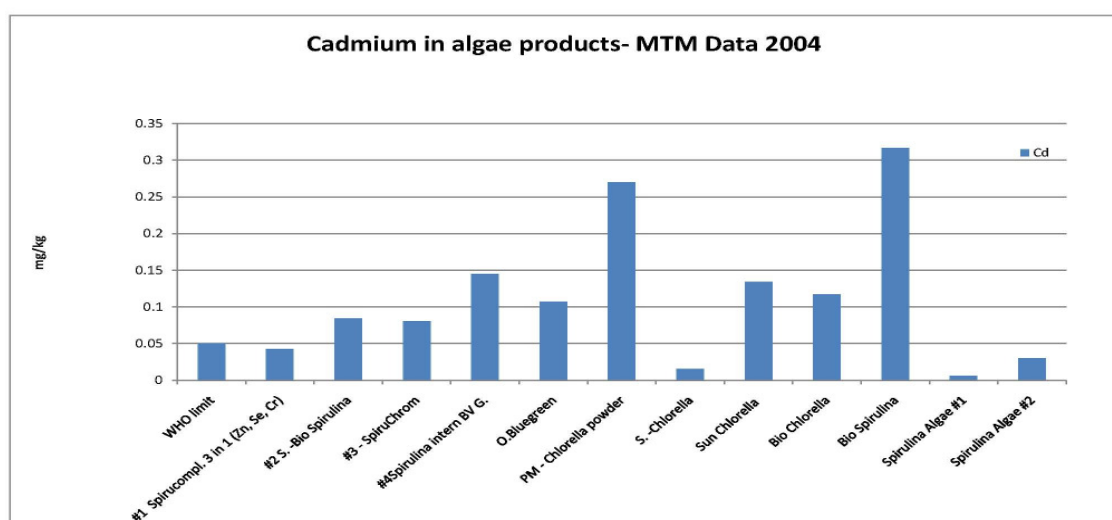
evaluates how much of the oral metal intake is excreted through normal digestion. Fecal analysis reflects the metal intake from water, food, tins, aluminum foils and cookware, medicine, etc. For example, if we eat fish rich in arsenic and/or mercury, metal excretion in feces will be high.

Thus, fecal metal analysis is an evaluation of the oral metal intake and the resulting fecal metal excretion. Fecal metal analysis does not provide information about a patient's systemic toxic metal burden; it cannot be used to verify systemic intoxication or detoxification. Fecal metal analysis will only show the concentration of metal that passes through the digestive tract.

METALS IN CHLORELLA

For instance, if we eat cadmium-containing algae products as shown in the following table, we can expect fecal concentrations representing the intake. No chelation happened. The body eliminated what was taken in. It is a simple case of metal in and metal out. In most cases, however, the total amount taken in is not eliminated, and tissue storage is a potential threat.

Cadmium content of some algae products.



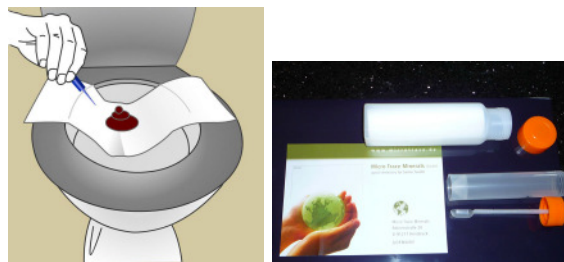
Fecal matter is easily influenced by the oral intake of metals, and reflects the amalgam metal release. While the toxicological consequences of exposure to mercury from dental amalgam fillings continue to be a matter of debate in many countries, researchers at the Department of Dental Toxicology and the Institute of Environmental Medicine, Karolinska Institute (Stockholm, Sweden) proved that point. Their findings were presented in March 1996 at the 74th General Session of the International Association of Dental Research.¹⁶³

In summary, the researchers obtained data on mercury concentrations in saliva and feces before and after removal of dental amalgam fillings. In addition, mercury

concentrations in urine, blood, and plasma were measured. Ten subjects had all amalgam fillings removed at one dental session. Before removal, the median mercury concentration in feces of this group was more than 10 times higher than in samples from an amalgam-free reference group of 10 individuals (2.7 vs. 0.23 [micro]mol Hg/kg dry weight, $p < 0.001$).

A considerable increase of the mercury concentration in feces was seen 2 days after amalgam removal (median 280 $\mu\text{mol Hg/kg}$ dry weight), and then followed by a significant decrease. Sixty days after amalgam removal, the median mercury concentration of samples from the "amalgam group" was still higher than in samples from the reference group. In plasma, the median mercury concentration was 4 nmol/L at baseline. Two days after removal, the median mercury concentration in plasma was increased to 5 nmol/L and declined subsequently to 1.3 nmol/L by day 60. In saliva, there was an exponential decline in the mercury concentration during the first 2 weeks after amalgam removal. It was concluded that amalgam fillings are a significant source of mercury in saliva and feces. All samples from the amalgam group showed a considerable decrease in mercury after amalgam removal.

FECAL SAMPLING PROCEDURE



With the help of paper sampling of fecal matters is made easy. After feces are collected on the strip of paper, less than 2 g are taken with the help of a small spatula. Both sample and spatula are placed in a specific tube for mailing. For metal testing, no refrigeration or overnight shipping is required.

