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Uranium and other alpha emitting nanoparticulates : the forgotten pollutant

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2916 words

Abstract

Background : Depleted uranium use in weapons is certainly one of the main reasons, together with contamination from uranium mines and nuclear reactor explosions, why the health effects of uranium and other alpha emitters have not been researched with enough public funding.

Methods : The regional variations in epidemiological data available for a number of illnesses in developed countries are correlated with variations of natural radioactivity. This is compared with evolutions in countries where the use of depleted uranium is known (using WHO DALYs for 2000 - 2015).

Results : There is a direct correlation of these diseases with levels of natural radioactivity which can be linked with the explosion of these illnesses after depleted uranium bombings in countries like Iraq, Afghanistan and Pakistan.

Conclusions : The impact of alpha emitters was never taken in account in studies on pesticides, endocrine disruptors, lead, etc, which means that the dangerousity was likely associated with these non radioactive contaminants mistakenly. The very high kinetic energy of helium nuclei from alpha decay explains the dangerousity of uranium and other alpha emitters even at low levels of contamination. It is able to damage any vital function of the body from the inside as nanoparticulates travel through nerves, blood, lymph. It is capable to damage the genetic content of gametes in gonads through the same mechanism and create birth defects. It is in fact the main factor of genetic evolution (some changes may be positive and be kept through natural selection).

What is already known on that subject ?

The mutagenic effect of alpha particles at low levels was already known and a number of studies have provided, using local groups of populations and in vitro experiments, a good way to see the strong effects of internal exposure to alpha emitters. The effects of depleted uranium weapons bombings have also shown similar effects, on a more acute level, in the hospitals of the target areas. However, the link between depleted uranium weapons and these diseases has been the target of criticisms based on the insufficiency of proof available.

What does this study add ?

This study brings together the epidemiology of long level exposure to high levels of natural radioactivity and of acute exposure to depleted uranium in target areas, by showing that the same diseases appear, and that the sole difference is a difference of intensity. It uses several regions in Europe and in the USA, with an elevated number of subjects, using existing epidemiological research on several diseases (cancers, birth defects, Down syndrome, autism, schizophrenia, neuromuscular diseases), to show that levels of exposure to natural radioactivity are the common factor underlying their variations. These results are confirmed using data from Fallujah Hospital and from WHO DALYs in Iraq, Afghanistan and Pakistan for the 2000-2015 period. It demonstrates the need to inform populations about the dangers of long term exposure to low levels of contamination with alpha emitting nanoparticulates and to ban depleted uranium weaponry.

The link between radon and lung cancer has been established long ago (the link between radon and skin cancer is also increasingly under the spotlight), as well as the capacity of uranium and its descendants to travel in the body – see also [1] for a direct link between low levels of increase in radon exposure and birth defects. The capacity of nanoparticulates of uranium and other heavy

metals such as lead (the natural decay product of uranium) to accumulate in the blood and to circulate in the nerves to the brain is known [2]. The carcinogenic effect of low doses of alpha particles has been verified in vitro [3]. The mutagenic effect on DNA is also explained by the high relative biological efficiency of alpha particles (see [4] for a good example of high RBE). The mutagenicity even at low doses of radioactivity has also been demonstrated through a careful epidemiological review [5]. Common genetic factors between autism and schizophrenia have been established (see for instance [6]) and persons with Down Syndrome have also a more important incidence of autism and of several other conditions (ADHD, Alzheimer's, blood diseases, endocrine diseases...).

A quick comparison with natural radioactivity levels of countries where incidence and prevalence was surveyed shows clearly a link with natural radioactivity, explained as always by either :

- direct damage in the brain, synapses, or on any other cell,... by alpha "shots" of uranium / thorium / decay products nanoparticles (see Figure 1), able to travel all across the body, through nerves, blood, lymph, and, for cancer, subsequent proliferation due to proximity effect, or :
- Genetic change in gametes caused by alpha shots inside gonads, leading to mutations in the genes of children even though healthy carriers of mutations can extend over generations the emergence of illnesses (two healthy carriers with damaged genes because of alpha shots giving birth to a sick child)

An early version of the work exposed in this article was provided to the European Commission DG SANTE, which replied in a written letter that it "will take the freedom to refer to it in future discussions". A copy of the letter of the author to the Commission and of the reply is in annex.

