

Heavy metal poisoning is the accumulation of heavy metals, in toxic amounts, in the soft tissues of the body. Symptoms and physical findings associated with heavy metal poisoning vary according to the metal accumulated. Many of the heavy metals, such as zinc, copper, chromium, iron and manganese, are essential to body function in very small amounts. But, if these metals accumulate in the body in concentrations sufficient to cause poisoning, then serious damage may occur. The heavy metals most commonly associated with poisoning of humans are arsenic, cadmium, lead, and mercury, arsenic and cadmium. The World Health Organization has expressed concern about arsenic, cadmium, lead, and mercury as potentially harmful to human health due to the fact that arsenic, cadmium, lead, and mercury exposure are ubiquitous and they can affect the human brain, kidneys and heart even at very low levels. Heavy metal poisoning may occur as a result of industrial exposure, air or water pollution, foods, medicines, improperly coated food containers, or the ingestion of lead-based paints.

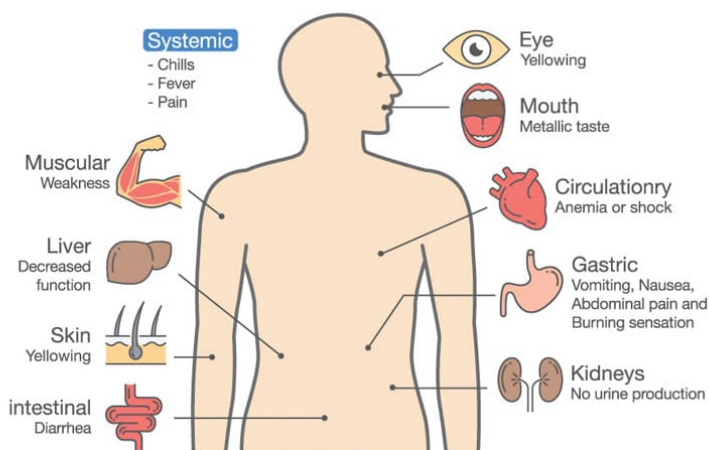
Causes and Symptoms

A toxic accumulation of certain metals cause competition with and replace certain essential minerals in the course of which several of the body's organ systems may be affected. Symptoms of heavy metal toxicity include sensory impairment (vision, hearing, or speech), lack of coordination, peripheral neuropathy (tingling, itching, burning, or pain) skin discoloration (pink cheeks, fingertips, and toes), swelling, and shedding or peeling of skin.

Arsenic poisoning may be caused by medications including potassium arsenite and some topical creams used in the treatment of some skin conditions. Ingestion of herbicides, insecticides, pesticides, fungicides, or rodenticides containing arsenic may cause arsenic poisoning. Occupational exposure to arsenic in the manufacture of paints, enamels, glass, and metals may cause arsenic poisoning. Other forms of occupational exposure include galvanizing, soldering, etching, lead plating, smelting, and wood preserving. Arsenic is also found in contaminated water, seafood, and algae.

One of the mechanisms by which arsenic exerts its toxic effect is through impairment of cellular respiration by the inhibition of various mitochondrial enzymes, and the uncoupling of oxidative phosphorylation leading to cell death. Inorganic arsenic can undergo a methylation process inside the body to become methylated arsenic which have more potent toxic properties because it is carcinogenic causing DNA methylation.^{1,2}

Long term effects of arsenic exposure include gross pigmentation with hyper keratinization, wart formation, dermatitis, vasospasticity, Raynaud's phenomenon, decreased nerve conduction velocity, lung cancer, conjunctivitis, peripheral rhinitis, and death.



neuropathies, encephalopathy, laryngitis, bronchitis,

Cadmium poisoning may be caused by ingestion of food (e.g. grains, cereals, and leafy vegetables) and cigarette smoke. Occupational exposure to cadmium in metal plating, battery, and plastics industries may also occur. Eating foods/drinks contaminated with high levels of cadmium can cause symptoms of nausea, stomach cramps, kidney damage, fragile bones. Breathing in cadmium can results in vomiting, shortness of breath, swelling of the upper respiratory tract.

Cadmium can induce ROS production causing depletion of reduced glutathione (GSH) which results in oxidative stress, affects DNA repair mechanisms causing mutations and chromosomal deletions, and induces apoptosis

affecting cell proliferation, differentiation and cell death. At low concentrations, cadmium binds to mitochondria and inhibits both cellular respiration and oxidative phosphorylation.³

Cadmium is especially a problem for the kidney, which holds 50% of the total body burden. Once cadmium enters the body, much of it is bound to metallothioneins. These compounds are cleared through the glomeruli but are then reabsorbed by the tubules where they then become stuck. As the metallothioneins slowly degrade, highly toxic free cadmium is constantly released. Although it then passively migrates into the urine, it also causes oxidative stress to the tubules. The cadmium damage to the kidneys helps explain why it accounts for a surprising 20% of osteoporosis. As the kidneys degenerate, they not only lose their ability to excrete toxins, but now are less able to perform their other functions.

