Medicine, Conflict & Survival

ISSN: 1362-3699 (Print) 1743-9396 (Online) Journal homepage: https://www.tandfonline.com/loi/fmcs20

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Bart Hoek

To cite this article: Bart Hoek (2004) Military Explosives and Health: Organic Energetic Compound Syndrome?, Medicine, Conflict & Survival, 20:4, 326-333, DOI: 10.1080/1362369042000285955

To link to this article: https://doi.org/10.1080/1362369042000285955

Published online: 08 Sep 2010.

Military Explosives and Health: Organic Energetic Compound Syndrome?

BART HOEK

Delft, The Netherlands

Military explosives, which are Organic Energetic Compounds (OECs), might be initiating factors in clusters of warfare related illnesses. Substances such as HMX, RDX and TNT are neurotoxic and are possible human carcinogens. Not all the explosive material is consumed in an explosion so that the use of explosives generates harmful dust. In many clusters of illnesses a link can be defined with explosives. In researching for the cause of the illnesses several possibilities are mentioned, but explosives are rarely mentioned. This article considers the possible role of OECs, with the intention of encouraging studies to make the role of explosives clear: no cause, a link with insufficient evidence or the cause of many illnesses.

KEYWORDS Carcinogens Depleted uranium Explosives Gulf War Syndrome Neurotoxins Post-traumatic stress disorder

Introduction

Some years ago I developed the idea that inhalation of the fine dust of military explosives is a hidden factor in warfare related illnesses. It was discussed with military personnel. One replied: 'Why have the Americans not thought of that before?' but the discussion stalled. The idea was published in a Dutch medical journal, and a doctor later replied: 'Politicians have to act first'. I wrote to the Dutch Parliament about this subject, and the Minister of Public Health was asked for a reply, but unfortunately the government fell and no answer has yet been given. The hypothesis will be difficult to prove or disprove, but making the effect of explosives part of studies of the health effects of war will itself be a move forward.

Organic Energetic Compounds (OECs)

Nomenclature

Military explosives are mixtures of organic energetic materials such as HMX (1,3,5,7-tetranitro-1,3,5,7-tetrazacyclooctane), RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine), TNT (trinitrotoluene), with binders and other ingredients. Examples include Composition C-4, Cyclotol, Octol, and

MEDICINE, CONFLICT AND SURVIVAL, VOL. 20, NO. 4, 326–333 (2004)
ISSN 1362-3699 print
DOI: 10.1080/1362369042000285955

Semtex,[1] and many others exist with a variety of names and acronyms. New ingredients and compounds are still being developed.

Toxicity

Most chemicals in military explosives are toxic.[2,3] Both Yinon and Palmer focus on the manufacturing of explosives and little is written about the conditions of their use in warfare.

Carcinogenicity

The United States Environmental Protection Agency has listed TNT and RDX as possible human carcinogens.[4,5]

Neurotoxicity

According to Yinon:

> Ermakov *et al* observed 574 TNT workers of whom 122 showed TNT poisoning. All workers were subject to medical examinations including electrical activity of the heart (ECG) and of the brain (EEG). The clinical findings showed a preeminent lesion of the central and vascular systems [ref 2: 8].

and:

> Kaganov et al. showed that 20.8% of workers having long contact with TNT showed disorders of the nervous system, mainly in the motor and sensory neurons. In 50% of examined patients a disorder in the thermoregulating reactions to heat and cold was observed [ref 2: 10].

In one paper:

> We report the first human intoxication to occur in a non-wartime setting. This intoxication presented with status epilepticus in a child and permitted the description of RDX human pharmacokinetics. It also suggested a strong association between central nervous system dysfunction and RDX intoxication.[6]

In another study no differences were found between RDX exposed workers and unexposed control workers. In a chapter on TNT, it is proposed that workers should be selected [ref 2: 15]. So care should be taken with identifying control groups for such workers.

On RDX:

> Stone *et al* reported that RDX-poisoned patients were able to respond to their environment within 48 h. Orientation, concentration, recall, and memory for recent and remote events were impaired. Mental capacity returned to normal in 1 to 2 months [ref 2: 149].

Longterm Neurotoxic Effects

Marihuana causes addictiveness in (only) about 10 per cent of its users, because of permanent changes in their brain.[7] This is a long-term effect. Could OECs have similar long-term neuro-toxic effects?

