Case: Is Depleted Uranium Ammunition Causing Cancer?

The question we will explore in this case is whether exposure to depleted uranium (DU) contamination contributes to greater cancer risk in current and former war zones.

Background:

Depleted uranium (DU) is a waste product of the enrichment process that isolates fissile uranium for power plants and nuclear warheads. Naturally occurring uranium contains about 0.72% <sup>235</sup>U while DU has about 0.3%. The rest of DU is composed of non-radioactive <sup>238</sup>U. DU is about 60% as radioactive as natural uranium metal.

DU is 68.4% denser than lead, and is used for radiation shielding in medical equipment and to contain and transport other radioactive materials. Military uses include armor plating and armor-piercing projectiles.

Use of DU ammunition is commonplace today. It is reasonable to assume that DU ammunition is being used in any military action against metal-armored targets. An estimated 315-350 tons of DU were used in the 1991 Gulf War. US and NATO allies used DU in the Bosnia war, the 2003 invasion of Iraq, and 2015 airstrikes on ISIS in Syria. Other countries with nuclear enrichment capabilities repurpose their DU waste in similar ways.

Like lead and many other metals, uranium metal is toxic. It affects the kidney, brain, liver, heart, and numerous other systems. The biological half-life for uranium (the average time it takes for a human body to eliminate half the amount in the body) is about 15 days.

Military use of DU in ammunition and armor plating is controversial because of concerns about potential long-term health effects of the metal itself, AND because DU is weakly radioactive. DU rounds disintegrate and burn when they strike a target, literally melting their way through armor. This can contaminate wide areas around impact sites, leading to possible inhalation by human beings.

Goals For This Case:

Since the 1990s, there have been suspicions that DU contamination in current and past war zones causes:

* an increase in general mortality rate,
* higher rates of birth and developmental defects, and
* increased rates of solid cancers and leukemias.

Today you will be evaluating the claims in the lay press against the scientific evidence.

Day 1:

***A. Initial Reading: News and Opinion***

1. Each member of your team should select one of the three linked lay press articles.
2. Read the article, and make a list of the health claims being blamed on DU contamination.
3. As a group, compile a single list of claims, and identify the ones specifically associated with cancer. Do not rely on the authors to tell you which are associated with cancer; use what you have learned about the cancer development process to make that decision.

*Iraqi Cancers, Birth Defects Blamed on U.S. Depleted Uranium*

11/12/2002 by Larry Johnson, Foreign Desk Editor for Seattle Post-Intelligencer.

<http://www.seattlepi.com/national/95178_du12.shtml>

*Depleted Uranium Blamed for Cancer Clusters Among Iraq War Vets*

8/15/2004 by Christopher Bollyn, for the Nuclear Age Peace Foundation

<http://www.wagingpeace.org/articles/2004/08/15_bollyn_depleted-uranium-blamed-cancer.htm>

*Study Suggests Cancer Risk From Depleted Uranium*

5/8/2007 by James Randerson for UK Guardian.

<http://www.guardian.co.uk/science/2007/may/08/cancer.medicineandhealth>

***B. What Is the Evidence?***

1. Next each member of your team should select one research article and one white paper to read from the two sets below.
2. Start reading the two additional resources. Look specifically for information relating to the cancer-related claims you identified in Part A. If you have questions about terminology or interpretation, ask your teammates or me for help.
3. If you need more time to read the two resources, you can complete them as homework.
4. Write a short summary (1-3 sentences is enough) of each piece of information you find related to your team’s list from Part A.

***Research Articles***

Macfarlane, 2003. Incidence of cancer among UK Gulf war veterans: a cohort study. *British Medical Journal,* 327:1373. doi: 10.1136/bmj.327.7428.1373

<http://www.bmj.com/content/333/7575/971.3.long> (Journal PDF)

<http://www.ncbi.nlm.nih.gov/pubmed/14670879> (Link in PubMed)

Editorial in 2006 British Medical Journal regarding cancer in Persian Gulf.

*BMJ* 2006; 333:820. doi: 10.1136/bmj.39003.517731.BE (Published 19 October 2006)

<http://www.bmj.com/content/333/7573/820.full.pdf>

<http://www.bmj.com/content/333/7573/820.full?ijkey=93fec622ade6cb7d7fa1e5d079f952343acdff26&keytype2=tf_ipsecsha>

A letter to BMJ in response to the above editorial.