1) Variations linked to natural levels of radioactivity

Natural uranium, depleted uranium, and all the radioactive decay products of uranium, as well as thorium and all the actinids, transuranics, present the same problem as they are mostly alpha emitters (there are some major beta emitters in actinids, Pu241, and Pb-210 in the uranium decay chain for instance, but these are a minority). The oxide nanoparticles from the ground, as well as depleted uranium oxide, are all able to travel through the body. They can for instance travel to the bone marrow and cause leukemia, but any cancer is likely to be caused by some alpha emitter because of the vast territory that nanoparticles can invade in the body – in fact, simply everywhere. Many other illnesses can be triggered by alpha emitters : any cell can be damaged, any function can be hindered or permanently diminished. The dangerousness of uranium has usually been associated mostly with its chemical properties [8] but it is doubtful that the long list of effects that has been associated with its chemical properties cannot be in fact linked, especially for low level effects, with its alpha radioactivity.

In France, the 2015 map of the relative risk of infantile cancer published by the French National Cancer Institute [9] reproduces quite well the map of the radon potential of the grounds, especially the ex-post estimation according to a Bayesian hierarchical model. Three of the departments known for high natural radioactivity (*Loire, Puy de Dôme, Finistère*) have an above average relative risk ([1.05 ; 1.09]) of infantile cancer (mostly blood and central nervous system). All the departments where the relative risk is under average ([0.93 ; 0.95]) are departments with low background radioactivity, according to the IRSN radioactivity map. It also has to be noted that the presence as "NORMs" of alpha emitting nanoparticulates in fumes is well documented (the other departments

where the relative risk is high are departments with dense urban areas : *Haute-Garonne* (Toulouse), *Bas-Rhin* (Strasbourg), *Gard* (Nîmes, bordering on Avignon) and *Hérault* (Montpellier), four departments which also have some high natural radioactivity areas, and Paris as well as the *Hauts de Seine* (a very crowded area). On acute lymphoblastic leukemia in the US age-adjusted incidence is also lowest in the South, an area with a typically very low natural radioactivity, and in non-Hispanic Blacks, whose populations are concentrated in that area [10]. Data on leukemias also show a similar trends with rates significantly lower in Blacks and Hispanics [11] which are groups concentrated in states with very low or average natural radioactivity. For Blacks, the same is true of non-Hodgkin's lymphoma, thyroid cancer, urinary bladder cancer, uterine corpus cancer, and breast cancer as well as (for females, less likely to smoke) lung cancer [12]. And the overall rate of cancer incidence in Hispanics is 20% lower than non-Hispanic Whites [13].

A direct correlation can be established between radon and cases of Down Syndrome, on the basis of data collected in the USA [14]. It is possible to sort in ascending order of radon risk the ten US states that have been tested, and to observe a direct correlation with the cases of Down Syndrome (the more natural radioactivity the more frequent the syndrome), with Iowa and Utah having the highest rates and Texas and Arkansas having the lowest (the level in Iowa is 131% of the level of Arkansas and the level of Utah is 141% of the level in Arkansas)¹. In England, one of the least radioactive parts of Western Europe, the rate is only 6,6 / 10 000 [15].

There is a more important prevalence of Down Syndrome in Hispanics in the USA [14], but it is extremely important to remember that the Iberic mountains (North-West of Spain) are one of the most naturally radioactive parts of Europe, which could explain a specific genetic heritage in American Hispanics having ancestors from that area. The pathway of cancer is more directly linked to immediate contamination and less likely to be affected by such a genetic pattern.

The higher prevalence of Down Syndrome in high natural radioactivity areas has also been demonstrated already in 1976 in India [16].

Near these mountains, there also is an elevated rate of autism, according to a national study undertaken in Portugal [17] on more than 332 000 children (questionnaires sent to directors of schools). The Azores, known for their very elevated natural radioactivity and radon levels, have according to this study the most elevated rate of autism, and the South of continental Portugal has the lowest level. The level in Lisbon is also significant but the main source of potable water of the city is in Castelo de Bode, on the Rio Zêzere, an affluent of the Tage which takes its source in the Iberic mountains, another area where the autism rate is elevated in Portugal².

In Finland, mental illnesses, including schizophrenia (see [18], and [19] for a map of mental handicap in Finnish adults) are correlated very well with geological outcrops of uranium, which are concentrated in the North-East of the country according to the GTK (Finnish geological service) map of deposits and mines : the exploitation had been planned in Sotkamo together with other ores, there is a mining project in Nuottijärvi and a former mine in Paukkajanvaara, most of the other mining claims / deposits are in Lapland.

Natural radioactivity is stronger in the South but uranium is cast into granite and dissolves thus less easily in water. Furthermore lichens, the feed of the reindeer, an important protein source in Lapland, can absorb important levels of radioactive elements, for instance radon-222.

