SOLDIER EXPOSURE TO DEPLETED URANIUM AND HUMAN HEALTH RISK ASSESSMENT METHODOLOGY UPDATE - 2010

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INTRODUCTION

• Assessment of depleted uranium (DU) use on the battlefield and potential adverse health effects is a sentinel event in addressing all battlefield environmental and occupational hazards

• Experience with DU to be used for developing policy and procedures for assessing other environmental chemical and embedded metal fragment injuries from combat
BACKGROUND (I)

• Operation Desert Storm – First combat use of DU munitions by U.S. Military (1991)
  – Walter Reed Army Medical Center – First patient identified with embedded DU metal fragment
  – OTSG Consultants identified through medical records review first 35 patients with fragments from fratricide (“friendly-fire”) incidents
  – Initial urine bioassay program to identify patients with undiagnosed, embedded metal fragments
OSAGWI Vision (1998) for DU Issue

- RAND DU Literature Review
- Health Risk Communication
- Army DU Health Risk Assessment
- VA DU Medical Surveillance Program
- WRAMC
  Gulf War Patient with Embedded DU Fragment
- AFRRI Basic DU Research
BACKGROUND (II)

• MOA between Army OTSG and VA for DU Medical Surveillance and Follow-UP Program (1993)
• Interpretation of laboratory results develops into formal Health Risk Assessment (HRA) Program
• HRA is bridge between lab results and clinical guidance for healthcare provider
• Archiving of letter reports for potential future use in patient assessments
• Determination of what is best for Soldier-patient with potential DU exposure
APPLICATION TO AN INTEGRATED ARMY HEAVY METALS PROGRAM

Experience gained in the DU Health Risk Assessment Process is being used as a model for addressing issues with other heavy metals

• Assessment of retained metal fragments in Servicemembers and Veterans
• Awareness Training and Effective Risk Communication for Servicemembers, their Families, and their Healthcare Providers
• Integration of AMEDD’s Health Hazard Assessment and Human Health Risk Assessment Programs – Requirement for Communication with Munitions Developers
POTENTIAL DU EXPOSURES FROM MILITARY OPERATIONS

- Hard target impact and perforation of armored vehicles by DU munitions
- Vehicle fires involving DU munitions
- Potential for subsequent environmental exposures through resuspension of DU residues
**DU EXPOSURE CATEGORIES**

| I | Soldiers in, on, or near armored vehicle struck and penetrated with DU munitions |
| II | Soldiers whose MOS requires entering DU-damaged vehicles |
| III | Soldiers with incidental DU exposure |
FACTORS AFFECTING DU TOXICITY

- Route of exposure
- Chemical form
- Amount internalized
- Solubility
- Particle size and distribution
ARMY/BATTELLE CAPSTONE
DU HUMAN HEALTH RISK ASSESSMENT

FINDINGS

• Greatest potential for inhalation exposure - in, on or near an armored vehicle at time of impact by a DU penetrator (DU Exposure Level I)

• Chemical toxicity may be the more limiting factor for soluble DU forms; however, military DU sources limit the availability of the more soluble forms

• All other potentially exposed individuals received significantly less intake through inhalation (DU Exposure Levels II and III)

NAS COMMITTEE ON TOXICOLOGY
PEER REVIEW

“Review of Toxicologic and Radiologic Risks to Military Personnel from Exposure to Depleted Uranium During and After Combat” (2008)

• Army DU Research-Integrated Process Team recommended an independent scientific peer review by the National Academy of Sciences Committee on Toxicology

• See link to the NAS-COT review of the Capstone Reports: http://www.nap.edu/catalog.php?record_id=11979

• Findings and recommendations presented in the Academy’s report compared and contrasted with the “Depleted Uranium Aerosols Doses and Risk: Summary of U.S. Assessments” (2005) for close-out of project
THE CAPSTONE DEPLETED URANIUM (DU) AEROSOLS STUDY AND HUMAN HEALTH RISK ASSESSMENT

- Final two Data Quality Objectives for this project completed in the year 2009:
  - Review of the Capstone DU Project reports by the NRC, Council, National Academy of Sciences Committee on Toxicology
  - Publication of a series of 14 technical articles on the project in a dedicated, special issue of Health Physics, an independent, peer-reviewed scientific journal (Health Physics Journal, The Radiation Safety Journal, Special Issue: The Capstone Depleted Uranium Aerosol Characterization and Risk Assessment Study, ISSN 0017-9078, Vol. 96, No. 3, March 2009)
LESSONS LEARNED
CAPSTONE DU STUDY AND HUMAN HEALTH RISK ASSESSMENT

