Toxic Effects of Inhalational Exposure to Uranium Oxide Dust Particles Derived from Depleted Uranium Munitions

Zeitbombe AtomEnergie
20 Jahre Tschernobyl
Bonn, 8 April 2006

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URANIUM HISTORY

1789  Klaproth discovers Uranium
1824  Gmelin describes Uranium toxicity
1896  Becquerel discovers radioactivity
1900s Renal Toxicity of Uranium established
1943  largescale Uranium Toxicology Research Program begins under Manhattan Project
1945  $^{235}$U Fission bomb used on Hiroshima
1950s DU weapons research begins
1991  1st largescale use of DU weapons in battle
URANIUM TOXICITY

Before Becquerel discovered radioactivity in 1896, Uranium was known to be TOXIC.
URANIUM TOXICOLOGY

Radiation – mediated toxic effects
  Delayed Onset
Chemically – mediated toxic effects
  Early Onset [heavy metal effects]
  → KIDNEY TUBULES
  → NERVOUS SYSTEM
  → DNA, RNA
Uranyl ions bind to DNA

While bound to DNA, uranyl ions are chemically reactive and can give rise to free radicals which may damage DNA.
• Uranium is a  KIDNEY TOXIN
• Uranium is a  NEUROTOXIN
• Uranium is a  CARCINOGEN
• Uranium is a  MUTAGEN
• Uranium is a  TERATOGEN
• Uranium is an  IMMUNOTOXIN
Following impact with hard targets, uranium metal undergoes combustion releasing large quantities of very small uranium oxide dust particles into the environment.
The dust formed from the combustion of Depleted Uranium Munitions

- contains extremely high concentrations of uranium oxides
- includes many sub-micron particles
- is readily inhaled into and retained by the lungs
Compared to the uranium naturally present in the environment, DU dust contains uranium which is vastly more bioavailable that is, more readily internalized.
URANIUM TOXICITY

Routes of Exposure

- Respiratory
- GastroIntestinal
- Transdermal
- Conjunctival
- Shrapnel
- [Intravenous]
MAJOR URANIUM OXIDES

$\text{UO}_2$  
very insoluble
(tetravalent)

$\text{U}_3\text{O}_8$  
moderately soluble
(smaller particles dissolve faster)

$\text{UO}_3$  
(hexavalent)
$\text{UO}_2$ → Lungs → very gradual transport to tracheo-bronchial lymph nodes

$\text{UO}_3$ → Lungs → dissolve and enter circulation as uranyl ions
   → excretion by kidney
   → uranyl ions enter every organ and tissue
   → storage in bone
Organs of Uranium Oxide Uptake following Inhalational Exposure

Lungs
Kidneys
Skeleton and Teeth
Pulmonary Lymph Nodes
• Uranium is a **KIDNEY TOXIN**
• Uranium is a **NEUROTOXIN**
• Uranium is a **CARCINOGEN**
• Uranium is a **MUTAGEN**
• Uranium is a **TERATOGEN**
• Uranium is an **IMMUNOTOXIN**
OVERVIEW of URANIUM TOXICOLOGY

based on Literature Reviews and on the clinical symptoms of a small cohort of U.S. soldiers with documented inhalational exposures to DU dust in As Samawah (June-August 2003)
RENNAL SYMPTOMS OF ACUTE URANIUM TOXICITY

Occult or Gross Hematuria (Proteinuria)
Polyuria
Kidney Stones
Flank pain
Urethritis
Common Neurologic Symptoms

- blurred vision
- migraine headaches, photophobia
- cognitive dysfunction
- short-term memory loss
- difficulty concentrating
- erectile dysfunction
- sensory neuropathy, numbness
- vertigo
COMMON SYMPTOMS (cont’d)

Chronic fatigue

Sleep disorders

Mood disorders
  (depression, irritability, anxiety, panic attacks)

Fibromyalgia Syndrome
  (chronic widespread pain, allodynia, hyperalgesia)
ALLERGIC / AUTOIMMUNE SYMPTOMS

Cutaneous rash
(atopic dermatitis, chronic urticaria)

Angioedema
(localized swelling, often asymmetric)

Arthralgia

Myalgia
• Feedback welcome!

• Much work to be done.

• Importance of international collaborations with Iraqi colleagues to document exposures of Iraqi civilians to DU dust.
DU has a unique isotope signature consequently, DU can be traced.

The presence of DU in human urine or in tissues such as lung, lymph node, bone or teeth can be documented by Mass Spectroscopy.

Uranium Oxide Dust derived from DU weapons:

- is inherently toxic
- is intrinsically indiscriminate
- damages the environment
- persists on the battlefield
- is not confined to the battlefield
- causes superfluous injury
Since 1996, the U.N. Sub-Commission on the Promotion and Protection of Human Rights has consistently ruled that Depleted Uranium weapons are incompatible with existing international humanitarian and human rights laws.
U.N. Sub-Commision on the Promotion and Protection of Human Rights: Weapons Incompatible with existing International Law

- DU weapons
- Cluster bombs
- Fuel-air bombs
- Chemical weapons
- Bacteriological weapons
- Biological weapons
Changing Incidence of Pediatric Malignancies in the Basrah Governate

- Ascertained from records of the Basrah Women and Children’s Hospital (BWCH)
- BWCH receives all pediatric oncology patients from the Basrah Governate
- Cases per 100,000 children
- Study limitations
Percentage rise in the incidence of malignancies in general and leukaemias among children in Basrah with reference to the year 1990
Percentage rise in the incidence of malignancies in general and leukaemias among children in Basrah with reference to the year 1990

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<th>Leukaemia</th>
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Distribution of leukaemic patients according to age during the years 1993-2002 compared to 1990
The distribution of leukaemic patients according to age.

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Changing Incidence of Congenital Malformations in the Basrah Governate

- Monitored from birth records of the Basrah Women and Children’s Hospital (BWCH)

- ~11,000 births per year at BWCH
  ~20-25% of all births in Basrah Governate

- Cases per 1000 births

- Study limitations
Incidence rates of congenital malformations in Basrah 1990 – 2001

Year


Incidence rate per 1000 births

3.04  2.84  1.95  1.31  2.93  4.35  4.56  2.34  7.76  9.78  17.6  22.19
### Incidence rates of congenital malformations in Basrah 1990 – 2001

<table>
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<th>Year</th>
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<th>No. of congenital malformation</th>
<th>Incidence rate per 1000 births</th>
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