Cancers and Down Syndrome are the swifter to conclude on because of the easy diagnostic and the anterior research. DNA damage may be one factor affecting meiosis, but direct impacts of alpha particles from radioactive sources that have migrated into the gonads, if they are occurring during

¹ Please note that the Georgia data was obtained only in Atlanta, and that the metropolis is located right upon an area which has a high natural radioactivity, unlike the rest of the state, according to the available map for US levels

² It is very easy to see the trace of radioactive sediments in the final part of the Tage in the LNEG radiometric map of Portugal http://www.lneg.pt/download/7078/radiometric%20map%20of%20Portugal_portal.png demonstrating the contamination of potable water in the city

the meiosis process are likely to be another major element involved. The Finnish results directly contradicts usual claims that schizophrenia is concentrated in cities (diagnosis is certainly quicker in cities because of the frequency of human contact and there are more clinicians available) and a more careful survey of other countries should produce similar results. For autism the Portuguese study was wide-ranging, furthermore the peak of autism cases in the Azores is again difficult to associate with other types of contamination than radon. All of these results also confirm the ability of radon and its decay products as well as of uranium and thorium dissolved into water to travel into the body and reach vital areas such as bone marrow, gonads and the central nervous system.

On neuromuscular diseases, in spite of the low incidence of the diseases, the epidemiological data available [20] still allows to draw conclusions. One can compare for instance England, the Netherlands, Denmark and Norway, Eastern China (Jiangsu...), the US "Old South" including Texas, where the levels ought to be low, with the US, France, Germany, Ireland, Scotland, Italy, Spain, Australia, Japan where they should be higher. For *Myasthenia gravis* the epidemiology matches perfectly this differentiation on natural radioactivity grounds. For Guillain-Barré syndrome too, the matching is absolutely perfect (it makes sense that the levels are low in Eastern China and Cantabria). For amyotrophic lateral sclerosis there is a good amount of data, especially on incidence, there are several matches (low level in Texas, in England, in Uruguay, higher level in Ireland, Nova Scotia (high uranium potential), Scotland, France, Missouri, Italy, Sweden, Japan in one study, Germany) but a few discording elements (Netherlands, Norway have a higher level than expected), though *these are countries where the diagnosis is maybe easier thanks to the high quality of health services* (and these are diseases for which the variations are more difficult to detect due to the low incidence).

For inclusion body myositis [20] provides data that may be partly conflicting but in [21] the levels are low in the Netherlands, higher in Australia and highest in Minnesota. Some other neuromuscular diseases have high levels in low radioactivity areas (e.g. Duchenne, Becker). One simple explanation is an anterior contamination (before populations migrated and settled down elsewhere) and mutation of maybe a single gene in a few subjects that may have stayed in the genetic pool (because of the limited level of immigration in e.g. Norway and England until the industrial revolution). It is important to understand that (as already suggested by [5] in their concluding remarks) very low variations of radioactivity may lead to a strong regional divergence after dozens of generations (and, in some cases, even far in the past before the age of coal use, events such as volcanic eruptions can change the exposure of a population to alpha emitting nanoparticulates, making genealogy of the mutation harder).

2) Confirming the effects of massive depleted uranium bombings

Alpha emitters can damage absolutely anything from the inside of the body. Nanoparticulates travelling anywhere can hurt any cell and cause every kind of dysfunction. These effects can be shown using mass aggregates and juxtaposing them with variations in exposure to radioactivity, and, unfortunately, the vast fields of use of depleted uranium weapons have provided the biggest live experiment for medical science ever known in the history of mankind. The simple study of DALYs 2000-2015 provided by the World Health Organization, looking at data in Iraq, Pakistan and Afghanistan allows to see this (Figure 2, Figure 3).

The link ovary / testicle cancer // birth defects is particularly obvious and demonstrates with force the common cause : depleted uranium dust going down the body because it is a heavy metallic

element and circulates with gravity down the body. Testicles, for instance, seem slightly more exposed than ovaries but they are all very exposed to contamination.

The effect is here also clearly confirmed for bone marrow, immune and endocrine disorders (to be linked with the hypothesis of the abilities of nanoparticulates to travel anywhere and damage any vital cell) as well as heart diseases and circulatory diseases, sickle cell traits (a clear case of genetic effect) and disorders, haemoglobinopathies and haemolytic anaemias. And a rapid chi-square calculation confirms that Afghanistan, Iraq and Pakistan are highly correlated (chi-square is $\sim 91,37$ for 38 degrees of freedom) and that their average evolution is totally decorrelated from the average world evolution.