Information from the Capstone DU reports applied almost daily to current military operations regarding occupational and environmental health issues

• Army Training Ranges
• Historical weapon systems with DU
• Southwest Asia military operations
• Radioactive waste clean-up and disposal
• BRAC installations and environmental issues
• Soldier Post-Deployment Health Assessments
• DU Activist challenges
OVERVIEW
DEPLETED URANIUM (DU) AND
ITS HEALTH EFFECTS (I)

• An overview of uranium health effects may be found in the US Agency for Toxic Substances and Disease Registry (ATSDR) Toxicological Profile for Uranium (see http://www.atsdr.cdc.gov/toxprofiles/tp150.html, a 1999 update to the original profile published in May 1989)

• Quote: "While natural and depleted uranium are considered chemically toxic, they are not considered a [significant] radiation hazard"

• Discussions are currently ongoing among several Federal Agencies to fund ATSDR to produce an updated addendum to this Uranium Toxicological Profile
OVERVIEW
DEPLETED URANIUM (DU) AND ITS HEALTH EFFECTS (II)

• The International Agency for Research on Cancer (World Health Organization) Monographs, Volume 78, Ionizing Radiation, and Volume 78, Part 2: Some Internally Deposited Radionuclides (2001), are another basic source of information on radiological effects

• See http://monographs.iarc.fr/ENG/Monographs/vol78/mono78.pdf

OVERVIEW
DEPLETED URANIUM (DU) AND ITS HEALTH EFFECTS (III)

• “As part of a longitudinal surveillance program, 35 members of a larger cohort of 77 Gulf War I veterans who were victims of depleted uranium (DU) "friendly fire" during combat underwent a 3-day clinical assessment at the Baltimore Veterans Administration Medical Center (VAMC)"

• “Sixteen years after first exposure, this cohort continues to excrete elevated concentrations of urine U as a function of DU shrapnel burden. Although subtle trends emerge in renal proximal tubular function and bone formation, the cohort exhibits few clinically significant U-related health effects.”
OVERVIEW
DEPLETED URANIUM (DU) AND ITS HEALTH EFFECTS (IV)

• The National Academy of Sciences Institute of Medicine recently updated its literature review on the health effects of DU and other Gulf War environmental hazards:
  ▪ "Gulf War and Health - Volume 8 - Update of Health Effects of Serving in the Gulf War" (IOM, NAP, April 2010)
  ▪ In this report, the IOM determines that DU is not a significant source of occupational exposure

• The Department of Veterans Affairs (VA) published a notice in the Federal Register (FRN) in March 2010 on its decision related to a 2006 Institute of Medicine (IOM) report on the potential health effects of DU (IOM, NAP, Report, Gulf War and Health, Volume 4: Health Effects of Serving in the Gulf War, 2006) and the Volume 8 Update
OVERVIEW
DEPLETED URANIUM (DU) AND
ITS HEALTH EFFECTS (V)

• The VA’s FRN states that the IOM also concluded there was limited or suggestive evidence of no association between uranium and clinically significant renal dysfunction and between uranium and lung cancer at specified cumulative internal doses.

• Therefore, the VA has decided NOT to service-connect any diseases related to DU, as listed in the IOM report.


• [Link](http://edocket.access.gpo.gov/2010/pdf/2010-4882.pdf)
SCREENING BIOASSAY
DATA QUALITY OBJECTIVES

- Laboratory performs urine uranium analysis using Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS) on MTF urine specimens
- Laboratory determines isotopic ratios for DU in urine specimen at detection limits as low as possible with laboratory method
- Health Physics Program reviews laboratory results and prepares a health risk assessment report for requesting healthcare provider at MTF
- AMEDD, through the DoD Deployment Health Clinical Center, refers patients with elevated urine uranium levels indicative of DU to VA Medical DU Follow-Up Program

PROGRAM GOAL
Identify all personnel with elevated levels of DU and embedded fragments that contain DU (and tungsten composites) for referral to the VA Medical DU Follow-Up Program
Policy for DU Bioassay and Fragment Analysis:

• Supersedes OTSG/MEDCOM Policy 07-022, 26 June 2007).
• See http://www.pdhealth.mil/du.asp#army
OIF DU Results Summary (as of 30 Sep 10)

