



## Effects of Heavy Metal Poisoning during Pregnancy

Kapoor Neeti<sup>1</sup> and Tiwari Prakash<sup>2</sup>

<sup>1</sup>Assistant Professor, Institute of Forensic Science, RTM Nagpur University, Nagpur, Maharashtra, INDIA

<sup>2</sup>Department of Criminology and Forensic Science, Dr. Hari Singh Gour University, Sagar, MP, INDIA

Available online at: [www.isca.in](http://www.isca.in)

Received 22<sup>nd</sup> October 2012, revised 29<sup>th</sup> October 2012, accepted 10<sup>th</sup> November 2012

### Abstract

*Heavy metal and their salts are considered as very important group of environmental pollutant which in small quantities may be essential nutrients that protect your health, yet in larger quantity it become toxic and dangerous to human being. When you're pregnant you want to provide the best for your developing baby, starting with what you eat. Your diet, however, may include toxic metals that pose health risks to both you and your child. Heavy metals such as arsenic, mercury, lead and copper, cadmium are produced adverse effect during pregnancy which discuss below. This review paper provides an overview of the current knowledge of toxic effect of metal during pregnancy and to newly born baby. It will be helpful in causing awareness among the masses about the harmful effects of heavy metals and their detection.*

**Keywords:** Heavy metal, heavy metal toxicity, reproductive system, chelation therapy.

### Introduction

Heavy metals define as any metallic chemical element that has a high density and is poisonous at lower concentration. Heavy metals include arsenic, lead, copper and mercury which mainly effects reproductive system and especially toxic to growing fetus<sup>1</sup>. These heavy metals are not filtered by placenta from mother to child and are directly deposit in growing fetal tissue. Women under the influence of toxic metals may be infertile, wildly irregular hormone level. Their unborn children receive heavy metals from their pregnant mother. This review paper provide an overview of the current knowledge of toxic effect of metal during pregnancy and to newly born baby. The main objective is to encourage detoxifying mother before conception.

**Arsenic:** Arsenic is a grayish substance which is not poisonous, as it is insoluble in water which is not absorbed from alimentary canal. However, it is continuously changing into arsenious oxide or white arsenic which is tasteless and highly poisonous. Arsenic may be harmful during pregnancy. Exposure to arsenic in the diet may come from agricultural areas that use fertilizers that contain the toxic metal<sup>1</sup>. Arsenic in the diet may also come from well water in areas near mines or electronic manufacturers that use the heavy metal for their products and Women who live in agricultural areas where arsenic fertilizers (now banned) were used on crops or who live near hazardous waste sites or incinerators also may be exposed to higher-than-normal levels of arsenic. Arsenic affects the pregnant women having increased risk of impaired sugar metabolism and gestational diabetes. Chronic arsenic exposure from drinking water may increase the risk of fetal and infant death. Pregnant women who are exposed to arsenic risk of mental retardation and developmental disability in new born baby.

**Lead:** Lead is a heavy metal that is found in the environment and may be ingested in food prepared with water transported through lead pipes or from processing plants using equipment or painted walls that contain trace amounts of the lead. The soluble compounds of lead is poisonous .lead may access into body through inhalation, by ingestion or by absorption through skin and mucous membrane<sup>2</sup>. When women encountered to lead during pregnancy can cause a miscarriage, premature birth Low birth weight and it effects development of fatuous brain and growth of new born baby also retarded. Lead poses health risks for everyone, but young children and unborn baby more porn to lead toxicity which contributes to effect development of growing children and their behavior and learning ability<sup>3</sup>

**Copper:** Copper in metallic form is not poisonous but some of its salts are poisonous such as blue vitriol and sub acetate. Copper is a powerful inhibitor of enzyme. Sources of copper are common in the diet, particularly in vegetarian diets, and can be found in the water due to copper plumbing<sup>4</sup>. Many multiple vitamins contain relatively high doses of copper. The hormone estrogen promotes the retention of copper and this is why women are particularly vulnerable to the problem of copper toxicity. Copper toxicity may leads to poor fertility rate<sup>5</sup>