FECAL METAL REPORT

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MINERAL ANALYSIS			Stool		
			Lab Number	1St100100	
Doctor	Dr. John		Test Date	8/25/2011	
Patient Name	A		Sex	m	D.O.B. 9/5/1970
Clinical Information	DMSA		Page	1/2	
	Acceptable Range	Test Value			
Essential Trace Elements in mcg/kg					
Chromium	< 270.00	74.70			
Copper	< 10,000.00	6,695.04			
Zinc	34.00 --- 69.00	53,627.16	↑		
Trace Elements in mcg/kg					
Tungsten	< 90.00	6.87			
Potentially Toxic Elements in mcg/kg					
Antimony	< 80.00	7.23			
Arsenic-total	< 300.00	52.74			
Beryllium	< 9.00	10.50	↑		
Bismuth	< 50.00	0.65			
Cadmium	< 50.00	41.26			
Gallium	< 395.00	4.85			
Lead	< 50.00	34.09			
Mercury	< 10.00	14.24	↑		
Nickel	< 1,000.00	868.86			
Palladium	< 32.00	27.06			
Platinum	< 3.00	1.14			
Thallium	< 20.00	2.06			
Titanium	< 250.00	96.30			
Uranium 238	< 120.00	6.64			

n.n. = not detected

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MINERAL ANALYSIS		Stool			
Patient Name	Andreas Schneider	Lab Number	1St100100	Page	2/2
<p>Stool is a transport medium. The concentrations of essential and toxic elements found in stool are influenced by food intake and the digestive breakdown of food. A factor influencing the metal concentration of stool may be the frequency of elimination. The information contained in this elemental analysis report is designed as an interpretive adjunct to normally conducted diagnostic procedures. The findings are best viewed in the context of a medical examination and history.</p> <p>The reference ranges listed represent a statistical reference range in the 95percentile.</p> <p>For more information, please contact us: service@microtrace.de or www.microtrace.de</p>					
<p>BERYLLIUM (Be): Ingested Be is not considered highly toxic, because it is poorly absorbed through the gut. However, excessive uptake can cause severe rickets. Beryllium is stored in the liver and skeleton and known to replace magnesium. Beryllium overexposure affects liver function. Berylliosis, a fatal lung disease, has affected workers in the nuclear industry, especially plutonium processing. THERAPEUTIC RECOMMENDATION: avoid smoking. Increase antioxidant intake, with emphasis on vitamin A. Amino acids and fatty acids support liver function.</p>					
<p>MERCURY (Hg): Elemental mercury is easily converted to organic mercury by living systems. Symptoms of poisoning include inactivation of enzyme function, birth defects, brain damage and other central nervous system disorders. Early symptoms of mercury overexposure include insomnia, dizziness, fatigue, drowsiness, weakness, depression, tremors loss of appetite, loss of memory, nervousness, headache, dermatitis, numbness, and tingling of lips and feet, emotional instability and kidney damage. Symptoms of acute toxicity: loss of teeth, extreme tremor, mental and emotional disorders, kidney failure. SOURCES: overexposure may stem amalgams in dentistry, contaminated seafood. THERAPEUTIC RECOMMENDATION: in mild cases, increase oral intake of cysteine and antioxidant intake, esp selenium and vitamin E.</p>					
<p>ZINC (Zn) high levels in fecal matter may be due to supplementation of nutritional zinc. The daily recommended intake is 3-30mg/day, depending on age and status.</p>					

n.n. = not detected

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URINE METALS

Urinary metal analysis plays a significant role in clinical chemistry. Sampling and preparation of urine are critical and errors in collecting or preparing the urine greatly affects test results.

Urine is a liquid waste product. This fluid produced by the kidneys consists of excess water and the toxic waste products from food and drink. It normally is a clear, transparent fluid of amber color. The urine of an inadequately hydrated person is more concentrated and darker in color, while the urine of a well hydrated person is light. The more hydrated a person is, the more watery the appearance of the urine. When taking riboflavin-containing B-vitamins, urine turns to dark-yellowish. After the consumption of red beets, urine turns purplish red, because the beet color is not metabolized by the body and thus excreted as is.

The average amount of urine excreted in 24 hours is from 40 to 60 ounces (about 1.2 liters). Chemically, the urine is mainly an aqueous (watery) solution of salts (sodium chloride and other metals), urea and uric acid. Normally, urine contains about 960 parts of water to 40 parts of solid matter. Abnormally, it may contain sugar (in diabetes), albumen (as in some forms of kidney disease), bile pigments, or abnormal quantities of one or another of its normal components

BASELINE URINE

In chelation, we distinguish between a baseline and a challenge test.

The baseline urine test is used to compare the urine metal concentration of the unprovoked or unchallenged (baseline) urine with the metal values of the urine challenge test. The baseline urine needs to be taken only once prior to the start of the chelation treatment. The initial comparison of the baseline urine metal concentration with the first, second or last urine challenge test result foster patient understanding of the chelation process and help physicians to set up a realistic treatment schedule. In case of an insurance inquiry, the comparison of urine baseline and challenge test results provides treatment proof.

BASELINE URINE COLLECTION INFORMATION

A baseline urine test is generally the first morning specimen. Since the urine is collected in the bladder overnight, it is not important if the sample submitted to the laboratory is a first, or mid- or last stream urine. It is easiest for the patient to collect some urine in a regular urine cup and fill 10ml of that in the urine tube, provided by the lab.

To avoid arsenic and mercury contamination, it is advisable that the patient does not eat fish for at least one or two days prior to urine sampling. Better would be 3-4 days of no fish. Algae products should be avoided for the same duration of time.

Any type of nutritional supplementation, including Vit.B12 which contains cobalt, should be discontinued at least 24hrs prior to sampling.