Exposure Routes: Aerosols of Fine Explosive Particles?

Explosive Particles Aerosol

The exposure routes have to do with the generation of an aerosol of fine explosive particles not necessarily visible. In detonation not all the explosive material is consumed; when the propagation of the detonation ends the remainder of the charge is blown away, chemically unchanged.[8] This is well known from the clearing of landmines; after the blast to destroy recovered mines, explosive material spreads over large areas and hampers the further tracing of unexploded mines by the smell of their explosive content for the 'noses' (dogs, rats and artificial).[9] Forensic scientists look for residues from the original explosives, for even in an almost complete explosion, the remaining unexploded residues can identify the original explosive. They look first for discrete, unconsumed particles on the collected debris, which can be analysed directly.[1]

Another route of exposure is open burning and detonating of obsolete explosives and ammunition, which can lead to both direct and indirect exposure through the contaminated soil.

A mixture of RDX and TNT is called Cyclotol and is used in the submunitions of cluster bombs. Small charges tend to fail sooner in their detonation, spreading relatively more harmful fine dust when they explode. The ammunition in destroyed tanks and weapons factories is likely to contaminate the air and surroundings.

Carbon and Inorganic Salt Particles

The products formed during an explosion are usually either gases or inorganic salts.[1] Explosives with excess carbon also form solid carbon as a detonation product. Test explosions in explosive chambers with inert gas produced diamonds with an average diameter of four nanometers. Graphite was identified as curved ribbons of about four nanometers in thickness.[10] These carbon and inorganic salt particles are not further discussed here.

Nighttime Exposure and Photochemical Degradation

Exposure of TNT to strong sunlight results in the formation of decomposition products.[2] It can be assumed that night-time inhalation of fine dust of explosives cannot be compared with daytime exposure in sunlight. In further studies attention should be given to the rate of decomposition of inhalable explosive particles.

Particle Size

The dust not visible is a key aspect; very modern diesel engines produce no visible soot, but the soot that is produced is so fine that it is considered a threat to public health because particles carrying harmful substances can persist in the lungs. With regard to explosives:

> Vogel described RDX poisoning in German munitions workers who had handled finely pulverized RDX powder. The finer the dust, the earlier the adverse reactions occurred [ref 2: 147–8].

Particle Meters

The detection of explosives has been described in detail.[1,4] To measure the chemical composition of airborne substances a commercial system the size of an office cabinet is available which is based on the first generation of Delft particle analysers. This mass spectrometry system can detect airborne cannabis particles. It uses a laser to generate ionised molecules from the particles under investigation. The particles can first be coated, in case the laser light breaks down the molecules. Particles smaller than 0.3 micrometer must be grown in size by condensing auxiliary compounds on them. This is done in the second generation of analysers.[11] These systems should be able to detect airborne explosive particles but have not yet been tested for this.

Clusters of Illnesses

Gulf War Syndrome: Post-Traumatic Stress Disorder (PTSD), or Not?

In the mass media several substances are mentioned as a possible cause for the so-called Gulf War Syndrome. In 1999 the RAND Corporation excluded as possible causes the burning oilfields, insecticides, ammunition with depleted uranium and stress (PTSD). Their researcher, Beatrice Golomb, did suggest the anti-nerve-gas agent pyridostigmine bromide as a possible cause.[12] Does this mean that explosives in ammunition were then already ruled out? PTSD is still considered as a cause in some cases.

An analogy with Three Mile Island and Chernobyl can be made. After the near nuclear disaster of Three Mile Island people were made ill by the idea that they might become ill. This will also have happened due to Chernobyl, but there, people – among others the so-called 'liquidators' – died due to the release of radioactive substances, particularly iodine-131.

According to Michael Moore's television documentary *The Awful Truth*, approximately 9600 Gulf War veterans have died: a Chernobyl-like situation? Mikhail Gorbachev mentioned, in his role as head of the International Green Cross, concern with health problems within Iraq.[13]

How can one distinguish between psychological and non-psychological causes? According to one paper: 'Changes in immune parameters seen in Gulf War veterans but not in civilians with chronic fatigue syndrome'.[14] Did they examine Iraqi civilians? It has been suggested that wartime chemical exposure causes brain damage in veterans.[15] Is there a distinction?

