

ARSENIC POISONING

Dr. Vidhi Gautam

Department of Veterinary Pharmacology and Toxicology
College of Veterinary Science & A.H., NDVSU, Jabalpur (M.P.)

Sources

- The most common arsenic compound in general use is arsenic trioxide.
- Heating of metal ores results in the production of arsenic trioxide some of which is carried to the surrounding in dust or smoke.
- Copper arsenite was formerly used as a cheap pigment for colouring wall papers, artificial flowers etc. But it has been discontinued, as it was the cause of many deaths.
- Copper acetoarsenite (Paris green) was used as an insecticide.
- Sodium and potassium arsenite are extensively used as weed killers, dressings for grains, insect poison, sheep dip and wood preservative.
- Arsenical dips are usually combined with sulphur for the use in sheep and cattle.
- Organic arsenicals are used in the treatment of blackhead (histomoniasis) in turkey and also as general tonics and skin alteratives.
- Acetarsol, neoarsphenamine, sulpharsphenamine and liquor arsenicals (Fowler's solution) were used in the treatment of certain skin conditions and as skin alteratives.
- Arsenic poisoning in animals is practically always due to human carelessness.
 - Animals gaining access to receptacles that contained arsenical dips, weed killers or insecticides.
 - Contamination of herbage by lead and calcium arsenate sprays.
 - Contamination of water and herbage in the neighbourhood of metal smelting works.
 - Animals licking wood preserved with an arsenical preparation.
 - Inadvertent use of arsenicals because of their resemblance to other preparations.
 - Ingestion of arsenical rat poison.
 - Following dipping in arsenical baths.
 - Use of contaminated deep well water

Factors affecting arsenic toxicity

- Trivalent compounds are more toxic than pentavalent compounds.
- Pentavalent compounds are said to exhibit their toxic effects only after conversion to trivalent form.
- The other factors, which affect the toxicity of arsenic, are:
 - The physical state – whether solid, coarse powder or fine powder or solution – finely divided soluble forms are more toxic.
 - The condition of the digestive tract.
 - Nature of ingesta.

- Method of application.
- Weak, debilitated and dehydrated animals are more susceptible.
- Poisoning is more common in bovines and felines. Poisoning is also noticed in horses and sheep. It is occasional in dogs and rare in swine and poultry.
- Herbivores are commonly poisoned as they eat contaminated forage.
- Chronic poisoning can occur due to long continued small doses.

Absorption and fate of arsenic compounds

- The rate of absorption of inorganic arsenicals from the digestive tract depends on their solubility.
- Soluble salts are more toxic and are absorbed through skin also. Absorption is very rapid from a fresh wound.
- After absorption, arsenicals tend to accumulate in liver.
- After continued administration, there is a tendency for arsenic to be stored in the bones, skin and keratinized tissue such as hair and hoof.
- Arsenic stored in the tissues may be found there for a long time, even after it has disappeared from the faeces and urine.
- Once arsenic is deposited in the keratinized cells of hair, it is irremovable, moving slowly along the hair as the hair grows.
- Arsenic is excreted in urine, faeces, sweat and milk.
- In the body, arsenic is found in association with protein and it is believed that it attaches to the sulphhydryl groups of the sulphur containing aminoacids.

Mechanism of arsenic toxicity

- Arsenic reacts with the sulphhydryl group of lipoic acid.
- Lipoic acid is an essential co-factor for the enzymatic decarboxylation of keto acids such as pyruvate, ketoglutarate and ketobutyrate.
- By inactivating lipoic acid, arsenic inhibits formation of acetyl, succinyl and propionyl coenzymes A.
- So there is inhibition or slowing of glycolysis and of the citric acid cycle.
- Arsenic also inactivates sulphhydryl groups of oxidative enzymes and glutathione.
- Pentavalent arsenate is a well-known un-coupler of mitochondrial oxidative phosphorylation.

Consequences of Arsenic toxicity

- Arsenic affects those tissues which are rich in oxidative enzymes especially in the alimentary tract, kidney, liver, lungs and epidermis.
- It is a potent capillary poison. Although all beds are affected, the splanchnic areas are more sensitive.
- Loss of capillary integrity and dilatation allows transudation of plasma fluid into the intestinal mucosa and lumen which results in sharply reduced blood volume, hypotension, shock and circulatory collapse.

- Toxic arsenic nephrosis is common in small animals and man.
- Glomerular capillaries dilate, swell and varying degree of degeneration occur. This results in oliguria and urine contains red blood cells and casts.
- Following percutaneous absorption, capillaries dilate and arsenic causes blistering and oedema.
- Skin becomes dry, papery and may crack, bleed and develop secondary infection.
- Tolerance to arsenite: Habitual use of small quantities of arsenic is said to render the body tolerant much larger doses.

Clinical Symptoms

- *Per-acute* – In per-acute poisoning death is rapid. The symptoms noticed are intense abdominal pain, staggering gait, collapse, paralysis and death.
- *Acute* – In acute cases the symptoms are salivation, thirst, vomiting in possible species, violent colic, watery diarrhoea with peel off mucous membrane sometimes haemorrhagic, exhaustion, collapse and death.
- *Sub-acute* – Sub-acute cases may live for several days and there may be additional symptoms of depression, loss of appetite, staggering gait, apparent paralysis of the hind quarters, trembling, stupor, convulsions, coldness of the extremities and sub-normal temperature. Proteinuria and haematuria may also occur. Arsenical dermatitis is common in man.
- *Chronic* – The symptoms include indigestion, thirst, wasting and general appearance of unthriftiness, dry staggering coat, brick red colour of visible mucous membrane, weak and irregular pulse.
- Some organic arsenicals have been used as production aids in poultry and pigs.
- Pigs in particular have suffered damage to peripheral nerves characterized as demyelination following repeated ingestion of medicated feeds. This problem is not amenable to BAL but is sometimes slowly reversible following withdrawal of medicated feed.

Postmortem lesions

- Intense rose-red inflammation of the alimentary tract.
- Soft and yellow liver.
- Edematous and congested lungs.
- Haemorrhages in the heart, peritoneum, kidneys and liver.
- Inflammation of proventriculus and gizzard in birds. Horny layer of the gizzard may be sloughing off.

Diagnosis of arsenic poisoning

- Symptoms like colic, thirst, straining and purgation and vomiting occur suddenly. This might give a suspicion for some irritant poisoning like arsenic. Chronic poisoning is difficult to diagnose.

Treatment of arsenic poisoning

- Induction of emesis.
- Gastric lavage with warm water.
- Enema in carnivores.
- Purgatives in ruminants.
- Use of demulcents to reduce irritation.
- Freshly prepared ferric hydroxide can be given but its use is doubtful.
- Sodium thiosulphate (hypo) can be given orally and intravenously.
 - Horse and cattle – 8 to 10 g as 10-20% solution i/v 20 to 30 g orally in about 300 ml of water.
- Dimercaprol (BAL-British Anti Lewisite)
 - Dimercaprol binds with arsenic-lipoic acid complex and forms arsenic-mercaptide complex. This complex is non-toxic and easily excreted from the body.
 - BAL is relatively ineffective unless given prior to onset of clinical symptoms. Overdosage of arsenic is common in horses and is known as 'tying up' in animals.
 - Water soluble BAL compounds like DMSA (Succimer) and DMPS (Unithiol) are found to be effective.
- Thiocetic acid (lipoic acid) can also be administered.
- d-Penicillamine is also useful as a chelating agent.