

WHO Guidance on Exposure to Depleted Uranium
For Medical Officers and Programme Administrators

**Prepared in collaboration with
United Nations Joint Medical Staff**

World Health Organization 2001

Introduction

Depleted uranium (DU) has been used in medical and industrial applications for decades but only since its use in military conflicts in the Gulf and the Balkans has public concern been raised about potential health consequences from exposure to it. Concerns have been particularly for peacekeeping forces, humanitarian workers and local populations living and working in areas contaminated by DU following conflict.

There has been a large amount of research on the health consequences to workers in the mining and milling of uranium, and on its use in nuclear power, that enables a reasonable assessment of its impact on human health. Since DU acts chemically in the same way as uranium, and the radiological toxicity is somewhat less than uranium, this research can be used to evaluate health risks from ingestion, inhalation and contact with DU.

In late 1999, the WHO Department on the Protection of the Human Environment (PHE) recognized the need for an independent review of the scientific literature from which health risks could be assessed from various DU exposure situations. This review was published as a monograph in April 2001. For further information on this monograph, refer to the WHO web site: http://www.who.int/ionizing_radiation/env/du/en/. The information and recommendations in this guidance are largely based on this review.

Significant input was provided in the compilation of this guidance by the United Nations Joint Medical Staff and other members of the review group formed to complete the monograph. WHO acknowledges, with sincere gratitude, the contributions of all the authors and reviewers of this guidance. As further information becomes available, this guidance will be updated by the Radiation Project within WHO's Unit on Occupational and Environmental Health.

Scope and Purpose

These recommendations, produced by the World Health Organization in conjunction with the United Nations Joint Medical Service, are for medical officers and for programme administrators who are about to send or have staff working in areas where DU has been used in conflict. This report provides advice on the need for special medical examinations or monitoring the health of populations living in conflict areas, and for medical staff examining patients who may have had significant exposure to DU.

The following questions are addressed:

1. Should staff be sent into areas where DU was used in conflict?
2. Should staff have special medical examinations before, during or after working in DU areas?
3. Is it necessary to screen populations living in DU areas?
4. What are the medical procedures for people possibly exposed to high levels of DU?

Depleted Uranium

There has been much concern expressed that populations living in conflict areas where depleted uranium (DU) has been used may be at greater risk of some health consequence resulting from exposure to DU as dusts, contact with DU munitions or armoured tanks, or ingesting DU in food or through the water supply.

Brief details of the characteristics of DU are given in the Annex. A thorough review of the possible health effects of exposure to DU has been completed by WHO and is available on the web site at:

http://www.who.int/ionizing_radiation/env/du/en/

There are a few web sites that provide details on locations where DU was used in conflict. In order to make preliminary judgements about exposure of people to DU, it may be helpful to refer to these sites to determine if patients claiming to be exposed to DU were really in conflict areas. Web sites containing helpful information are:

UNEP: <http://www.unep.ch/balkans/>

NATO: <http://www.nato.int/du/>

See US Department of Defence web sites for Gulf war

Other environmental risk factors

It is important to realize that during conflict there is the possibility that many different heavy metals, chemicals and biological agents can be released into the environment. Thus patients claiming to have been exposed to DU may have some other exposure to a chemical or biological agent that should be assessed. This will become evident from a thorough assessment of all potential exposure situations.

Responses To Questions

1. Should staff be sent into areas where DU was used in conflict?

Healthy staff can be sent into DU conflict areas without fear of adverse health consequences from DU exposure. There may be areas where there is significant DU debris or dusts, but these should have been cordoned off and sign-posted accordingly.

2. Should staff have special medical examinations before, during or after working in DU areas?

Staff undertaking a medical examination prior to taking up duties in areas where DU munitions were used should be healthy. If there is kidney impairment, judgement should be made on the basis of their fitness to perform the tasks required and not on any possible exposure to DU.

Even if present in areas in which large amounts of DU munitions were used, the possibility that significant quantities of dust and debris could have been inhaled or ingested by civilians is remote. Small intakes of DU will be passed quickly by the urine or faeces without residual effects.

Unless there are special circumstances where significant amounts of DU could have been inhaled or ingested, people should only be treated on the basis of symptoms observed. People normally do not show any symptoms related to DU exposure.

Patients undertaking a routine medical examination should be told that:

- normal levels of DU in the environment are extremely low
- the possible consequence of significant DU exposure is some transient impairment of the kidneys, but that this may not be clinically detectable

3. Is it necessary to screen populations living in DU areas?

There is no health-based reason to perform medical screening for DU toxicity on populations living in regions where DU was used in conflicts, or for civilians staying in these places during their duty period. Measurements taken at selected sites during a UNEP mission to Kosovo found that levels of DU contamination were very low and localised only to impact areas.

4. What are the medical procedures for people possibly exposed to high levels of DU?

The general approach to dealing with patients who claim or suspect that they have been exposed to DU is as follows.