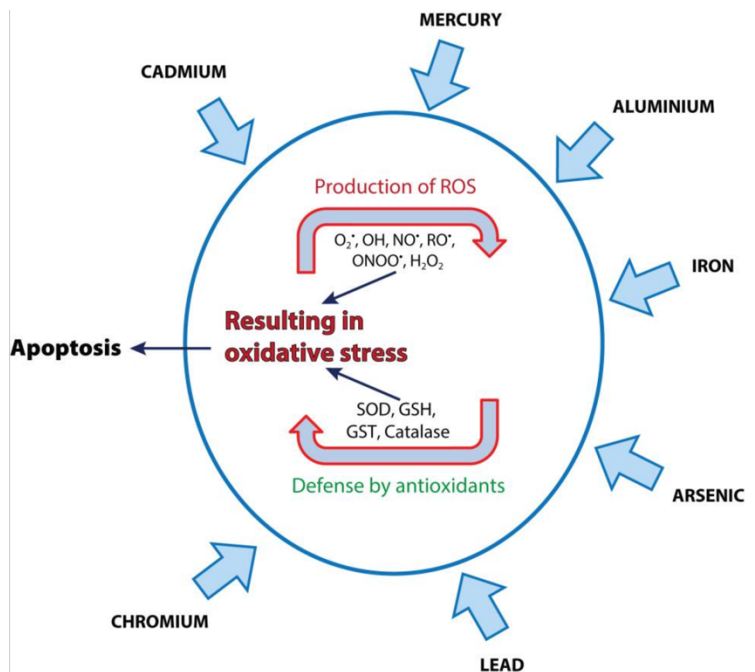
Lead poisoning may be caused by exposure (e.g. chewing or ingestion) to deteriorating lead paint in older houses. Occupational exposure to lead in painting, smelting, firearms instruction, automotive repair, brass or copper foundries, printing, battery manufacturing, mining, brass foundry, gasoline, glass, and bridge, tunnel and elevated highway construction may also occur. Another cause of lead poisoning is through the contamination of water from lead pipes.

Lead is a cumulative toxicant that affects multiple body systems including the brain, liver, kidneys and bones and is particularly harmful to young children. It is stored in the teeth and bones, where it accumulates over time and is released into blood during pregnancy where it becomes a source of exposure to the developing fetus. The level of exposure is usually assessed through the measurement of lead in the blood.

The primary target of lead toxicity is the central nervous system and its neurotoxicity is the induction of oxidative stress, intensification of apoptosis of neurocytes, interfering with calcium dependent enzymes like nitric oxide synthase.⁴ Lead exposure can have serious consequences for the health of children. At high levels of exposure lead attacks the brain and central nervous system, causing comas, convulsions and even death. Children who survive severe lead poisoning may be left with intellectual disability and behavioral disorders. At lower levels of exposure that causes no obvious symptoms, lead can produce a spectrum of injuries across multiple body systems. In particular, lead can affect children's brain development, resulting in reduced intelligence quotient (IQ), behavioral changes such as reduced attention span and increased antisocial behavior, and reduced educational attainment. Lead exposure also causes anemia, hypertension, renal impairment, immunotoxicity and toxicity to the reproductive organs. The neurological and behavioral effects of lead are believed to be irreversible.

Acute lead toxicity can cause gastrointestinal problems such as nausea, vomiting, loss of appetite, stomach cramps, and constipation. It can also cause sleeping problems, fatigue, mood changes, headache, joint/muscle aches, anemia, and a decreased sexual drive. Long term problems with lead exposure include nervous system, genitourinary system, and blood-forming system problems. Chronic exposure to lead can lead to death.

Mercury poisoning may be caused by exposure to large amounts of mercury in the manufacturing of thermometers, mirrors, incandescent lights, x-ray machines, and vacuum pumps. Another cause of mercury poisoning is contaminated water and fish. Children often are exposed to mercury through paint, calomel, teething powder, and mercuric fungicide used in washing diapers. Additional causes of mercury poisoning are exposure to mercury in thermometers, dental amalgams, and some batteries.



