Cobalt

Atomic number 27
Atomic weight 58.93

Collection

Serum/Plasma	2 mL	Plastic tube No anticoagulant
Urine	20 mL	Sterile Universal

Reference ranges

			Reference
Serum/plasma	nmol/L	Less than 10	1,2
Blood	nmol/L	Less than 10	3-5
Urine	nmol/L	17	6,7
	nmol/mmol creatinine		
	µmol/mol creatinine	Male 2.0 (95th percentile) Female 2.6 (95th percentile)	7

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Clinical

Cobalt is an essential element, being required for the synthesis of vitamin B12. Cobalt metal is used to make high temperature, high strength alloys and for the preparation of tough carbide-tipped cutting and drilling tools. Cobalt alloys are also important for their magnetic properties. Cobalt is also used in the manufacture of semi-conductors, magnetic alloys and catalysts. Cobalt salts are highly coloured and have been used from the earliest times for pigment production. Dicobalt edetate is used in the treatment of cyanide poisoning.

Biological function

The most important role for cobalt is as a component of vitamin B12 or cobalmin. This is produced by bacteria and is an essential nutrient. There are several cobalmin dependant enzymes. Cobalt is also essential for a few other enzymes. One mammalian cobalt containing enzyme is methionine amoinopeptidase 2.

Deficiency

Vitamin B12 – cobalamin – contains cobalt and deficiency of this vitamin, causing pernicious anaemia, is due to failure of absorption from the diet through absence of the so-called intrinsic factor.

Cobalt deficiency per se is virtually unknown in man, although occurring in animals: an anaemia results from the inability of microorganisms in the gut of the affected animals to manufacture sufficient quantities of vitamin B12.

Toxicity

Inorganic cobalt causes increased production of haemoglobin and can induce hypertriglyceridaemia and hypercholesterolaemia. Cardiomyopathy has been seen in individuals with chronic ingestion. In the past cobalt has been used as a haematinic agent but this has been discontinued due to possible side effects.

Inhalation of cobalt-containing dust is a hazard in the manufacture and use of hard metal alloy tools, and causes interstitial lung disease with cough and dyspnoea.

Although several other elements such as tungsten, nickel, vanadium and chromium may be involved, this so-called "hard metal" disease is thought to be largely due to the toxic effects of cobalt. Cobalt dermatitis may occur but the condition is more likely from associated chrome or nickel.

Surgical implants

Much of the recent clinical interest in chromium and cobalt arises from the use of a chromium/cobalt/molybdenum alloy in orthopaedic implants, especially hip replacements. Chromium and cobalt and the main components of the alloys used in many of these implants, but other metals are also present. Chromium and cobalt are primarily released from wear on metal-on-metal surfaces. The most important of these is the surface between a metal cup in the pelvis and a metal ball. The release of metal is due to friction at the surface, which can be due to misalignment of the components and can lead to failure of the implant. If uncorrected there can be severe local tissue damage with formation of a 'pseudo tumour' and necrosis of soft tissue. There have been two warnings on these implants from the UK MHRA suggesting that patients may need to be followed up for the life of the implant. Recent evidence suggests that other surfaces may also contribute to metal release, especially the junction between the stem in the femur and the ball in modular implants. After revision surgery chromium concentrations may remain high for some considerable time due to chromium accumulation in soft tissue surrounding the implant, whereas cobalt does not accumulate.

The UK MHRA suggest that a concentration of 7 ug/L (118 nmol/L) is indicative of increased wear of the implant. Slightly lower concentrations have been proposed by other works and a European multi-disciplinary group.

Cobalt has been implicated in a few rare cases of toxicity seen in these patients, primarily toxicity to sensory nerves, especially aural and visual effects. There has been some evidence that cobalt can cause toxicity in vitro. In almost all patients there is no evidence of toxicity from metal release in these patients. There has been some concern about possible carcinogenicity, but evidence to date suggests that there is no increased cancer risk in these patients.

The same alloys are used in other implants, such as knee and other joints, but the hip is the only implant with a metal-on-metal surface, so the metal release is less important in these implants.

Laboratory Indices of Exposure

For occupational exposure urinary cobalt concentrations provide a sensitive index of recent exposure. Concentrations increase throughout the working day and week but return from very high to basal levels within 2-3 days.

For monitoring wear in orthopaedic implants measurement of serum or blood chromium concentration is the best available index of excess exposure, and concentrations may still be high some weeks after the incident. The MHRA advice recommends that whole blood is used for monitoring patients with metal-on-metal implants. There are differences between blood and serum, but blood will give the total circulating metal concentration, although both can be used.

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