• Urine bioassay specimens
  – Over 2350 individuals screened
  – Over 2750 analyses
  – 8 individuals with DU in specimen
    • 5 elevated above NHANES, 3 in NHANES range
  – Preliminary dose estimates for 6 Soldiers
    • E(50) range: 0.00001Sv (0.001 rem) to 0.012 Sv (1.2 rem)
    • U kidney concentration: 0.003 to 11.1 μg U per gram kidney tissue
  – 4 Soldiers referred to VA DU Follow-Up Program

• Fragment analyses
  – 80 fragments from 69 individuals
  – 3 fragments from 2 individuals positive for U

• Urine uranium results consistent w/ CDC 3rd NHANES data/higher than 4th NHANES data
Comparison of Uranium Specimen Values to 4th NHANES Data and Laboratory Screening Level (as of 30 September 2010)
New Metal Fragment Policy

• Memorandum, Assistant Secretary of Defense for Health Affairs, HA Policy 07-029, 18 December 2007, subject: Policy on Analysis of Metal Fragments Removed from Department of Defense Personnel

• Memorandum, U.S. Army Medical Command, MCPO-SA, OTSG/MEDCOM Policy Memo 10-041, 29 June 2010, subject: Management of Metal Fragments Removed from Army Personnel

• Application of lessons learned from DU Policy experiences
  – Eventual integration of two policies into a Heavy Metals Policy
  – Eventual electronic patient records
Metal Fragment Policy

• Specifically, as part of the new DOD and Army MEDCOM embedded metal fragment policies, USAIPH received 235 embedded metal fragments from 147 patients from October 2009 through 30 September 2010

• Cumulative analysis results (under the embedded metal fragment policies) are provided in the following table and graph
## Summary of Laboratory Results

### Removed Embedded Metal Fragments

**Cumulative Reporting Period:**
18 September 2008 – 30 September 2010

<table>
<thead>
<tr>
<th>Report Period</th>
<th># of personnel</th>
<th># fragments received</th>
<th># fragments analyzed*</th>
<th># packages sent out¹</th>
<th>Content: common metals²</th>
<th>Content: lead³</th>
<th>Content: any tungsten⁴</th>
<th>Content: tungsten-nickel-cobalt</th>
<th>Content: High content Nickel</th>
</tr>
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<tbody>
<tr>
<td>18 Sep 08 through 30 Sep 10</td>
<td>147</td>
<td>235</td>
<td>207</td>
<td>137</td>
<td>182</td>
<td>15</td>
<td>2</td>
<td>0</td>
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**Notes:**

* One fragment not analyzed due to fragment size and composition
1. “Packages Sent” listed by # of fragments, but actually are combined per person when sent.
2. “Common Metals” are considered anything other than lead, tungsten or high content nickel. There are no separate packages (with Cover Memo interpretation and fact sheet) to separate out these metals for special consideration
3. Thirteen (13) fragments with primary content lead. There are 2 more with small to trace amounts of lead on common metals.
4. “Any Tungsten” often includes surface tungsten only. Tungsten content analyzed through 30 September 2010 has been considered minor and is counted under “Common Metals.”
Composition of Fragments Completed
Under HA Policy 07-29
through 30 September 2010
Embedded Metal Fragment Assessment

For the 207+ fragments analyzed since implementation of HA Policy 07-029:

• None are depleted uranium (several fragments submitted previously were identified as DU)
• None are radioactive
• Tungsten has been detected, but in relatively low concentrations; primary tungsten alloy (composite) of concern has not been identified
PROPOSED DISCUSSION TOPICS

DU researchers, medical planners, and combat operations staff are suggesting follow-up:

• Additional follow-up studies of exposed populations have the potential to improve knowledge of the health effects of DU. To permit an adequate assessment of the risks of cancer, renal toxicity, and other possible health effects faced by DU-exposed soldiers, a careful follow-up of the exposed groups should be continued, including the cohort now being followed by the Department of Veterans Affairs.

• An examination of subgroups of Soldiers with high, medium, and low exposure to uranium, with appropriate matching on other risk factors, should be implemented for selected health-related end points and biomarkers.

• The DU researchers should ask the military medical planners and combat operations staff what information is still needed to protect the Soldier and other Servicemembers on the battlefield.
References


• Centers for Disease Control and Prevention, National Center for Environmental Health, Fourth National Report on Human Exposure to Environmental Chemicals, National Health and Nutrition Examination Surveys (NHANES), December 2009 (www.cdc.gov/exposurereport)

• DU Questionnaire: DD Form 2782 Test, Feb 2004 and DD Form 2782-1 Test, Feb 2004. Available at: www.pdhealth.mil/du.asp

• DU information available at: http://fhp.osd.mil/du/