Short-term effects of mercury toxicity include lung damage, nausea, vomiting, diarrhea, hypertension, tachycardia, skin rashes, and eye irritation. With chronic exposure to mercury, the nervous system is susceptible to damage. Brain and kidney damage are common with high levels of mercury exposure. Other common systemic side-effects are irritability, shyness, tremors, vision and hearing problems, and memory deficits.

Mercury exists in multiple oxidative states, as inorganic salts, and as organic complexes. Mercury ions produce toxic effects by protein precipitation, enzyme inhibition, and generalized corrosive action. Mercury binds to proteins (including enzymes) and rendered them inactive. Elemental mercury vapor is highly lipid soluble which allows it to readily cross cellular membranes. It can also be oxidized to the mercuric state. Mercuric salts which is divalent are more soluble, therefore, are more toxic than the mercurous salts which is monovalent. Thus, when ingested they will be more rapidly absorbed and produce greater toxicity. However, the organic mercury is more toxic because only about 10% of an inorganic mercury salt (regardless of the oxidative state) is absorbed compared to 90% of the organic form is absorbed via the GI tract.⁵

The highest accumulation of inorganic mercury is in the kidneys, because the kidneys have a high affinity for them. In fact, within a few hours of exposure, 50% of the mercury salts that gets into the blood ends up in the kidneys and can cause damages to both the glomeruli and the tubules. Much of the tissue damage appears due to poisoning of the kidney mitochondria so there is not enough ATP for the cells to protect themselves from the toxins they are excreting. Mercury also blocks catecholamine (i.e. epinephrine) catabolism which leads to a high level of catecholamines causing symptoms of profuse sweating, tachycardia, increased salivation, hypertension, kidney dysfunction (e.g. Fanconi syndrome), insomnia or neuropsychiatric symptoms such as emotional instability, or memory impairment. Mercury blocks the conversion of important antioxidant molecules (i.e. Vitamin C and Vitamin E) to their reduced forms which are important antioxidants to help remove reactive oxygen species (ROS).

Organic mercury can be found in the forms of aryl, short, and long chain alkyl compounds such as methylmercury and ethylmercury. Organic mercury compounds are accumulated in the food chain and have been used to inhibit bacterial growth in medications. Organic mercury is also found in fungicides and industrial run-off. They are absorbed more completely from the GI tract than inorganic salts in part because they are more lipid-soluble. Once absorbed in tissues, the aryl and long chain alkyl compounds are converted to divalent mercuric that possess inorganic mercury toxic properties. The short chain alkyl mercurials such as methylmercury are readily absorbed in the GI tract (90% to 95%) and remain stable in their initial forms. Alkyl organic mercury compounds have high lipid solubility and are distributed uniformly throughout the body, accumulating in the brain, kidneys, liver, hair, and skin. They can also cross the blood-brain barrier and placenta and penetrate erythrocytes, attributing to neurological symptoms, teratogenic effects, and high blood to plasma ratio. Methylmercury has a high affinity for sulfhydryl groups, which explains its effect on enzyme dysfunction. One enzyme that is inhibited is choline acetyl transferase, which is involved in the final step of acetylcholine production. This inhibition may lead to acetylcholine deficiency, contributing to the signs and symptoms of motor dysfunction.

Excretion of Heavy Metals

The liver plays a key role in the body's detoxification of unwanted toxic chemicals. The hydrophobic waste (fat soluble) molecules are normally changed to more hydrophilic (water soluble) molecules when passing through the liver in order to be secreted out of the body. The waste molecules are secreted out of the body using two routes which include kidney filtration to urine and transporting from the liver to the bile duct and then to stool.

The hydrophobic waste molecule is a lot slower in passing through the microcapillaries in the kidneys to be secreted out through urine. When the hydrophobic waste molecule is mixed with bile and loaded to the digestive tract, most of them will be reabsorbed back. If patients have weak kidney function, or sluggish bile flow due to a liver deficiency, the hydrophilic waste molecules will not be secreted out effectively. The liver will conduct two step processing of the toxin using cytochrome P450 enzyme system in the first step and six different types of modification depending on the types of toxins which include glutathione conjugation, amino acid conjugation, methylation, sulfation, acetylation, and glucuronidation.

For heavy metals including the cadmium, lead and mercury detoxification, the glutathione pathway is particularly crucial. Glutathione has a high affinity with heavy metals and functions as a chelating agent to form a conjugator with the heavy metal. The conjugator will be then transported with bile to the GI tract to be excreted as feces.⁶ While in arsenic detoxification, the conjugator will be further methylated before exported and removed by the liver with the bile.⁷ Besides functioning as a chelating agent of heavy metals, glutathione is also an antioxidant found in all mammalian tissues to help remove reactive oxygen species (ROS). This is very important to counter the increased oxidative stress induced by the heavy metals. The glutathione pathway is the most efficient pathway of heavy metal detoxification and has been ubiquitously used among not only mammals but also yeast and even plant.