Medicine containing metals such as Lithium should be temporarily omitted, unless medically necessary. Read the pharmaceutical's label and discuss this with your physician and pharmacist.

Smoking should be stopped at least the night before sampling. The longer the better. Smoke contains a number of toxic elements, including arsenic, beryllium, lead, cadmium and nickel. Hence, the urine of an active smoker automatically shows a higher concentration of potentially toxic metals than the urine of a non-smoker.

Provide the laboratory with patient name, date of birth or age, and sex. This information is necessary for the laboratory to make reports based on age and sex-relevant reference ranges. This information is needed to convert mg/L and mcg/L data to mg/g and mcg/g creatinine levels.

THE URINE CHALLENGE TEST

This test is performed to evaluate the success of the chelation treatment. It also provides information regarding the severity of the intoxication and allows the physician to set up realistic treatment schedules.

DMSA CHALLENGE TEST PROTOCOL

(For other chelator-specific urine collection protocols, contact service@microtrace.de)

- For children, it is easiest to take oral DMSA at night.
- No mineral supplements should have been taken during the day, unless clinically necessary.
- No algae or chlorella products should be given. These supplements contain high amounts of nutrient metals such as manganese and iron, and may contain toxic metals.
- Wake up the child at 3AM. Give DMSA with 1-2 glasses of water and let him or her go back to sleep.
- When the child wakes around seven AM, collect some urine in a normal urine cup before all urine is voided in the toilet. Fill a total of 10ml in the laboratory-provided test tube and prepare for shipping.
- The child can now have breakfast and should drink plenty of water throughout the day.

URINE METAL COMPARISON REPORT

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MINERAL ANALYSIS				Test Value Comparison	
Doctor	Dr. A			Compare No.	129
Patient Name	PATIENT B		Sex	m	D.O.B.
Clinical Information	DMSA; 500mg oral			Page	1/1
	Baseline URINE Norm	Chelator-specific orientation range	1UB120001 8/6/2012	1UA120001 8/6/2012	
Creatinine (g/l) *			1.15	0.98	
Essential Trace Elements (mcg/g Creatinine)					
Chromium	0.10 --- 3.50		0.31	0.33	
Cobalt	< 5.00		2.98	4.15	
Copper	1.45 --- 60.00		30.95	93.62	
Iron	2.00 --- 95.00		7.07	9.91	
Manganese	< 4.50		3.80	5.91	
Molybdenum	9.70 --- 100.00		24.31	16.46	
Selenium	12.00 --- 90.00		113.38	56.03	
Vanadium	< 1.40		0.10	0.11	
Essential Macro- & TraceElements (mg/g Creatinine)					
Calcium	55.00 --- 245.00		249.28	147.99	
Magnesium	12.00 --- 150.00		94.76	111.67	
Zinc	0.07 --- 7.00		1.41	0.93	
Trace Elements in mcg/g Creatinine					
Germanium	< 1.50		0.68	0.70	
Lithium	< 175.00		24.96	29.67	
Strontium	< 570.00		62.85	86.02	
Potentially Toxic Elements in mcg/g Creatinine					
Aluminum	< 125.00		3.50	8.53	
Antimony	< 1.00		0.20	0.07	
Arsenic-total	< 15.00		3.01	6.32	
Barium	< 8.22		0.94	1.30	
Beryllium	< 1.20		0.05	0.05	
Bismuth	< 0.15		0.01	0.02	
Cadmium	< 0.80		1.60	0.76	
Lead	< 5.00		1.42	45.64	
Mercury	< 1.00		0.70	25.11	
Nickel	< 3.00		5.43	3.24	
Platinum	< 0.60		n.n.	n.n.	
Silver	< 1.40		0.02	0.03	
Thallium	< 0.60		0.15	0.22	
Tin	< 5.00		0.33	1.07	
legend:					
UA = DMSA Urine		UB = BASELINE URINE			

n.n. = not detected

These 95percentile Reference Ranges listed above are representative for a healthy population. All elements are tested quantitatively.

Accreditation: DIN EN ISO 17025; Quality control: Dipl. Ing. Friedle, Ing. J. Merz, Dr. Rauland; Validation: Dr. E.Blaurock-Busch
PhD, Laboratory physician: Dr. med. A. Schönberger

EVALUATION OF COMPARISON REPORT RESULTS:

Lead and mercury are clearly the main problem, and monthly detoxification treatments may be needed for 6 to 9 months, after which another DMSA challenge test should be repeated. While there is no obvious nutritional problem, a multivitamin/mineral supplement containing zinc should be provided between treatments, but be stopped two days prior to the treatment and resumed the day after.

Because nickel and cadmium levels are higher in the baseline urine than in the challenged urine, no smoking should be allowed around the child, and the vitamin C and E intake should be increased.

Neurological improvement can be expected with the removal of mercury and lead.

WATER METAL ANALYSIS

The water people drink influences their metal status. This is especially true during chelation. It is thus important to know about the metal content of the water. If you drink strontium-rich water (which is naturally found in Wisconsin, USA), your blood or urine test may show high strontium. To rule out a health hazard, use bottled water that is not high in strontium for 3-4 days and repeat the test.

If you used this strontium-rich water on a daily basis for a long time, a hair analysis would show if strontium has been deposited in the body. Since strontium is chemically similar to calcium, it has the ability to find its way into muscle and bone, especially when the patient is calcium-deficient.

United States and European countries enforce strict standards that regulate the safety of drinking water supplies. While the World Health Organisation proposes similar (but usually more lenient) regulations for other nations, these are not necessarily followed. In rural areas of India, for instance, water supply systems are often inadequate or not available, and contaminated water remains a source of disease for millions of people.