**Mercury:** Mercury in metallic form refers as quick silver. Metallic form of mercury is not poisonous but when it is in vaporized form it is highly toxic. Elemental mercury and methyl mercury are two types of mercury that may increase health risks in pregnancy, Elemental mercury is found in dental fillings that can release small amounts of mercury vapor that can be inhaled, whereas methyl mercury is frequently found in natural water sources including waterways where fish swim. Toxicity from mercury may harm the developing nervous system of an unborn baby and cause learning disabilities and it effects reproductive

system and produces defects such as infertility, miscarriage and prematurity. Mercury lowers zinc levels, which can pass through both the placental barrier and the blood-brain barrier. Low libido (sex drive) and premenstrual syndrome {PMS} Lowered progesterone levels can lead to infertility. PMS and infertility are common among many young female dental workers due at least in part to their mercury exposure. Male dental workers also suffer from infertility. Mercury lowers zinc levels, which in turn leads to lower testosterone (male hormone) levels. Mercury transmitted to mother milk to child and affects their learning ability.

**Cadmium:** Scientists suspect that cadmium may pose a risk in pregnancy. One study suggests that cadmium may damage the placenta and reduce weight of new born baby. This metal is used in many occupations, including semiconductor manufacturing, welding, soldering, ceramics and painting. Women who work with cadmium should take all recommended precautions and avoid bringing it home on clothing. Pregnant women also may want to consider eliminating sources of cadmium from the house, such as fungicides containing cadmium chloride, certain fabric dyes and ceramic and glass glazes and some fertilizers. Cadmium at lower concentration may produces adverse effect during delivery it causes abortion and weight of new born child will retarded.

## General Symptoms

Heavy metal toxicity may be characterized by any of these symptoms: i. Chronic pain throughout the muscles and tendons or any soft tissues of the body, ii. Chronic malaise – general feeling of discomfort, fatigue, and illness, iii. Brain fog – state of forgetfulness and confusion, iv. Chronic infections such as Candida, v. Gastrointestinal complaints, such as diarrhea, constipation, bloating, gas, heartburn, and indigestion, vi. Food allergies vii. Dizziness, viii. Migraines and/or headaches, ix. Visual disturbances, x. Mood swings, depression, and/or anxiety, xi Nervous system malfunctions – burning extremities, numbness, tingling, paralysis, and/or an electrifying feeling throughout the body

**Note:** Heavy metal toxicity can produce vague symptoms that sometimes are mistaken for other chronic conditions such as Autism, Chronic Fatigue Syndrome, depression, Multiple Sclerosis, and a host of other serious disorders. Discuss heavy metal toxicity with your healthcare professional before receiving any diagnosis or treatment for a serious chronic condition.

## Effects of metallic poisons on new born baby

**Arsenic:** Effects muscular growth, low birth weight, mental growth retarded, low IQ level of new born baby,

**Lead:** Adverse effect on neurodevelopment, brain growth is retarded, increases risk of miscarriage and increases changes of premature birth, effects IQ level of growing children, It decreases fetal growth.

**Copper:** Increases chances of miscarriage, complication during delivery, low birth weight, muscular weakness in new born baby, it leads neurological problems in growing children.

**Mercury:** Effects mental growth of new born baby, adverse effect on nervous system, effects cognitive thinking.

**Cadmium:** Effect growth of new born baby, low IQ level, creates cardiac abnormalities, It produces craniofacial abnormalities such as eyes of new born baby is small, nasal bridge is poorly formed, leads to renal abnormalities.

## Diagnosis

The following tests and procedures may be helpful in diagnosing heavy metal toxicity and/or other chronic conditions:

**DMPS provocation test** – A blood test that measures the amount of heavy metals being removed through the urine after a provoking agent (DMPS) has been used. The key to this test is that it does NOT show the amount of mercury and other heavy metals that are in the body; it only shows what is being removed. Therefore, this test must be taken numerous times over the course of the detoxification protocol. Once excretion levels begin to drop within normal ranges, this means that there is only a small amount of metals left to excrete. This is the best test for accurate measurement. For more information, contact your healthcare practitioner about DMPS.

**Hair analysis:** A tablespoon of hair collected from the nape of the neck is analyzed for its mineral content. Hair holds a history of the past 3 months, but there is much speculation concerning the effectiveness of this type of testing and many believe that the test is useless.

**Fecal testing and urine analysis:** Fecal testing and urine analysis reveal the effectiveness of chelation therapy in excreting heavy metals from the body. During chelation therapy, a chelating agent “provokes” excretion of heavy metals. These tests then measure the amounts of heavy metals that are being excreted during chelation therapy.