Glutathione is highly concentrated in the liver and the liver plays a key role in heavy metal detoxification. However, an increase of ROS and oxidative stress resulting from heavy metal toxicity can cause depleted glutathione in the liver cell rendering reduced ability to remove the heavy metals by the liver. Glutathione supplement has been used as a supplement for heavy metal detox. However, the body can't effectively absorb it because glutathione is a peptide and is subject to degradation by peptidase enzymes in the digestive tract. The digestive system breaks glutathione into its basic components—glycine, cysteine, and glutamate. There is no way to absorb it directly intact. The liver has to rely on its own endogenous synthesis to produce glutathione. On the other side, the damage to the liver caused by the increased oxidative stress may result in reduced glutathione synthesis by the liver causing accumulation of the heavy metal inside the body. The increase ROS can also cause liver inflammation as well and patients may experience symptoms of skin itching, tingling, or pain sensation due to the bile leaking into the blood causing nerve irritation.

Wellness Recommendation

TCM herbal therapies are very effective for restoring the liver to health to supply sufficient amount of glutathione, ultimately regulating and aiding successful heavy metal detoxification. The first-line wellness recommendation includes Turkey Tail, Brown, LC Balancer, and Xcel.

Turkey Tail formula enhances Liver Qi and clears Liver Heat to address liver toxicity caused by heavy metals and other toxins. It helps support the livers detoxification function and increases the efficiency of toxin metabolism by reducing liver inflammation and improving liver immune function. It also helps repair liver damage caused by toxin build up. Radix Bupleuri, another ingredient in Turkey Tail, contains flavonoid compounds that protect the liver. The most studied family of compounds in bupleurum roots are saikosaponins: immune-modulating and anti-inflammatory compounds with an affinity for liver cells.¹¹ Yunzhi, an ingredient in Turkey Tail, also has various immunological functions and has been shown to increase T helper cells.⁸ Patients can experience symptom improvement in the symptom reduction of the liver toxicity such as skin itching, tingling, or pain sensation in 1-3 days. 2-4 weeks is recommended for significant improvement with sustained results.

Brown, LC Balancer, and Xcel are also recommended to help support the detoxification process. Brown supports liver structure and function to enhance liver function and glutathione synthesis. Hawthorn fruit, an ingredient in Brown, has been shown increase antioxidant enzymes, namely, super-oxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GSH-Px) in serum, liver, and brain.⁹ Rhizoma Alismatis, another herb in Brown, addresses the structural deficiencies of the liver by increasing lipid export, controlling inflammatory markers, and reducing oxidative stress levels.¹⁰ As the kidneys are a major target of heavy metals, LC Balancer and Xcel which support kidney repair are also important in the heavy metal detoxification protocol. LC Balancer nurtures kidney Yin. It helps to improve the structure of the kidneys. Gynostemma, an herb in LC Balancer, helps to remove toxicity and inflammation, improves lipid metabolism, and has protective effects on both the liver and kidneys.¹² It also helps to improve microcirculation by increasing serum nitric oxide level.¹² Xcel nurtures kidney Yang. Xcel helps to improve adrenal gland and kidney function. It helps with kidney filtration and balancing of minerals. Catapol, a compound of rehmannia root in Xcel, has been shown to have endless benefits for the kidneys. Its been shown to preserve kidney structure and renal function.¹³ Patients can experience symptom improvement in 2 weeks. 6 weeks to 3 months is recommended for significant improvement with sustained results in the clearance of heavy metals.

If a patient has low-grade inflammation of the liver, Levera is recommended as well. Levera removes Heat from the liver to reduce inflammation. If a patient has low-grade inflammation of the kidneys, KS is recommended. KS removes Heat from the kidneys and reduces inflammation. If a patient has low grade inflammation of the brain, Hepavin and Platinum are recommended.

Selected Case Studies

Case 1: Successful Resolution of Heavy Metal Toxicity

Sheila LaPlante, TCM practitioner/LAC

A patient came for treatment after they received a reading from a blood test which revealed high arsenic levels in the blood (74ng/mL). We began Wei Labs heavy metals protocol three months ago utilizing Brown, LC Balancer and Xcel.