The high increases found in neighboring countries (Jordan, Saudi Arabia and in a lesser significance Israel) could easily be linked to the winds blowing depleted uranium dust from the warfields. The fact that the increases are higher in Jordan and Saudi Arabia than in Israel also suggests that the origin of the regional variations all come from Iraqi depleted uranium dust. That depleted uranium contamination from other war fields may be one of the factors in cancers and other diseases found for instance in Gaza and must be pondered by all researchers willing to point at Israeli strikes (the data on cancers and birth defects in Gaza is sparse and contradictory).

The three tested countries follow quite clearly the same trend over all diseases : Afghanistan and Pakistan have similar increases, Iraq is behind. This is simply a proof that uranium dust behaves the same way in any body and that thus on aggregate on large groups of population it is possible to predict the approximate number of cases for each illnesses. The higher increase in birth defects in Iraq suggests quite logically an higher absolute threshold of contamination needed for birth defects as Iraq has been already contaminated severely before 2000 ; yet the issue is also the transparency of local communities regarding birth defects (which may be or have become a taboo) in the more remote places that have been the main targets of missiles and bombs in Afghanistan and Pakistan.

In fallout areas near Chernobyl the strong increase in cases of Down Syndrome has been documented [22]. In Fallujah in Iraq where depleted uranium weapons have been used, the observed rate of Down Syndrome [23] is 49 / 10 000 (30 cases over a sample of 6 049 births), a study which also showed very elevated rates of birth defects of all kinds in the population of the city (see also [24] for link between congenital anomalies and uranium contamination in the parents). An explosion of autism and ADHD cases has been noted in Fallujah after the bombings by Dr Samira Alaani. For schizophrenia, epilepsy and mental disorders in general the rates found in Vietnam are much higher in Thanh Hoa (North, area bombed massively during the Vietnam War) than in the South (Ben Tre) [25]. There is significant proof (for instance a document on the manufacturing of depleted uranium from the Y12 plant published in 1972 which already noted that depleted uranium fires present “a radiological hazard” (as opposed to a chemical hazard) and that “adequate respiratory protection” is needed in the vicinity of uranium fires [26]) that depleted uranium was already used in the Vietnam War and that dioxin is not the true responsible of the birth defects and other illnesses after the conflict.

3) A comment on virus mutations

It may also be suggested quite logically that the paths for genetic changes are the same for humans, the fauna, flora and even bacteria or virus. Virus inside humans or cattle in highly contaminated areas are more likely to meet a nanoparticulate emitting an alpha shot that may affect its RNA (for instance) and lead to the emergence of new forms. It seems that many of the most dangerous bacteria and virus have appeared in areas of high natural radioactivity (the “Spanish Flu” in China according to the *Institut Pasteur*, the 1347 Black Plague in Mongolia – for the Zika mutation the first outbreak started in French Polynesia and the link with artificial contamination from French

nuclear tests may be suggested– the virus would have absorbed defective RNA from an individual that was born with microcephaly due to parental contamination with uranium and / or plutonium).

Conclusion

The linear no threshold model for alpha emitters is entirely confirmed. The same mechanism explains obviously the apparition of competitive mutations, that can thrive through natural selection, yet it is for the first time shown that the same mechanism responsible for evolution is responsible for hereditary diseases, cancers, birth defects. Harsh measures should be implemented by public authorities to stop contamination : prohibiting radioactive ammunition and cleaning the already existing contamination, and providing to the public world maps of natural radioactivity as well as clear information on its dangers on the long term. To encourage people to drink treated water, to fight radon in dwellings, to discourage human consumption of meats that accumulate intakes of radioactivity because for instance of the water given to animals, to reduce the use of phosphate fertilizers (including for animal feed production) or, more simply, to extract alpha emitters from phosphates, coal, fuels, etc (or replace alpha sources with tritium in shaped charges³), the author believes (as a PhD student in economics) that market solutions, i.e. private undertakings and liberty of choice are the best way to achieve not only cost-efficient solutions but also social acceptability esp. in regions of high natural radioactivity where it would hurt the sensibility of inhabitants to forbid them for instance from drinking untreated water.

Ethics

No study approval was obtained.

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³ The book of the author *Depleted uranium, the invisible genocide and the seeds of terrorism* which was provided to the European Commission in the email quoted at the beginning of the article explains why « NORMs » in oil and gas are not of natural origin but linked to shaped charge technology.

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