Tungsten Poisoning

Tungsten, chemical symbol W (for Wolframite, its mineral form's German name) - atomic number 74 - is a widely used metal that has a very high tensile strength and melting point. It is used in its elemental form in military guns and projectiles, wear-resistant machinery/products, lightbulb filaments and electron and television tubes. Compounds of tungsten are used in fluorescent lighting tubes, in the chemical and tanning industries and, as tungsten disulfide, in industrial lubricants.

Although the medical literature on the toxic effects of tungsten is limited, a review of available literature reveals major concerns about the long-term risk to health of tungsten and tungsten compounds. Most tungsten is rapidly eliminated from the body in the urine and faeces but a small amount can be retained in the bones.

Acute tungsten poisoning

This is an extremely rare presentation. Much of the information on human toxicity comes from case reports of a purported acute toxic reaction to tungsten dissolved in alcoholic drinks following a tradition of French army artillery recruits drinking wine/beer which had rinsed a recently fired gun barrel. Introduction of tungsten into the alloy of the barrel was thought to be the cause of this novel poisoning event. Toxicological analysis confirmed grossly elevated levels of tungsten in blood, urine, hair and nails. Clinical features of this acute episode included:

- Acute nausea within 15 minutes of ingestion.
- Sudden onset of seizures.
- Rapid onset of clouded consciousness leading to coma with evidence of encephalopathy.
- Initial moderate kidney failure progressing to acute tubular necrosis with anuria within 24 hours.
- Hypocalcaemia.
- Gradual symptomatic recovery over weeks with complete resolution of biochemical/metabolic abnormalities after five months.

Elemental tungsten is often produced in a powdered form so there is a theoretical risk of acute toxicity from inhaling the substance in this form or from machine wear/artillery disruption, although there are no reports of this form of acute poisoning.

Chronic tungsten poisoning

- Hard metal workers (involved, for example, in grinding metals) and soldiers with embedded shrapnel may be exposed to the risk of long-term tungsten exposure. Tungsten may be implicated in cases of pulmonary fibrosis due to hard metal lung disease. This giant cell interstitial pneumonitis is contracted from inhaling the dust formed from the manufacture, utilisation or maintenance of hard metal, a material composed of tungsten carbide and cobalt. However, it appears that the vast majority of the toxicity is attributable to the effects of cobalt on respiratory tissues in susceptible individuals.
- Similarly, a dermatitis in hard metal workers appears to be due largely to the effects of cobalt. It has, however, been noted that tungsten carbide appears to modify the toxicity of cobalt and that cobalt alone does not have the same potent toxic effects.
- Hard metal workers have also shown evidence of mild-to-moderate neuropsychological impairment, particularly with regard to memory function.
- Tungsten was introduced in America as an environmentally-friendly alternative to lead in the manufacture of bullets for the military. In certain circumstances - eg, low pH, low oxygen concentration, the presence of iron - it can dissolve. There is a potential for leakage into soil and drinking water. Animal research suggests that long-term exposure can be carcinogenic but more research is needed to determine whether this is relevant to humans.
The long-term exposure risk of embedded shrapnel containing tungsten is a cause for concern.\[1\] There is some evidence that some forms of tungsten may be more toxic than others.\[8\] A large American survey found that individuals with higher urinary tungsten concentrations had double the odds of reported stroke. It is hypothesised that the pathological pathway resulting from tungsten exposure may involve oxidative stress.\[9\]

### Medical use of tungsten arterial embolisation coils

It has recently been noted that tungsten coils used in interventional radiology may be subject to degradation. This has implications for their ability to maintain arterial occlusion and any possible toxic effects due to dissemination of the material into patients' bodies. It appears, thus far, that there is very little risk of toxicity, based on follow-up studies and in vitro analysis.\[10, 11\] However, patients have shown elevated blood tungsten levels and the long-term significance or possible effects of this are uncertain. The carcinogenic potential is of particular concern. It is not thought prudent to continue to use tungsten coils for this purpose.\[11, 12\]

Leachable tungsten is known to develop in glass pre-filled syringes containing protein solution and is thought to be due to the tungsten pins used in the supplier's syringe barrel forming process.\[13\] The potential risks of this phenomenon are currently being studied.\[14\]

### Diagnosis

- Suspect if there are symptoms of acute poisoning, as outlined above, in industrial workers or soldiers who may be exposed to tungsten.
- Inductively coupled plasma-mass spectrometry (ICP-MS) may be used to detect and determine the concentration of tungsten in body fluids/tissues.\[15\]

The following is a guide:\[1\]

- In cases of acute poisoning initial blood levels of 5 mg/L have been detected. In patients with degraded embolisation coils in situ, blood levels of 0.47-1.51 mg/L have been detected.
- Average blood levels in controls (those who had undergone aortic aneurysm grafting without coil embolisation) were 0.044 mg/L.
- The probable minimum lethal exposure range is 0.5-5 g/kg.

### Management\[1\]

- Get expert toxicological and ITU advice if tungsten poisoning is suspected.
- Treatment is mainly supportive.
- Charcoal may be given if it is not contra-indicated.
- In addition, oxygen should be given for respiratory symptoms.
- Benzodiazepines may be given for seizures.
- Haemodialysis has been used for kidney failure and its sequelae but with limited effect on tungsten clearance.

### Prognosis\[1\]

From the limited information available it appears that patients who survive an acute tungsten poisoning episode have a good chance of short- and long-term recovery if they receive appropriate supportive therapy and haemodialysis.

### Further reading & references

- Tungsten Issues Paper; Association of State and Territorial Solid Waste Management Officials, 2011
7. van der Voet GB et al; Metals and health: a clinical toxicological perspective on tungsten and review of the literature, Mil Med. 2007 Sep;172(9):1002-5.

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