Health Effects of Radiation on Human Health — a review of academic articles

by Editorial staffs

[SUMMARY] We made a quick review of academic articles that assess (ionizing) radiation effects on human health. The Hiroshima and Nagasaki atomic bomb survivors' life span study (LSS) has been the most renowned and comprehensive data source. The Radiation Effects Research Foundation (RERF, Hiroshima), which has been conducting this study, applied a linear dose response model based on the "Linear No Threshold (LNT)" model, and it has been the biggest basis of the International Commission of Radiological Protection (ICRP)'s recommendations. However, the effects of a low dose (less than 100mSv) are not statistically significant and there have been a lot of biological studies that advocate that low dose radiation risks are less than those induced by the LNT model.

BASIC FACTS ABOUT RADIATION

(Ionizing) radiation has been on the earth since its origin. However, it was only a century ago that humans recognized its existence. Dr. Roentgen discovered X-rays in 1885 and Dr. Marie Curie named characteristics that release radiation as "Radioactivity" three years later. Research into the useful application of radiation has been conducted since then.

On the other hand, the history of radiation research is also the history of radiation-caused hazards. In January 1896, a technician who worked in vacuum valve production suffered from dermatitis caused by X-ray exposure. In 1902, the fact that X-ray exposure causes skin cancer was confirmed. Additionally, atomic bomb attacks on Hiroshima and Nagasaki in August 1945 caused the first huge public radiation exposure [1].

Here are some basic facts about research into the effects of radiation on human health:

(1) Radiation has always been in the natural environment, both in space and on the Earth, and humans and other organisms have evolved by adapting to this natural radiation exposure. Radiation in the natural environment is called "Background Radiation" and its worldwide average dose rate (including internal exposure) is 2.4mSv/year.

(2) It is vital to distinguish between "dose"(which is represented by units such as mSv) and "dose rate", (such as mSv/hour). They are akin to "speed" and "drive miles" of a vehicle. Dose is calculated by integrating the dose rate for a certain period of time.

(3) There are many radiation-related units. Among them "Sievert(Sv)" represents the effects of radiation on human and other beings' organs and Sv measured radiation is comparable whatever the radioactive source is.

(4) Radiation effects on humans are classified into "deterministic effects" and "stochastic effects". Deterministic effects only occur when people are exposed to high-dose radiation (more than 1Sv). There are no civilians who have been exposed to such a high dose in Fukushima. Stochastic effects refer to a higher disease rate caused by excess radiation exposure. The existence

of many other carcinogenic factors (e.g. smoking, drinking) makes radiation effect study more difficult.

(5) There are two main approaches to radiation research: biology and epidemiology. Since we cannot conduct experiments on humans, radiation effects on humans can only be assessed by tracking accidentally exposed people over a long term and analyze the relationships between dose and illness. This is an epidemiological approach. Biological approaches consist of “in vivo" and “in vitro" studies. The hypothesis can be tested on biological mechanisms, however, whether research results are also valid for humans needs to be examined.

SURVEY RESULTS ON SUIRVIVERS OF ATOMIC BOMB, CHERNOBYL, AND NUCLEAR POWER PLANT WORKERS

Most people believe in the assertion that even tiny doses of irradiation will be harmful and the effect is relative to the dose. This is so-called “Linear No Threshold (LNT)" model, a hypothesis, which was discovered by Dr. Muller's irradiation experiment on flies in 1930.
The LNT model has had a kind of authority since the RERF adopted an LNT-based statistical model to stand for the radiation effects of the Hiroshima and Nagasaki atomic bomb survivors' life span study (LSS) [2]. The International Commission of Radiological Protection (ICRP) has issued recommendations that are based on this LSS study. However, we have to be careful of the fact that the RERF mentioned that there is no significant solid cancer risk increase under 50mSv dose [3].

The atomic bomb survivors' life span study (LSS) is the authoritative radiation effect epidemiological study in the world. Individual doses were estimated by computer simulation and about 120,000 survivors' medical histories have been accurately traced.The ICRP's recommendations have been primarily based on the LSS study results. This LSS data is open to thepublic on the RERF website

Epidemiological studies of nuclear plant workers have been conducted widely in several countries including Japan [4] [5]. The Chernobyl nuclear power plant accident in 1986 caused the world's widest radioactive pollution. Shibata [3] described the epidemiological study results of areas nearby Chernobyl and says that thyroid carcinoma risks from drinking milk have been high, but there has been no significant leukemia increase and the biggest effects on health were mental ones.

NO COMPLETE EVIDENSE ABOUT ‘LNT HYPOTHESIS'

It has been revealed that the result of Dr. Muller's research, which is the basis of the LNT model, is valid only for cells without a DNA repair function. There are some recent researches denying this LNT model [6].

The LNT is just a “hypothesis" if it does not have any biological grounds. Most epidemiological research shows that there is no significant cancer risk increase under 100mSv exposure. However, scientists tend to open only statistically significant results. Many studies, therefore, apply regression lines and show that the slopes of excess relative risks are significantly greater than zero. That does not mean that cancer risks are significantly greater than zero in low dose areas. It is a limitation of epidemiology, which it cannot claim that low dose radiation is not harmful, because researchers cannot control other factors that are assumed as error terms, even with such LSS data with many samples.

A recent debate about LNT model for a low dose (less than 100mSv) was made in the “Radiation Research" journal, between 2007 and 2008. Tubiana et. al.[8] criticized the 2007 US BEIR IV report[7] which aligned with LNT for its lack of biological basis. On the contrary, Brenner et. al.[9] stated that it was too early to make a conclusion. Then again, Tubiana and other

researchers wrote comments that were against Brenner's note [10][11][12][13].

Tubiana et. al.[14] made a comprehensive review of radiation effect studies and says that the LNT model is inconsistent with recent research results.

Another important thing we have to take into account is the “dose rate effect", which means that the more slowly we are irradiated, the less effects we will have from the irradiation. The ICRP adopts “2" as a coefficient of dose and dose rate effectiveness factor (DDREF). However, the amount of effect reduction is still being researched and discussed.

All articles referred to here were written before the Fukushima accident.

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