To make safe water available to all requires awareness and an enormous financial commitment. Drinking water quality varies from place to place, depending on the condition of the source water from which it is drawn and the treatment it receives. EPA, for instance, does not regulate private wells, but provides [recommendations](#).

Every community water supplier must provide an annual report (sometimes called a consumer confidence report) to its customers. The report provides information on your local drinking water quality, including the water's source, the contaminants found in the water, and how consumers can get involved in protecting drinking water. These annual reports will by necessity be short documents, but more information is provided on request. Environmental agencies of European governments provide websites concerning water safety. For the US, the United States Environmental Protection Agency (EPA) regulates drinking water standards.¹⁶⁴

Information regarding the British water safety board can be found at: www.dwi.gov.uk/

Please note that the British and US environmental agencies may recommend slightly varying maximum contaminant levels (MCL). If you need information about your city water, you may contact your local water company about local water standards. You may request information and quality control information regarding the safety of your drinking water. Take into account that the pipes in your house can greatly change water quality and the metal content of your drinking water.

COMMON WATER CONTAMINANTS

Contaminant	MCLG ¹ (mg/L) ²	MCL or TT ¹ (mg/L) ²	Potential Health Effects from Ingestion of Water	Sources of Contaminant in Drinking Water
Antimony	0.006	0.006	Increase in blood cholesterol; decrease in blood sugar	Discharge from petroleum refineries; fire retardants; ceramics; electronics; solder
Arsenic	0 ⁷	0.010 as of 01/23/06	Skin damage or problems with circulatory systems, and may have increased risk of getting cancer	Erosion of natural deposits; runoff from orchards, runoff from glass & electronic production wastes
Barium	2	2	Increase in blood pressure	Discharge of drilling wastes; discharge from metal refineries; erosion of natural deposits
Beryllium	0.004	0.004	Intestinal lesions	Discharge from metal refineries and coal-burning factories; discharge from electrical, aerospace, and defense industries
Cadmium	0.005	0.005	Kidney damage	Corrosion of galvanized pipes; erosion of natural deposits; discharge from metal refineries; runoff from waste batteries, paints

Chromium (total)	0.1	0.1	Allergic dermatitis	Discharge from steel and pulp mills; erosion of natural deposits
Copper	1.3	TT ⁸ ; Action Level=1.3	Short term exposure: Gastrointestinal distress Long term exposure: Liver or kidney damage Wilson's Disease Patients should consult their doctor if amount of copper in their water exceeds the action level	Corrosion of household plumbing systems; erosion of natural deposits
Fluoride	4.0	4.0	Bone disease (pain and tenderness of the bones); Children may get mottled teeth	Water additive which promotes strong teeth; erosion of natural deposits; discharge from fertilizer and aluminum factories
Lead	zero	TT ⁸ ; Action Level=0.015	Infants and children: Delays in physical or mental development; Adults: Kidney problems; high blood pressure	Corrosion of household plumbing systems; erosion of natural deposits
Mercury (inorganic)	0.002	0.002	Kidney damage	Erosion of natural deposits; discharge from refineries and factories; runoff from landfills and croplands
Nitrate (measured as Nitrogen)	10	10	Infants below the age of six months who drink water containing nitrate in excess of the MCL could become seriously	Runoff from fertilizer use; leaching from septic tanks, sewage; erosion

			ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.	of deposits natural
Nitrite (measured as Nitrogen)	1	1	Infants below the age of six months who drink water containing nitrite in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.	Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits
Selenium	0.05	0.05	Hair or fingernail loss; numbness in fingers or toes; circulatory problems	Discharge from petroleum refineries; erosion of natural deposits; discharge from mines
Thallium	0.0005	0.002	Hair loss; changes in blood; kidney, intestine, or liver problems	Leaching from ore-processing sites; discharge from electronics, glass, and drug factories

WATER COLLECTION FOR METAL TESTING:

The mineral and trace element content of water easily varies, and is greatly influenced by the environment, geographical location, water treatment and the pipes in which the water flows.

The mineral and bacterial content of City water is less influenced by weather conditions such as prolonged heat or rain than the ground water found in wells and cisterns.

Checking your cistern or city water:

Turn on your kitchen faucet and let the water run for 10 minutes. After that time, you are drawing water deep from the well or from the city pipes. Open the plastic tube or bottle provided from the laboratory, rinse it three times and then fill. Do not fill totally to the top. Leave about one centimeter space unfilled.

Checking your water pipes

Old water pipes are a source of metals and bacteria. When water stands over several hours in the pipes, depending on its acidity or alkalinity, it may cause mild corrosion and free metals. Old solder can release toxic metals into your drinking water. Copper may be released from copper pipes.

To see how your drinking water is affected, you must take the water sample first thing in the morning. Open the faucet and rinse the plastic tube or bottle three times, then fill as outlined above.

Microbiological water testing

This test should be performed by a local laboratory within driving range as bacteria grow during shipping. A bacteria-free water sample will remain bacteria-free as long as no bacteria is introduced into the container, but if water contains small amounts of any type of bacteria, the bacteria concentration will increase during shipping, especially during hot weather. Chlorination of water eliminates bacteria growth.