Three months later, after these three formulas were given, the patient's blood tests revealed that the arsenic levels had been reduced to 11 ng/mL. Normal levels are considered to be below 12 ng/mL. The patient feels better and her symptoms of muscle fatigue and blood vessel problems have subsided.

Case 2: Reduction of Mercury Levels in the Blood

Wei Laboratories Practitioner

A male patient who is a dentist and in his 50's came for treatment for heavy metal toxicity. The patient had received a blood test that showed he had a blood mercury level over 1,000 µg/L.

The patient was recommended Wei Labs Brown, LC Balancer, and Xcel. After 3 months on the protocol, the patient received another blood test that revealed a significant drop of under 10 µg/L. The patient is very satisfied with his results.

References:

1. Singh, A. P., Goel, R. K., & Kaur, T. (2011). Mechanisms pertaining to arsenic toxicity. *Toxicology international*, 18(2), 87–93. <https://doi.org/10.4103/0971-6580.84258>
2. Hughes MF. Arsenic toxicity and potential mechanisms of action. *Toxicol Lett.* 2002 Jul 7;133(1):1-16. doi: 10.1016/s0378-4274(02)00084-x. PMID: 12076506.
3. Rafati Rahimzadeh, M., Rafati Rahimzadeh, M., Kazemi, S., & Moghadamnia, A. A. (2017). Cadmium toxicity and treatment: An update. *Caspian journal of internal medicine*, 8(3), 135–145. <https://doi.org/10.22088/cjim.8.3.135>
4. Nemsadze K, Sanikidze T, Ratiani L, Gabunia L, Sharashenidze T. Mechanisms of lead-induced poisoning. *Georgian Med News.* 2009 Jul-Aug;(172-173):92-6. PMID: 19644200.
5. Park, J. D., & Zheng, W. (2012). Human exposure and health effects of inorganic and elemental mercury. *Journal of preventive medicine and public health = Yebang Uihakhoe chi*, 45(6), 344–352. <https://doi.org/10.3961/jpmph.2012.45.6.344>
6. <https://www.naturalmedicinejournal.com/blog/glutathione-system-key-optimal-detoxification>
7. Lawley, S. D., Yun, J., Gamble, M. V., Hall, M. N., Reed, M. C., & Nijhout, H. F. (2014). Mathematical modeling of the effects of glutathione on arsenic methylation. *Theoretical biology & medical modelling*, 11, 20. <https://doi.org/10.1186/1742-4682-11-20>
8. Wong CK, Tse PS, Wong EL, Leung PC, Fung KP, Lam CW. Immunomodulatory effects of yun zhi and danshen capsules in health subjects--a randomized, double-blind, placebo-controlled, crossover study. *Int Immunopharmacol.* 2004 Feb;4(2):201-11. doi: 10.1016/j.intimp.2003.12.003. PMID: 14996412.
9. Rezaei-Golmishah, A., Malekinejad, H., Asri-Rezaei, S., Farshid, A. A., & Akbari, P. (2015). Hawthorn ethanolic extracts with triterpenoids and flavonoids exert hepatoprotective effects and suppress the

hypercholesterolemia-induced oxidative stress in rats. Iranian journal of basic medical sciences, 18(7), 691–699.

10. Choi, E., Jang, E., & Lee, J. H. (2019). Pharmacological Activities of *Alisma orientale* against Nonalcoholic Fatty Liver Disease and Metabolic Syndrome: Literature Review. Evidence-based complementary and alternative medicine : eCAM, 2019, 2943162. <https://doi.org/10.1155/2019/2943162>
11. Yang, F., Dong, X., Yin, X., Wang, W., You, L., & Ni, J. (2017). Radix Bupleuri: A Review of Traditional Uses, Botany, Phytochemistry, Pharmacology, and Toxicology. BioMed research international, 2017, 7597596. <https://doi.org/10.1155/2017/7597596>
12. Ye, Q., Zhu, Y. I., Ye, S., Liu, H., She, X., Niu, Y., & Ming, Y. (2016). Gypenoside attenuates renal ischemia/reperfusion injury in mice by inhibition of ERK signaling. Experimental and therapeutic medicine, 11(4), 1499–1505. <https://doi.org/10.3892/etm.2016.3034>
13. Jiang, P., Xiang, L., Chen, Z., Lu, H., Zhou, L., Yang, L., Ji, Y., Liu, Y., Sun, X., Deng, Y., Nie, X., Luo, R., & Zhao, X. (2018). Catalpol alleviates renal damage by improving lipid metabolism in diabetic db/db mice. American journal of translational research, 10(6), 1750–1761.