<http://www.bmj.com/content/333/7575/971.3.long>

***Government and Agency White Papers***

*WHO Media Fact Sheet* No. 257, Jan. 2003: <http://www.who.int/mediacentre/factsheets/fs257/en/>

*WHO Summary of Health Conditions in Iraq as of March 2003.*

<http://www.who.int/disasters/repo/9141.pdf>

*WHO Guidance on Exposure to Depleted Uranium For Medical Officers and Programme Administrators* (2001)

<http://whqlibdoc.who.int/hq/2001/WHO_SDE_OEH_01.12.pdf>

*Nuclear Regulatory Commission: Basic Background Information on Depleted Uranium* (2010)

<http://www.nrc.gov/about-nrc/regulatory/rulemaking/potential-rulemaking/uw-streams/bg-info-du.html>

*Case Study in Environmental Medicine: Uranium Toxicity* (2009)

Centers for Disease Control and Prevention’ Agency for Toxic Substances and Disease Registry

<http://www.atsdr.cdc.gov/csem/uranium/u_exposure-pathways.html>

*International Atomic Energy Agency News Center: Depleted Uranium* (undated)

<http://www.iaea.org/newscenter/features/du/du_qaa.shtml>

### Before Day 2

Be ready to share your summary of findings with your team. On Day 2, you will assemble your individual summaries into a single shared document.

Day 2:

### First Half of Day 2

For the first half of class, share your individual results, and begin combining them into a summary response to the lay press claims. This shared document will be part of the final assignment you must turn in.

Arrange your summary as a table, like the following:

|  |  |  |
| --- | --- | --- |
| Lay Press Claim | Current Evidence | Interpretation or Explanation |
|  |  |  |
|  |  |  |
|  |  |  |

### Second Half of Day 2: Testing Your Findings

Reuters News Agency has just released an investigative story about the impacts of use of DU ammunition by Russia in the Ukrainian War. Doctors in the combat zone claim to be treating dozens of patients a week, all with a leukemia-like illness, and all evacuated from areas experiencing heavy shelling. The doctors are claiming that extreme exposure to DU from the shells is the cause.

Consider the scenario described, the evidence you assembled, and what you know about cancer development. Then working individually, write a Letter to the Editor either in support of the Reuters report, or refuting it. Your response should be limited to 1000 words, and written so the lay public can understand your argument.

Case and Instructor Notes:

This case comes at the end of a senior-level cancer biology course. The scenario requires students to:

* Apply basic concepts and content knowledge from the course about cancer development;
* Extract data from both lay press and scientific sources;
* Synthesize the evidence; and
* Explain the evidence to a non-technical audience.

I intentionally selected a scenario where public perception and hyperbole cloud the facts. There are hundreds of anecdotal stories tying DU to cancer, and photos of horribly disfigured children only add to the emotional backdrop. Yet from a purely scientific point, there is insufficient evidence to conclude that DU ammunition leads to higher cancer rates.

The relevant facts that students should pull from resources or deduce from course knowledge are:

* The timeline is far too short. Other illnesses could easily be the result of DU poisoning, but leukemogenesis is a years-long process.
* DU ammunition is NOT highly radioactive as is widely claimed. Incidental exposure is not going to result in abnormal doses of radiation.
* Mutational analysis of the types of tumors most commonly observed in war zone patients do not indicate a toxic or radiologic agent. Diet and overall health seem to be primary risk factors (being in a war zone is unhealthy in general).
* There are well-established reporting biases, and observer effects.

This is not to say that DU does not cause acute health problems aside from cancer, or that long-term exposure over years will not lead to an increase in cancer rates, only that sudden, acute increases in leukemia are unlikely.

### Case Structure

This case originally was written when the U.S. was still in both Afghanistan and Iraq, so the lay press articles are no longer relevant. I kept the case as originally written rather than update the resources to illustrate how easily a case can be revised and updated.