## Specific Heavy Metal Toxicity Testing

**Urine Analysis:** A urine analysis is a series of tests that screens and evaluates the urine sample for abnormalities, presence of various compounds (protein, glucose, ketones), and to check for kidney and metabolic processes. The urinalysis also involves tests that assess the color, appearance, odor, and pH, and blood. A urinalysis is a part of routine medical examinations. It is especially done in patients who are pregnant, who are experiencing abdominal pains, blood in urine, frequent or painful urination, symptoms of dysuria, hematuria, diabetes, chronic renal failure, urinary tract infections, and other metabolic diseases.

There is no special diet or preparation before testing. However, taking some medications as some drugs can alter urinalysis results. Collection of urine sample during urinalysis is simple and will not cause any discomfort. This will only take a few minutes. There are no risks and side effects after this test.

**Table-1**  
**Major metabolic factors associated with environmental pollutants such as lead, mercury, cadmium and arsenic.**

	Lead	Mercury	Cadmium	Arsenic
Major route of entry	Ingestion and inhalation	Ingestion	Ingestion and inhalation	Ingestion
Gastrointestinal Absorption	~10	~95	~5	>20
Organ of accumulation	Bone, kidney, liver	Brain, liver, kidney	Kidney, Liver	Keratinous tissue
Major route of excretion	Urine	Feces	urine	Urine
Biological half life	20yrs	70yrs	>10yrs	10-30yrs

**Table-2**  
**Interpretations of Results**

Test	Normal level/range	Interpretation
Appearance Color	Clear Amber yellow	Cloudiness may indicate presence of pus, or bacteria. Red or brown urine indicates blood in the urine (bleeding from kidneys). Green may indicate infection
Odor	Aromatic	Strong smell of acetone indicates diabetic ketoacidosis. Foul odor is indicates presence of UTI. Fecal odor indicates enterovesicle fistula
pH	4.6-8.0	Abnormal pH may indicate kidney or urinary tract disorder. Increased levels indicate alkalemia, UTI. Decreased levels indicate academia, diabetes mellitus, COPD
Protein	0-8 mg/dl, 50-80 mg/24 (at rest), <250 mg/24 hr (during exercise)	Increased levels indicates renal disease, lupus erythematosus, heavy metal poisoning, CHF
Specific gravity	1.005-1.030	Low values indicate renal disease, over hydration, diabetes insipidus, diuresis. High levels indicate dehydration, diarrhea, decreased renal blood flow.
Leukocyte esterase	Negative	Detection of leukocyte esterase indicates possible urinary tract infection
Nitrites	None	Detection of nitrites indicates possible urinary tract infection
Ketones	None	Detection indicates anorexia, hyperthyroidism, diabetes mellitus, aspirin ingestion
Bilirubin	None	Detection indicates gallstones, liver metastasis, Rotor's syndrome, tumor, inflammation
Urobilinogen	0.01-1.0 Ehrlich units/ml	Increased levels indicate hemolytic anemia, pernicious anemia, hematoma, and ecchymosis. Decreased levels indicate cholestasis, biliary obstruction
Crystals	None	Detection indicates renal stone formation, urinary tract infection
Casts	None	Detection indicates UTI, pyelonephritis, acute tubular necrosis, chronic lead poisoning, mercury poisoning, heavy metal poisoning, eclampsia, CHF
Glucose	None	Detection and increased level of glucose indicates kidney damage, diabetes, pregnancy
WBC	0-4 per low power field	Increased WBC indicates bacterial infection.
RBC	≤ 2	Increased RBC indicates primary renal disease, cystitis, prostatitis, bladder trauma.
RBC casts	None	Increased RBC cast indicates systemic lupus erythematosus, vasculitis, subacute bacterial endocarditis

**Table-3**  
**Results of a test are usually available in 10-12 days**

Metals	Normal levels
Arsenic	≤50 µg/L
cadmium	22 µg/24 h
Copper	25 µg/24 h
Iron	<300 µg/dL
Lead	≤70 µ/dL
Mercury	20 µg/L