I - Any individual who feels that they have been exposed to high levels of DU and/or displays some symptoms that may be related to this exposure should be clinically evaluated. This includes:

a) Assessment of DU exposure:

Assess the relative amounts of dust or debris that could have been taken in by detailed questioning of the circumstances surrounding exposure:

1. Circumstances, date and time of the exposure, amount of dust in the air at the time, could the water supply be near a high DU impact area etc.
2. If contracted near an explosion, is there evidence of a wound or embedded fragments
3. If the patient is a child, was there play near damaged tanks or were fragments of munitions picked up, or is there a possibility of ingested DU dusts through play or hand-to-mouth activities.
4. Has the patient kept any DU metal pieces as souvenirs or wears a necklace with a DU penetrator or similar object so that prolonged skin contact is possible.

b) Provide a routine examination:

- medical examination
- determine blood urea or creatinine
- conduct a routine urine analysis, checking for protein, albumin and glucose
- full blood count
- chest X-ray if likely inhalation of significant amounts of material into lungs

II - Patients whose history suggests proximity to a source of DU dust or injury with DU fragments, or who show abnormalities in the above routine examination, should be tested for uranium exposure.

a) In the short term, the kidneys are the most susceptible organ if large amounts of material, either by inhalation or ingestion, are absorbed into the bloodstream. Signs of

tubulopathy should be investigated. If the tubules are damaged, there are many low molecular weight proteins that appear in the urine, among which β_2 -microglobulin is the most common.

Therefore the diagnostic procedure should be to determine the level of β_2 -microglobulin in a 24-hour urine collection. Many hospitals or laboratories are able to perform this analysis. The patients must be informed how to collect the 24-hour urine specimen correctly. This protein is unstable in urine, so urine collection should be performed according to instructions from the laboratory.

b) If the results indicate some pathology, the most appropriate test to show whether significant uranium has been incorporated is a urine uranium test. The most common laboratory method for measuring total uranium in a urine specimen is alpha spectroscopy (spectrometry).

However, as only a few laboratories are equipped for the determination of uranium in the urine, it is necessary to contact the laboratory before collecting the urine and to follow their instructions. A spot urine analysis is of less value, and should at least be coupled with a creatinine determination.

c) If urine uranium is elevated, the amount of DU excreted in urine in 24 hours should be determined:

Recommended testing in this case would include urine analysis with isotope-specific methods to identify the isotopic ratios of natural, enriched or depleted uranium. These methods include alpha spectrometry, inductively-coupled plasma-mass spectrometry (ICP-MS) and thermal ionization mass spectrometry (TIMS).

Few laboratories are able to assess the amounts of the different isotopes of uranium and thus determine if the exposure is due to DU or natural uranium. Urine samples are collected, according to appropriate collection procedures, and then the level of DU in the urine determined using alpha spectrometry procedures.

Referral to a nephrologist for further testing, diagnosis and treatment may be needed. Kidney disease is common, and many cases of proteinuria, even in the setting of proven DU excretion, may be found to be due to other causes.

III - Treatment

- There is no known specific treatment of uranium exposure. In case of acute exposure, it should be handled as any heavy metal incorporation.
- Treatment should be based on symptoms observed.
- In case of renal tubulopathy being diagnosed, treatment should consist of:
 - a) sodium bicarbonate perfusion to alkalinise the urine, bind the uranium present in the blood stream, facilitate its renal excretion and prevent its reabsorption in the renal tubules.
 - b) heavy metal chelation therapy may be useful, but it is doubtful whether this would be necessary for removal of DU material
- monitoring of the renal function if necessary; kidney dialysis may be indicated in cases of severe kidney damage
- monitoring of the liver function

Increased urinary excretion of uranium is only temporary and these methods are only helpful when applied early after exposure. They seem to have no effect once the uranium is fixed in the skeleton or in the kidney.

IV - Prognosis

In most cases no permanent effects will remain. In case of an acute DU exposure there is the possibility of renal tubular acidosis. If DU dust inhalation resulted in the incorporation of significant amounts of insoluble uranium compounds, long-term patient follow up should include checks for lung tumours. However, patients should be told that the likelihood that any health effects will develop is low.

Annex: Characteristics of Depleted Uranium

A review of the possible health effects of exposure to DU has been completed by WHO in a monograph published in May 2001 entitled: "Depleted uranium: sources, exposure and health effects" and is available on the WHO web site at:

http://www.who.int/ionizing_radiation/env/du/en/

Radioactivity

Depleted Uranium (DU) is weakly radioactive heavy metal. The chemical and radiological toxicity of uranium and DU are essentially the same except the DU emits about 40% less radioactivity than a similar mass of natural uranium.

Uranium isotopes emit mainly α , but also some β radiation and a very small amount of γ radiation. α particles cannot cross the superficial dead layers of skin, but β radiation can penetrate to the basal layer of the skin. However, the radioactivity of DU is such that skin contact even for long periods should not produce any adverse consequence.

Radiation toxicity

Inhaled depleted uranium particles that reside in the lungs for long periods may damage lung cells and increase the possibility of lung cancer after many years. The scientific evidence for this is tenuous because studies of uranium mill workers have not shown any excess of lung cancer. In studies of underground miners, the excess of lung cancer seems to be related to radon gas; radon being a radioactive decay product of natural uranium.

Chemical toxicity

Kidney dysfunction is the main chemically-induced effect of uranium in humans. Damage to renal tubules may lead to tubulopathy. To date, this has not been seen in the 1991 Gulf War veterans who have embedded fragments or had inhaled DU aerosols, although they do show a higher urinary elimination of uranium. Regardless of the route of exposure, once in the blood stream, all forms of uranium will pass through the kidneys. More soluble uranium compounds will enter the blood quicker than insoluble compounds, and will thus reach the kidneys quicker. Retention of uranium in the body is in the approximate proportions: skeleton (66%), liver (16%), kidneys (8%) and in other tissues (10%).

No study has established a link between exposure to DU and the onset of cancers or congenital abnormalities.