WATER SAMPLE REPORT

Micro Trace Minerals Laboratory

environmental & clinical laboratory

Röhrenstrasse 20, 91217 Hersbruck, Germany
P.O.Box 4613; Boulder, CO 80306-4613, USA

Phone: +49 (0) 9151/4332
Facsimile: +49 (0) 9151/2306
<http://www.microtrace.de>
service@microtrace.de



MINERAL ANALYSIS

Client: Sample Doctor
Sample Source: Sample Patient
hardness of water: 13.71°dH

WATER MINERAL ANALYSIS

Lab Number: 1WA120000
Test Date: 7/26/2012
Page: 1/2

The tested water is

moderately
hard

Your drinking water has been tested for total recoverable metals in accordance with EPA Method 200.8 and §15 of the European Drinking Water Regulation. Accreditation: DIN EN ISO/IEC 17025. Test values are compared to acceptable reference ranges, also called maximum contaminant levels (MCL) as available and defined by the EPA and the European Water Regulation offices. Concentrations greater than the MCL are considered potentially harmful to health.

	Acceptable Range	Test Value	
Essential Trace Elements in mcg/l			
Chromium	< 50.00	0.08	
Copper	< 2,000.00	359.20	
Iron	< 200.00	0.64	
Manganese	< 50.00	0.50	
Selenium	< 10.00	n.n.	
Zinc	< 5,000.00	292.02	
Essential Macro- & Trace elements (mg/l)			
Calcium	< 100.00	86.61	
Magnesium		6.92	
Trace Elements in mcg/l			
Boron	< 1,000.00	36.75	
Strontium	< 4,000.00	362.79	
Potentially Toxic Elements in mcg/l			
Aluminum	< 200.00	< 50.00	
Antimony	< 5.00	0.02	
Arsenic-total	< 10.00	< 5.00	
Barium		16.44	
Beryllium	< 4.00	n.n.	
Cadmium	< 3.00	0.02	

n.n. = not detected

These 95percentile Reference Ranges listed above are representative for a healthy population. All elements are tested quantitatively.

Accreditation: DIN EN ISO 17025; Quality control: Dipl. Ing. Friedle, Ing. J. Merz, Dr. Rauland; Validation: Dr. E.Blaurock-Busch PhD, Laboratory physician: Dr. med. A. Schönberger

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MINERAL ANALYSIS			WATER MINERAL ANALYSIS			
Sample Source	Sample Patient		Lab Number	1WA120000	Page	2/2
Acceptable Range		Test Value				
Potentially Toxic Elements in mcg/l						
Lead	< 10.00	3.40				
Mercury	< 1.00	0.07				
Nickel	< 20.00	1.56				
Silver	< 10.00	n.n.				
Thallium	< 2.00	n.n.				
Uranium	< 10.00	0.01				

n.n. = not detected

These 95percentile Reference Ranges listed above are representative for a healthy population. All elements are tested quantitatively.

Accreditation: DIN EN ISO 17025; Quality control: Dipl. Ing. Friedle, Ing. J. Merz, Dr. Rauland; Validation: Dr. E.Blaurock-Busch PhD, Laboratory physician: Dr. med. A. Schönberger

SUMMARY:

No laboratory test has all the answers, but each test provides specific information that is relevant to one specific part of the metabolic system. This means that no test is superior or inferior, but each laboratory test provides important answers, and like puzzle pieces, knowledgeable physicians know how to put them together until the picture is complete.

SAFE WAYS TO DETOXYFIFY CHILDREN

MAKING CHILDREN SWALLOW PILLS

Most children are taste sensitive and swallowing smelly pills is tricky. Try hiding tablets in food such as a banana slice, soft bread, a piece of sausage or chocolate may work. Or place the pills in the back of the mouth and make the child swallow. Quickly offer a drink or favourite food. When all else fails, get nutrients in capsule form, open the capsule and mix its content into food or drink.

Mixing foul-tasting medicine such as DMSA powder in a small portion of tomato or other juice may work. Yoghurt or apple sauce can cover the taste somewhat. Or divert the child's attention by offering a favourite drink or food. With a bit of coaching, it will swallow the chelating agent. Be clever and patient and you will get the job done.

1. SYNTHETIC CHELATING AGENTS

DMSA

DMSA (Dimercapto Succinic Acid) is FDA-approved since 1991 for the treatment of lead-poisoning children as young as 2 years of age when the blood lead levels exceed 45mcg/dl. The recommended dose is 10 to 30mg/kg BW.¹⁶⁵

DMSA effectively binds mercury, lead and other toxin. It does not significantly bind essential elements such as zinc or iron and therefore, DMSA chelation treatment is not likely to disturb the fragile biochemical make-up of children, if treatments are spaced apart reasonably well. Children diagnosed with a chronic metal overexposure do not need to be chelated more than once bi-weekly, at most.

Treatment protocols for the oral use of DMSA in combination with lipoic acid. Antioxidants, amino acids and other nutritional means are safe to use. Treatments are well tolerated and side effects are rare. Still, medical observation is needed, especially when considering the often highly allergic nature of the autistic child.

TRANSDERMAL DMSA

Autistic children are a challenge to doctors and parents. Simple tasks such as swallowing a pill are difficult to master and thus alternative routes of administering 'chelation substances' are proposed worldwide. The use of transdermal DMPS is promoted as an alternative by well-meaning doctors, however, this treatment does not work. The head chemist of the German Heyl Company, producer of DMPS,

advises against transdermal DMPS. According to Dr. Ruprecht, this form of application is not able to detoxify organ systems other than the skin- and mercury is usually not found in skin tissue. DMPS has a strong affinity to bind zinc and since zinc is necessary for skin health and wound healing, zinc depletion can cause skin problems.

EDTA + DMPS

Chelating agents such as EDTA or DMPS are not recommended for the use in children, unless a severe and acute toxicity warrants their use. Treatment must be provided and supervised by a physician trained in toxicology.