**Table-4**  
**Comparison of Various Instrumental Techniques**

	FAAS	GFAAS	ICP-AES	ICP-MS	XRF
Detection limit	very good for some element	Excellent for some element	very good for some element	Excellent for some element	very good for some element
Analytical capability	Single element	Single element	Multi- element	Multi- element	Multi- element
Linear dynamic range	10 <sup>3</sup>	10 <sup>2</sup>	10 <sup>5</sup>	10 <sup>5</sup>	10 <sup>5</sup>
Sample through put	10 sec/ element	2min/element	5-30 element	5-30 element/min/sample	All elements 2-6 min/sample 5-15min
Precision	0.1-1%	1-5%	0.3-2%	1-3%	1-10%
Interferences spectral	Few	Very few	Common	Few	Few
Interferences chemical	Many	Many	Very few	Some	Some
Interferences physical	Some	Very few	Some	Some	Some
Dissolved solids	Up to 5%	Up to 10%	Up to 20%	0.1-0.4%	Up to 100% solid
Applicability	>60%	>50%	>70%	>80%	>80%
Method development	Easy	Fairly easy	Fairly easy	Very difficult	Fairly easy
Ease of use	Easy	Easy	Easy	Easy	Easy
Initial cost	Low	Medium	High	Very High	Low
Operating cost	Low	High	Medium	High	Low
Cost per sample	Low	Medium	Low	High	Low

FAAS= Flame Atomic Absorption Spectroscopy; XRF= X-Ray Fluorescence; ICP-MS= Inductive Coupled Plasma-Mass Spectrometry; ICP-AES= Inductive Coupled Plasma-Atomic Emission Spectroscopy, GFAAS= Graphite Furnace Atomic Absorption Spectroscopy.

Factors such as prolonged refrigeration, presence of sperm in the urethra, consumption of foods such as carrots and beets and some drugs can affect the appearance and odor of the urine sample. Vaginal discharge can contaminate the urine sample and alter the results.

**Urine Element Testing:** For diagnosis of the presence of certain toxic element burdens, post provocation testing is recommended. This involves urine collection following oral or intravenous administration of chelating or complexing agents that mobilize elements from otherwise slowly exchanging tissue pools. For example, non-provoked levels of cadmium, mercury, and lead may not be indicative of deep tissue stores and only reflect ongoing or very recent exposure.

Unprovoked urinary levels of essential elements such as magnesium, calcium, sodium, and potassium may be indicative of renal wasting conditions and provide early warning of renal dysfunction. Magnesium loading tests can also be performed using urine elements testing. Provoked urinary levels of elements that chelation agents have an affinity for can provide

valuable information as to the efficacy of the provocation. Blood levels are better indicators of nutritional element status.

Analysis of elements in urine provides diagnostic information on potentially toxic elements such as lead, mercury, cadmium, nickel, beryllium, arsenic and aluminum, and assessment of the efficiency of renal re-absorption of essential elements such as magnesium, calcium, sodium and potassium. Urine element analysis is an invaluable tool for the diagnosis or confirmation of toxic element burden and monitoring of detoxification therapy.

The chelating agents (captomer) may be administered orally to provoke urinary levels of elements. Administration of chelating agents will only last for a few minutes. However, collection of the urine sample will be done over the next six to 24 hours depending on your physician's recommendations. This test will be painless and simple. Normally, there will be no side effects after the test.

Contamination during urine sample collection may alter the results for heavy metals. Specimen should immediately be transported to the laboratory for accuracy or refrigerated if it

cannot be processed right away. Positive results for heavy metal test must be confirmed by repeating the procedure

**Detoxification of body:** Detoxification means removal of metal toxicity from body, it is important for a lady to detoxifying their body before conception. The average time for detoxification depend upon the concentration of metal toxicity and efficiency of detoxifying organs. It is advisable to adopt healthy life style. Consume organic food and all organs which responsible for excretion must be opened for detoxification

**Treatment: Chelation therapy:** Chelation therapy is a treatment procedure used to treat heavy metal poisoning. This therapy involves injection of ethylene diamine tetra acetic acid (EDTA), a chemical that binds, or chelate, heavy metals, including, lead, mercury, cadmium, and arsenic. The term "chelation" comes from the Greek word 'chele', which means "claw," referring to the way the chemical grabs onto metals chelation therapy using EDTA has been approved by the U.S. Food and Drug Administration (FDA). The human body cannot break down heavy metals, which can build up to toxic levels in the body and interfere with normal functioning. EDTA and other chelating drugs lower the blood levels of metals attaching to the heavy metal molecules, which helps the body remove them through urination. EDTA can reduce the amount of calcium in the bloodstream, so help to reopen arteries blocked by mineral deposits, a condition called atherosclerosis or hardening of the arteries. They claim it is an effective and less expensive alternative to coronary bypass surgery, angioplasty, and other techniques designed to unclog blocked arteries.