There always seems to be an ongoing conflict involving DU. At the time I am writing this, the Russia/Ukraine War is in its second year. A quick search on the web turned up this Reuters article:

<https://www.reuters.com/world/europe/russia-says-use-depleted-uranium-shells-ukraine-would-harm-population-land-2023-03-24/>

Some of the same claims made in the Iraq wars are here as well.

Many other articles similar to the ones in the student handout came up as well. Simply switch the older articles for newer stories. The lists of scientific studies and white papers are still valid but would benefit from adding some newer sources.

If the topic of DU is not a good fit, another controversial substance could be substituted into the same overall case plan.

### Goals of the Follow-Up Activities

This case has two separate final assignments. The team assignment is to summarize the evidence, but each individual must write an editorial letter explaining it. I implemented this strategy as a way to identify students who relied on their teammates to do most of the work.

Use this section to describe how the questions at the end of each day lead students towards the overall case goals. Here is an example.

##### Day 2 Questions: Building Argumentation Skills

The questions at the end of the case are designed to guide and clarify students’ thinking using a practical argumentation and logic model called the **Toulmin model** to break down arguments into specific parts for analysis:

* **Claims** or conclusions
* **Evidence** or observations to support the conclusions
* **Reasoning**, inference, or rationale that connected the evidence and conclusions.

Toulmin’s full logic model has other elements, but for this exercise we only want students to be able to break a conclusion down and provide adequate support for it.

### Class Management

Use this section to describe any specific classroom practices you use to make the case more effective. It is better to split this section into specific goals or actions rather than have one long narrative. Here is an example.

I prefer to keep the format of this case open, because it gives the class freedom to follow up on any of the points raised by the groups. If needed, these are two options for formal scenarios:

* The class is a policy analysis group for the U.S. Army. The Pentagon wishes to know if DU ammunition poses a legitimate health threat to U.S. soldiers.
* National Science Foundation has issued a request for proposals (RFP) to assess the threat of DU ammunition. The class members are scientists on a team who wants to apply for one of the grants.

One way to extend this case is to ask students to pose alternative hypotheses. Why might a cluster of patients with a pre-leukemia syndrome suddenly appear?

Most of my case notes at least have these sections. I add any other information I think is helpful. For new cases, I usually include my raw development notes until I have run the case a few times.

### Background

Provide any additional information that an instructor who is not familiar with the topic would need to understand the overall structure and end goals of the case. In practice, you may want to include:

* Rationale for the scenario or the model system
* Additional information about the biological processes involved
* Links to outside supporting resources or reference

Here is an example.

1. *houstonianum* is the original source from which the compound methoprene was first isolated. Methoprene and its synthetic derivatives are JH disruptors. Methoprene is an effective IGR because JH has such broad effects. At low physiological doses, JH inhibits energy storage, so more is available for growth. It also prevents moving into the pupal stage, so that molting produces extra larval stage instars. At supra-physiological doses, JH and its mimics can inhibit production of essential energy storage molecules. Conversely JH blockers prevent normal metabolic function. Either way, resultant metabolic imbalances can be fatal.

### Case Data Structure

Provide an explanation of the main takeaway points of any data provided. Here is an example.

The case data table is written as if a diet containing 1% *A. houstonianum* leaves is equal to a **small** increase in JH. As a result caterpillars are eating more, and getting longer and heavier. Unlike the controls, they are NOT browning, which means they are not preparing to pupate.

### Goals of the Follow-Up Questions

Use this section to describe how the questions at the end of each day lead students towards the overall case goals. Here is an example.

##### Day 2 Questions: Building Argumentation Skills

The questions at the end of the case are designed to guide and clarify students’ thinking using a practical argumentation and logic model called the **Toulmin model** to break down arguments into specific parts for analysis:

* **Claims** or conclusions
* **Evidence** or observations to support the conclusions
* **Reasoning**, inference, or rationale that connected the evidence and conclusions.

Toulmin’s full logic model has other elements, but for this exercise we only want students to be able to break a conclusion down and provide adequate support for it.

### Class Management

Use this section to describe any specific classroom practices you use to make the case more effective. It is better to split this section into specific goals or actions rather than have one long narrative. Here is an example.

### Supplemental Activities and Case Extensions

Describe additional learning or skills development activities here that the case might be used for, but are not part of the primary purpose or goals of the case.