Uranium

Atomic number 92
Atomic weight 238.05

Collection

Blood	2 mL	Plastic tube. Anticoagulant EDTA
Urine	20 mL	Sterile Universal

Reference ranges

			Reference
Serum/plasma	pmol/L		
Blood	pmol/L	Less than 25	1
Urine	pmol/L	Less than 200	2,3
	nmol/24 h	Less than 3.5	4
	nmol/mmol creatinine	Less than 0.27	4

References

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Clinical

Uranium is present in the earth's crust and occurs naturally in soil and water. In its most common and bioavailable form, it exists as uranyl ion (UO_2^{2+}) and shares chemical and biological properties with alkali earth metals. Naturally occurring uranium is a mixture of three isotopes: ^{238}U (99.3% by mass), ^{235}U (0.72%) and ^{234}U (0.006%).[1] These decay to other radioactive elements and ultimately to stable non-radioactive isotopes of lead. Alpha and β particles and photons (X-rays and γ rays) are emitted, but the isotopes have long half-lives (10^5–10^9 years) and uranium is not very radioactive.[2] Enrichment of the ^{235}U isotope produces a valuable fuel used in nuclear power reactors. Depleted uranium is what is left. Typically, this contains 99.8% ^{238}U, with ^{235}U reduced to around 0.2%. It is 40% less radioactive than natural uranium. It is used in armour-piercing weapons and to enhance armour protection of some tanks. Large amounts were used in the Gulf War and some other conflicts. It is also used for X-ray shielding in hospitals, for manufacture of yacht keels and in counterweights for control mechanisms in aircraft.[1-3] Uranyl acetate and uranyl formate are used as electron-dense

"stains" in transmission electron microscopy. Uranium has been used in small amounts for yellow glass and pottery glazes

Uranium glass glowing under UV light

Exposure

Daily intake of uranium is around 1.5 µg, mainly from water, cereals, vegetables and table salt. Some exposure may occur by inhaling dust in air. The concentration in air is usually very small but can be significant for those with occupational exposure or who live near facilities that made or tested nuclear weapons. Subjects who live or work in an area where depleted uranium weapons were used, near a coal-fired power plant, facilities that mine or process uranium ore, or enrich uranium for reactor fuel, may also have increased exposure to uranium.[4,5] Houses or structures that are over uranium deposits (either natural or man-made slag deposits) may have an increased incidence of exposure to radon gas.

Intestinal absorption of the more soluble uranyl ion (UO^{2+}) can be up to 5% whereas much less, approximately 0.5% of insoluble species, such as the oxide, are absorbed. Following inhalation of uranium dusts, some is cleared rapidly in mucous and swallowed while some enters the circulation, and some stays in the lungs from where it is cleared slowly to the blood and local lymph nodes. Most uranium in blood is excreted rapidly in urine with about 90% of absorbed uranium eliminated within 24 hours, and most of the rest over the following weeks.[1] Around 10% is deposited in the kidneys, but is removed within weeks. A further 10% is deposited on bone surfaces where it remains for years because of it's affinity for phosphates, being lost slowly with bone remodelling.[3]

Toxicity

The health effects of uranium exposure have been studied extensively for more than 50 years among uranium miners, millers and processors. Radiation and chemical hazards are negligible if uranium does not enter the body.[1] Only dissolved uranium is chemically toxic. The critical site is the epithelium of the proximal renal tubules. High intakes (> 70-100 ug/kg body weight) may lead to reversible tubular damage.[1] Uranium is also a reproductive toxicant.[6,7] Uranyl ions, from e.g. uranium trioxide or uranyl nitrate, and other hexavalent uranium compounds, have been shown to cause birth defects and immune system damage in laboratory animals.[8] Large studies of uranium workers have not shown an excess of bone cancer or leukaemia, but an increased incidence of lung cancer was has been reported.[1,2] It was estimated that the life-time risk for lung cancer may be increased to twice that of the general population after battlefield exposure to depleted uranium under extreme circumstances, with much lower risks for other cancers.[9]

A voluntary surveillance programme of veterans exposed to depleted uranium in the Gulf War commenced in 1993/4 and now includes 60 volunteers. Those with uranium-containing shrapnel fragments retained in the body were still excreting high uranium concentrations in the urine 9 years after initial exposure. This was not associated with increased cancer or leukaemia risk, or abnormal renal function. Excretion of exposed veterans without retained fragments was normal, and a health hazard is unlikely.[1,2] Several studies in recent decades have been undertaken in response to the suggestion that exposure to depleted uranium is responsible for the so-called Gulf War Syndrome[3,9]. Measurement of uranium isotopes in urine samples have failed to provide evidence that is supportive of this theory.

Laboratory investigations

Uranium is analysed in urine. The chances of detecting a small intake are greatest soon after the potential exposure. A 24 hour urine collection is preferred but, as an expedient, random urine samples standardised for creatinine should be informative.[10,11]

Collection bottles should be checked for leaching or adsorption of uranium.

Accurate and precise analysis of the ratios of the isotopes ^{235}U to ^{238}U is required for environmental monitoring for nuclear contamination and for nuclear forensic studies to determine exposure to enriched or depleted uranium.

References

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