## Conclusion

Above described are some of the heavy metals which are poisonous in nature specifically harmful for the women who are pregnant and the baby whom they are carrying in their womb. Heavy metals such as arsenic, lead, copper and mercury effect reproductive system and are especially toxic to growing fetus .because they are not filtered by placenta from mother to child and are directly deposit in growing fetal tissue. Each and every mother wants her baby to grow well without and abnormalities. To achieve this goal she has to take care of her diet. These metals can get inside the body either by ingestion or inhalation. Therefore the food which a pregnant lady eats must be nutritious rather than metallicious. This paper concentrates on the symptoms caused due to the consumption of these metals and tests from which the presence of such heavy metals can be proved. There are some instrumental methods as well for the detection of heavy metals. Consumption of arsenic, lead, copper, mercury etc by pregnant women is genuinely a serious problem. Therefore care must be taken by the individual to avoid consuming such substances which may lead to further complications in their pregnancy and abnormalities in newly born infants.

## References

1. Goeringa P.L. and Barber D.S., Hepatotoxicity of Copper, Iron, Cadmium, and Arsenic, *Comprehensive Toxicology*, **9**, 501-526
2. Lead poisoning in pregnant women who used ayurvedic medications from India, center and prevention, [www.cdc.gov/mmwr/pdf/wil/mm6133.pdf](http://www.cdc.gov/mmwr/pdf/wil/mm6133.pdf), (2012)
3. Altmann L., Weinsberg F., Sveinsson K., Lilienthal H., Wiegand H. and Winneke G., Impairment of long-term potentiation and learning following chronic lead exposure, *Toxicol Lett*, **66(1)**, 105-112 (1993)
4. Sinkovic A., Strdin A. and Svensek F., Severe acute copper sulphate poisoning: a case report, *Arh Hig Rada Toksikol*, **59(1)**, 31-5 (2008)
5. Franchitto N., Gandia-Mailly P., Georges B., Galinier A., Telmon N., Ducassé J.L. and Rougé D., Acute copper sulphate poisoning: a case report and literature review, *Resuscitation*, **78(1)**, 92-6 (2008)
6. Zaiser A.E. and Miletic V. Prenatal and postnatal chronic exposure to low levels of inorganic lead attenuate long-term potentiation in the adult rat hippocampus in vivo, *Neurosci Lett*, **239(2-3)**, 128-130 (1997)
7. Chiodo L.M., Covington C., Sokol R.J., Hannigan J.H., Jannise J., Ager J., et al. Blood lead levels and specific attention effects in young children, *Neurotoxicol Teratol*, **29(5)** 538-546 (2007)
8. Kim Y., Kim B.N., Hong Y.C., Shin M.S., Yoo H.J., Kim J.W., et al. Co-exposure to environmental lead and manganese affects the intelligence of school-aged children, *Neurotoxicology*, **30(4)**, 564-571 (2009)
9. Canfield R.L., Henderson C.R. Jr, Cory-Slechta D.A., Cox C., Jusko T.A. and Lanphear B.P. Intellectual impairment in children with blood lead concentrations below 10 microg per deciliter, *N Engl J Med*, **348(16)**, 1517-1526 (2003)
10. Pizzol M., Thomsen M. and Andersen M.S. Long-term human exposure to lead from different media and intake pathways, *Sci Total Environ*, **408(22)** 5478-5488 (2010)
11. Heavy Metal Analysis and Interim Recommended Limits for Botanical Dietary Supplements, White Paper, the American Herbal Products Association
12. Dr Thomas Nissen, An In-depth Report on the Effects of Mercury Poisoning Toxicity, [Evenbetterhealth.com](http://Evenbetterhealth.com) (2004)
13. The adverse effect of alcohol on reproductive system, [www.come-over.to/FAS/alcoholhtml](http://www.come-over.to/FAS/alcoholhtml), Tuula-E-Taurmaa.
14. James Bowring, Heavy metal toxicity and the unborn child, [www.midwiferytoday.com](http://www.midwiferytoday.com), (2005)
15. CDC. Guidelines for the identification and management of lead exposure in pregnant and lactating women. Atlanta, GA: US Department of Health and Human Services, CDC; 2010. Available at <http://www.cdc.gov/nceh/lead/publications/leadandpregnancy2010.pdf>, Accessed August 20, (2012)
16. CDC. Lead poisoning associated with Ayurvedic medications—five states, 2000–2003. *MMWR*, **53**, 582–4, (2004) <http://www.umm.edu/ency/article/002496.htm>