World War I Shell Shock

World War I shell shock was thought to be caused by brain damage due to the explosions of shells and grenades, but soldiers not directly exposed to the explosions also became ill.[16] Might they have inhaled residue of the explosive material carried by the wind? The TNT used in those days contained the very unpleasant impurity tetranitromethane (TNM), the likely cause of TNT intoxication.[3]

Balkan Syndrome

This has been extensively discussed in the media, and in several scientific publications, with particular attention to Depleted Uranium (DU).

Vieques Island

The Caribbean island Vieques is intensively used for testing bombs and targeting practice. The rate of serious diseases and cancer among the inhabitants has tripled in the last twenty years.[17]

OECs as a Hidden Factor in Possible Causes for Warfare-related Illnesses

In a letter[18] responding to a previous article of de Vries,[16] I suggested the inhalation of the very fine dust of explosives as a possible cause of the illnesses of soldiers and peacekeepers. They replied that they think it is an interesting hypothesis; it appeared to have been considered already, but with no result so far.[19,20] The possibility of PTSD as a result is discussed above.

Depleted Uranium

Depleted uranium is often mentioned in relation to an increased incidence of cancer. However, one author concludes that at any conceivable level of uptake depleted uranium will have no appreciable radiological or chemical carcinogenic potential. A distinction is made between the soluble uranyl ion and insoluble uranium. Only uranium shrapnel is mentioned.[21] However, burning uranium forms small particles of uranium oxides: uranium dioxide is insoluble, so that after inhalation it might not show up at all in urine, while still emitting intense local radiation that could cause leukaemia.[22] In wartime conditions explosives should also be considered, as the uranium tipped projectiles destroy tanks loaded with explosives.

Uranium miners in the former East Germany have an increased risk of immune-system dysfunction.[23] This raises the question whether they used

the explosive Semtex, a mixture of PETN and RDX, in their underground operations.[24]

Independent Research

Medical research concerning explosives can present the same conflict of interest as appears with the debate on cigarette smoking. Researchers must be able to work and publish independently in the normal fashion in medical and scientific journals, declaring an interest if necessary.

In a preface Yinon emphasises that he has quoted only published work, journal articles and unclassified reports.[2] Some scientists refuse to cite information from classified reports because they fear legal claims for having used them.

Discussion

The literature cited on depleted uranium is not the most recent, but it suggests a development in the research: that the effects of the fine dust of insoluble uranium oxides should be examined. Similar open discussion and research is needed on the fine dust of explosives, which can be considered as much a source of health problems as uranium. As mentioned above, the neurotoxic properties of OECs can make them a cause for PTSD-like and immune-system disorders.

If this hypothesis is thought to be plausible the prevention of further exposures should be considered, such as the manufacture of ammunition types and weapon systems that do not generate harmful smoke in their intended use, or when destroyed by the enemy on the battlefield. Civil explosives such as nitroglycerine are much less harmful and could perhaps be used instead, at least for military exercises.

If tests with particle meters can prove that harmful dust decomposes in strong sunlight, advice could be given to destroy recovered explosives only at times of strong sunlight, and not, for example, in the evening, to prevent night-time exposure.

It might be wondered why the possibilities discussed here have not been previously considered. However, to put it in perspective, it took a long time before the addictiveness of marihuana was recognised.

If the hypothesis were disproved, military explosives would be yet another factor to be added to the list of factors excluded from causing ill-health. Such a finding would still contribute to the feeling of the veterans that attention is being paid to their complaints. It is hoped that the hypothesis will lead to studies to make clear the role of explosives: no cause, a link with insufficient evidence or the cause of many illnesses.

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(Accepted 3 June 2004)

Bart Hoek has a BE in mechanical engineering and works at Delft University of Technology, The Netherlands as a member of support staff, initially in the field of underground coal gasification, later in the physics of combustion and turbulent flow. He is interested in archaeology, technological developments in history and the development of education material for science and technology in secondary schools.

Correspondence: Section of Thermal and Fluids Sciences, Applied Physics Department, Delft University of Technology, PO Box 5046, 2600 GA Delft, The Netherlands. Email: < barthoek@ws.tn.tudelft.nl > .