DMPS can be given orally, but side effects are known.

EDTA is available in the oral form and as a suppository, but both of these detoxify the digestive tract. Systemic detoxification is very low with side effects.

2. NUTRITIONAL DETOXIFICATION

Vitamin C and other antioxidant nutrients are presumed to play a pivotal role in minimizing the damage from oxidative products, including free radicals. This protective function is twofold: the already-oxidized groups in prosthetic centers of enzymes are reduced and the oxidants and free radicals are removed. Much information has been accumulated by orthomolecular medicine to demonstrate that mineral replacement or detoxification through nutrients takes place.

As early as 1978 Prasad found that the daily ingestion of 150mg elemental zinc (as 660mg zinc sulfate) produced overt copper depletion with anemia in some patients (Prasad As eta I. JAMA 240:2166, 1978).

In 1986, Read et al reported that excessive supplementation of calcium decreases iron absorption. (Read MH et al. Mineral supplementation practices of adults in seven western states. Nut.Res. 6:375-83, 1986) and O'Donnell and Smith stated that excessive calcium impairs magnesium absorption probably due to competition for a common transport system. (O'Donnell JM, Smith DW. Uptake of calcium and magnesium by rat duodenal mucosa analyzed by means of competing metals. J.Physiol.229:733, 1973)

In 1983, Dr. Carl C Pfeiffer wrote that zinc may reduce blood manganese levels, (Pfeiffer CC, LaMola S. Zinc and Manganese in the schizophrenias, J.Orthomol.Psychiat. 12:215-34, 1983) and as early as 1967, Van Campen reported that copper decreases zinc absorption. (Van Campen DR. Copper interference with intestinal absorption of zinc-65 by rats. J.Nutr. 473, 1967)

In 1998, Dr. Earl B. Dawson of the University of Texas Medical Branch at Galveston found that men who took 1,000 milligrams daily of Vitamin C dramatically lowered lead levels in their blood within one week. In an abstract prepared for the American College of Nutrition, Dr. Dawson reported on his study in which dietary ascorbic acid, or Vitamin C, was given to 75 men aged 20 to 35 years. The men were randomly divided into three groups, receiving either 200 milligrams a day, 1,000 milligrams or a placebo which had no Vitamin C content. The test lasted for one month. Studying the

results each week, Dr. Dawson and his colleagues found no changes in the placebo test group or in the group receiving only 200 milligrams daily. But the group receiving 1,000 milligrams a day saw blood levels of lead drop sharply after only one week of the vitamin supplementation. Their blood lead levels remained low throughout the remainder of the test period.

Shinji Yoneda and Kazuo T. Suzuki of the Faculty of Pharmaceutical Sciences, Chiba University, Japan reported in Toxicology and Applied Pharmacology, Volume 143, Issue 2, April 1997, Pages 274-280 that the toxicity of mercury (Hg) can be reduced by co- administration with selenium. The study of Greenland animals by Dietz et al (see Abstract below) suggests that methyl mercury is detoxified by a chemical mechanism involving selenium.

Nutritional detoxification works. While this safe way to detoxify the body takes time, side effects are almost unknown.

LIPOIC ACID

Lipoic acid (1,2-dithiolane-pentanoic acid) is a dithiol which is effective in protecting against oxidative stress by virtue of its sulfur groups. It is present in all kinds of cells and functions as a cofactor in multi-enzyme complexes that catalyse the oxidative decarboxylation of α -keto acids such as pyruvate, α -ketoglutarate, and branched-chain α -keto acids. Lipoic acid is unique among antioxidants, because it retains powerful antioxidant properties in both its reduced (dihydrolipoic acid) and oxidised (lipoic acid) forms. Both lipoic and dihydrolipoic acids have metal-binding abilities. Alpha-lipoic acid does not cause nutritional deficiencies or imbalances.

Prof. Ming H. Wong of Hong Kong Baptist University, China and Dr. Paul K.L. Lam of Hong Kong report how functional abnormalities in newborn infants with feeding problems, unexplained hyperirritability and restless sleep were managed through nutritional detoxification treatments. Over a 5-year period, 121 such infants were subjected to hair mineral analysis and / or provocative urine test. Literally, all affected infants showed elevated concentrations of toxic metals (mercury, lead, cadmium, antimony, arsenic). The source of the toxic load was thought to be transplacental passage from asymptomatic mothers who had consumed pollutant laden seafood. An experimental treatment regime incorporating alpha lipoic acid as the major therapeutic agent yielded very positive results. The study underscores the impact of environmental pollution on prenatal health and seeks to raise the awareness of medical professionals that advances in nutrition and anti-oxidant research can be utilized to optimize health.¹⁶⁶

GLUTATHION

Nutritional detoxification does not have to be expensive, and the nutrient formulation does not need to be exotic. The reason why nutrients work equally well is simple: the body is able to formulate itself. For instance, we don't necessarily have to take expensive glutathione products and the following abstract explains how we can support important metabolic functions.

It might be smart to first provide adequate nutrition (which does not have to be expensive) and find out if the child's well-being improves. Studies indicate that dietary supplementation with a whey-based product can increase glutathione levels, improving the overall glutathione status.¹⁶⁷ If whey-based protein products are not tolerated, other protein sources such as hydrolysed proteins or amino acid may be used. Amino acids are the building blocks of proteins, and may be better tolerated. For hypersensitive patients, try a small amount and check for reactions.

Abstract: (highlights are added)

Wu G, Fang YZ, Yang S, Lupton JR, Turner ND. Glutathione metabolism and its implications for health. J Nutr. 2004 Mar;134(3):489-92.

