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, reviews of available literature reveal concerns about the long-term risk to health of tungsten and tungsten compounds [1] [2]. Tungsten may have carcinogenic potential [3].

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 [4]. Toxicological analysis confirmed grossly elevated levels of tungsten in blood, urine, hair and nails. Clinical features of this acute episode include:

- 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. It may be that the majority of the toxicity is attributable to the effects of cobalt on respiratory tissues in susceptible individuals.
- A 2009 study revealed that hard-metal plant workers co-exposed to tungsten carbide and cobalt displayed an increased risk to lung cancer compared to a control group[5].
- Hard-metal workers have also shown evidence of mild-to-moderate neuropsychological impairment, particularly with regard to memory function[2].
- 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[6].
- The long-term exposure risk of embedded shrapnel containing tungsten is a cause for concern[7].
- There is some evidence that some forms of tungsten may be more toxic than others[2].
- Individuals with higher urinary tungsten concentrations have been found to have double the odds of reported stroke[8].

Medical use of tungsten arterial embolisation coils

It has been noted that tungsten coils used in interventional radiology may be subject to degradation so embolisation coils and methods now use alternative inert materials [9].

Diagnosis [6]

- 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. The following is a guide:
    - 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

- Get expert toxicological and ITU advice if tungsten poisoning is suspected [10].
- 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

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.

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