"Glutathione (gamma-glutamyl-cysteinyl-glycine; GSH) is the most abundant low-molecular-weight thiol, and GSH/glutathione disulfide is the major redox couple in animal cells. The synthesis of GSH from glutamate, cysteine, and glycine is catalyzed sequentially by two cytosolic enzymes, gamma-glutamylcysteine synthetase and GSH synthetase. Compelling evidence shows that GSH synthesis is regulated primarily by gamma-glutamylcysteine synthetase activity, **cysteine availability**, and GSH feedback inhibition.

Animal and human studies demonstrate that **adequate protein nutrition** is crucial for the maintenance of GSH homeostasis. In addition, enteral or parenteral cystine, methionine, N-acetyl-cysteine, and L-2-oxothiazolidine-4-carboxylate are effective precursors of cysteine for tissue GSH synthesis.

Glutathione plays important roles in antioxidant defense, nutrient metabolism, and regulation of cellular events (including gene expression, DNA and protein synthesis, cell proliferation and apoptosis, signal transduction, cytokine production and immune response, and protein glutathionylation).

Glutathione deficiency contributes to oxidative stress, which plays a key role in aging and the pathogenesis of many diseases (including kwashiorkor, seizure, Alzheimer's disease, Parkinson's disease, liver disease, cystic fibrosis, sickle cell anemia, HIV, AIDS, cancer, heart attack, stroke, and diabetes). New knowledge of the nutritional regulation of GSH metabolism is critical for the development of effective strategies to improve health and to treat these diseases."

NUTRITIONAL DETOXIFICATION PROGRAM FOR CHILDREN OR SENSITIVE ADULTS

Nutritional chelation is one of the oldest means to detoxify the body. The sulfhydryl-containing amino acids are capable of binding heavy metals, just like any chelator of the thiol group.

A **thiol** is a compound that contains the functional group –SH, which is composed of a sulfur atom and a hydrogen atom. DMSA or DMPS are thiols, and cysteine or glutathione are others. As the name suggests, the –SH group binds tightly to the element mercury and other metals such as lead.

Vitamin C, E and other antioxidants including the bioflavonoids also support metal binding. Dr. Earl B. Dawson of the University of Texas Medical Branch at Galveston found that adult smokers who took 1,000 milligrams daily of Vitamin C dramatically lowered lead levels in their blood within one week. Dr. Dawson reported that Vitamin C was given to 75 men aged 20 to 35 years. The men were randomly divided into three groups, receiving either 200 milligrams a day, 1,000 mg/day or a placebo which had no Vitamin C content. The study lasted one month, and a weekly evaluation by Dr. Dawson and colleagues found no changes in the placebo test group or in the group receiving only 200 milligrams daily. But the group receiving 1,000 milligrams a day saw blood levels of lead drop sharply after only one week of the vitamin supplementation. Their blood lead levels remained low throughout the remainder of the test period.¹

Scientists at the University of California at San Francisco also found that Vitamin C helps reduce dangerous blood levels of lead. Dr. Joel A. Simon and Dr. Esther Hudes revealed that high dosages of Vitamin C are associated with reduced blood levels of lead in both young children and adults. The researchers said they believe the results of their studies on lead in blood can have "public health implications" for controlling lead toxicity, particularly for children. Their studies indicated that high levels of Vitamin C in blood correlated with lower levels of lead in blood.²

"Vitamin C levels are an important independent correlate of blood lead levels among Americans," says Joel Simon, MD, MPH, SFVAMC staff physician and UCSF assistant professor of medicine, epidemiology & biostatistics. "To our knowledge, this report is the first population-based study to establish such an association. If a causal relation is confirmed, increased consumption of ascorbic acid may have public health implications for the prevention of lead toxicity."

The author has used nutritional intervention in the treatment of chronic metal exposure long before she got involved in the teaching of synthetic chelation protocols. One of the most memorable cases was that of Oliver S., a Dutch teenager suffering from aplastic anemia, cause unknown. When she was first consulted, the 17-year old received weekly blood transfusions; his condition was considered serious. Through hair mineral analysis, we discovered a significant lead intoxication. His hair lead level was measured >80PPM (=>80mg/kg); the accepted reference range for adults is <3PPM. Blood levels turned out negative, not a surprise after many month of weekly blood transfusions.

Oliver and his family lived in a stately Dutch home. Water testing revealed some lead content, though values did not seem high enough to cause a severe case of chronic lead intoxication. As a precautionary measure, we asked the family to scratch paint off the walls inside Oliver's room (because lead paints had been used at the time of Oliver's birth). Sure enough, we found extremely high levels of lead. Further investigation provided the answer. As a young child, Oliver had a habit of scratching paint off the wall, licking it. Subsequently, he had slowly intoxicated himself at an early age. It took nearly 16-year for the disease to develop.

For cases of acute or chronic lead intoxication, EDTA infusions are considered the treatment of choice. Oliver was chelated at a Dutch medical center, but the young

man did not respond favourably. Because of his condition, we decided to utilize nutritional therapy.

The patient received sulphur-containing amino acids, moderate amounts of vitamin C (1000mg 3-4x daily), 400 IE Vitamin E, and other antioxidants, a B-complex and a multivitamin/mineral complex. We did not include Lipoic acid or Glutathion, simply because at that time, we did not know much about these nutrients' role in detoxification.

Glutathion can be synthesized from the amino acids L-cysteine, L-glutamate and glycine, and was, inadvertently, part of the program.

By today's standards, this oral nutritional program was moderate and rather simple, but within the first three month, Oliver's transfusion schedule could be stretched more and more until it was tapered off. After 1 ½ years of nutritional treatment, a repeat hair analysis showed a significant reduction in lead levels; within 2 years, his doctors released him from care, considering him healthy. Years later, he is alive and well.

Table 1 shows Oliver with his sister and friends after health was regained.



Yvette Busch (in white shirt), now CEO of Micro Trace Minerals, Germany is sitting next to Oliver

RESEARCH:

The following research abstracts speak for themselves (*italics provided by the author*); but clearly more analytical and clinical proof is needed.

Dietz R., Riget F, Born E.W. **An assessment of selenium to mercury in Greenland marine animals.** The Science of The Total Environment, Volume 245, Issues 1-3, 17 January 2000, Pages 15-24

Abstract

Information on mercury and selenium molar relation in muscle, liver and kidney tissue of Greenland marine animals is presented. In the majority of the samples selenium was present in a molar surplus to mercury. This was most clear in molluscs, crustaceans, fish and seabirds. A 1:1 molar ratio was found in tissues of marine mammals with high mercury concentrations (above approx. 10 nmol/g). This was most clearly demonstrated for liver and kidney tissue of polar bear and for ringed seal with high mercury concentration in the liver. These findings support previous results found in liver tissue of marine mammals, suggesting that methyl mercury is detoxified by a chemical mechanism involving selenium. If the anthropogenic release of mercury to the environment increases in the future due to increasing energy demands, species such as polar bears and seals with high tissue mercury concentrations should be monitored to elucidate whether this protective mechanism can be maintained in target organs.

Ercal N, Gurer-Orhan H, Aykin-Burns N. **Toxic metals and oxidative stress part I: mechanisms involved in metal-induced oxidative damage.** Curr Top Med Chem. 2001 Dec;1(6):529-39.

Abstract

Toxic metals (lead, cadmium, mercury and arsenic) are widely found in our environment. Humans are exposed to these metals from numerous sources, including contaminated air, water, soil and food. Recent studies indicate that transition metals act as catalysts in the oxidative reactions of biological macromolecules therefore the toxicities associated with these metals might be due to oxidative tissue damage. Redox-active metals, such as iron, copper and chromium, undergo redox cycling whereas redox-inactive metals, such as lead, cadmium, mercury and others deplete cells' major antioxidants, particularly thiol-containing antioxidants and enzymes. Either redox-active or redox-inactive metals may cause an increase in production of reactive oxygen species (ROS) such as hydroxyl radical (HO.), superoxide radical (O₂.-) or hydrogen peroxide (H₂O₂). Enhanced generation of ROS can overwhelm cells' intrinsic antioxidant defenses, and result in a condition known as "oxidative stress". Cells under oxidative stress display various dysfunctions due to lesions caused by ROS to lipids, proteins and DNA. Consequently, it is suggested that metal-induced oxidative stress in cells can be partially responsible for the toxic effects of heavy metals. Several studies are underway to determine the effect of antioxidant supplementation following heavy metal exposure. Data suggest that antioxidants may play an important role in abating some hazards of heavy metals. In order to prove the importance of using antioxidants in heavy metal

poisoning, pertinent biochemical mechanisms for metal-induced oxidative stress should be reviewed.

Patrick L. **Toxic metals and antioxidants: Part II. The role of antioxidants in arsenic and cadmium toxicity.** Altern Med Rev. 2003 May;8(2):106-28.

Abstract

Exposure to toxic metals has become an increasingly recognized source of illness worldwide. Both cadmium and arsenic are ubiquitous in the environment, and exposure through food and water as well as occupational sources can contribute to a well-defined spectrum of disease. The symptom picture of arsenic toxicity is characterized by dermal lesions, anemia, and an increased risk for cardiovascular disease, diabetes, and liver damage. Cadmium has a significant effect on renal function, and as a result alters bone metabolism, leading to osteoporosis and osteomalacia. Cadmium-induced genotoxicity also increases risk for several cancers. The mechanisms of arsenic- and cadmium-induced damage include the production of free radicals that alter mitochondrial activity and genetic information. *The metabolism and excretion of these heavy metals depend on the presence of antioxidants and thiols that aid arsenic methylation and both arsenic and cadmium metallothionein-binding. S-adenosylmethionine, lipoic acid, glutathione, selenium, zinc, N-acetylcysteine (NAC), methionine, cysteine, alpha-tocopherol, and ascorbic acid have specific roles in the mitigation of heavy metal toxicity. Several antioxidants including NAC, zinc, methionine, and cysteine, when used in conjunction with standard chelating agents, can improve the mobilization and excretion of arsenic and cadmium.*

SUMMARY:

- Laboratory tests allow us to diagnose problems.
- When we know the child's toxic status and its genetic ability to detoxify (see Booklet 1), we are able to select the appropriate detoxification treatment.
- Through proper support and treatment, we enable the body to rehabilitate itself.
- By freeing cells and nerve tissues from toxins such as mercury or lead, we aid recovery.
- By freeing the child's body of toxic substances, we are enabling a complex system to heal itself as much as possible.

DISCLAIMER:

This booklet provides information that cannot take the place of medical advice. We encourage you to talk to your health care providers (doctor, registered dietitian, pharmacist, etc.) about your questions regarding diagnosis and treatment. Any use of pharmaceuticals, dietary supplements and what may be best for your child's overall health needs to be discussed with a qualified pediatrician or health care provider. Any mention in this publication of a specific brand name is not an endorsement of the product.

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