
Radiation hormesis research findings and therapeutic applications

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Abstract: In 1982, Professor Thomas Don Luckey of Missouri University asserted 'radiation hormesis' in the journal *Health Physics*. Following his assertion, the CRIEPI initiated a research programme on radiation hormesis to confirm 'is it true or not'. Twelve years of research with 8–14 universities in Japan produced fruitful results on radiation hormesis. Hormone response tests on rabbits, enzyme response tests on rats and mice, p53 gene responses from mice and rats and helper-T responses from human patients gave us impressive information to consider the therapeutic application of radiation hormesis.

Keywords: radiation; hormesis; therapeutic applications; incurable diseases; cancer; HIV.

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1 Introduction

In a review article entitled 'Physical benefits from low levels of ionizing radiation', published in *Health Physics* in December of 1982, Professor T.D. Luckey of the University of Missouri, asserted 'radiation hormesis' with 200 references.

This resulted in the first International Symposium on Radiation Hormesis in Oakland, California (August 1985). CRIEPI studied and consulted many specialists about Luckey's paper, Oakland papers and others such as Lorenz (1954), Luckey (1980) and Liu et al. (1985).

Radiation Hormesis research in Japan has been based on the rationale that if Luckey's claim were to be true, then radiation management in Japan has been extremely erroneous.

CRIEPI organised a Hormesis Research Steering Committee composed of leading specialists in the field concerned, and began research in cooperation with a number of universities, as well as the National Cancer Research Institute, and the National Institute of Radiological Sciences. Since interesting results were obtained in various experiments on the health effects of exposure to low doses of radiation, the programme was expanded to involve fourteen universities.

Now, after several years of research activities, with convincing test results, on the effects of low-dose radiation on mammals, we are really recognising Luckey's claim. Some basic surveys including Hiroshima and Nagasaki and animal experiments brought us utterly new information on the health effects of low-dose radiation. The following are some topical research findings obtained across Japan.

Medical specialists observed these findings and envisaged the profound potential of the radiation hormesis in the therapeutic applications on patients who suffer from serious diseases, considered difficult to cure using conventional medicine. The optimum mode of the low level radiation application has to be discovered for the therapy of incurable diseases, of cancers, and of HIV.

2 Topics of low dose radiation hormesis research

2.1 Survey of A-bomb survivors

Professor Okumura of Nagasaki University compiled the data from Hiroshima and Nagasaki, and came up with new scientific information. The follow up data on the people who received radiation from the Atomic Bomb showed us the relatively lower risk compared to the people who did not receive significant radiation, especially in the low dose range.

It was shown through a survey of the people exposed to the radiation of the A-bomb that a certain optimum dose could exist for the suppression of leukaemia.

2.2 The beneficial effects of Misasa spa for cancer

Professor Emeritus of Osaka University Dr. Kondo and Dr. Tanooka, former Chairman of Japan Radiation Research Society, conducted statistical comparisons of cancer in the people of Misasa village (they are accustomed to drinking the high radon-level water), with the people of an adjacent village and to the SMR of Japan. The results of the suppression of total cancer in Misasa villagers was clearly encouraging.

2.3 Medical application: treatment of cancer

Professor Sakamoto of Tohoku University used whole-body low-dose radiation for the therapy of cancer in a hospital in Tohoku. He successfully applied whole-body or half-body low-dose of 10 cGy, three times in a week for several weeks combined with local high-dose irradiation to treat non-Hodgkin's lymphoma. The low survival rate of 50% in patients with non-Hodgkin's lymphoma after ten years of the conventional therapy, improved to 84% survival with an additional low-dose treatment scheme. Some analytical data of the patients showed an increase of helper cells and increase of the ratio of the helper T cells to suppresser T cells.

2.4 Cell rejuvenation

Yamaoka of CRIEPI et al. found cell rejuvenation, in the tests on mice and rats on the properties of cell membranes, like decrease of lipid-peroxide and increase of membrane permeability. They also found an increase in the enzymes that are essential to keep a person young, following 25–50 cGy of whole-body irradiation.

After low doses of X-ray, whole-body irradiation, the increase of enzymes and the decrease of lipid-peroxide was maintained for eight weeks.

2.5 Adaptive response

Professor Ikushima of Kyoto University of Education examined the radio-adaptive response to low-dose priming before very high challenging dose of radiation.

Professor Yonezawa of University of Osaka Prefecture confirmed two kinds of radio-adaptive responses to increase the survival after a sub-lethal dose administration. He found two windows of low-level priming doses to bring enhanced resistance to sub-lethal x-ray radiation given two months after 5–10 cGy whole-body dose, and two weeks after 30–50 cGy as well.

2.6 Response of p53

Professor Ohnishi of Nara Medical University carried out tests on mice and rats and discovered a marked increase in P53 protein production. Whole-body doses of 10–25 cGy were clearly effective in enhancing p53 activities in various organs.

P53 protein induced by the tumour suppression gene p53 brings important enhanced activities on DNA repair and cell apoptosis.

2.7 Increase of anti-oxidant enzymes

Yamaoka of CRIEPI (now Assistant Professor of Okayama University), Takahashi of Tokyo University (now Tokyo University of Science) and Professor Kojima of Tokyo University of Science found remarkable responses of anti-oxidant enzymes, SOD, GPx, and catalase in animal tests. They carried out various whole-body tests using mice, rats, and rabbits applying 20–50 cGy, and obtained 50% increase of those enzymes in cells.

2.8 Enhancement of hormone synthesis

Yamaoka carried out tests on rabbits with Professor Komoto, Mifune, etc. in Okayama University about the effects of low level radiation on the various hormone syntheses. They did inhalation tests of the vapour of radon spring water and of the vapour of ordinary water on several rabbits. Their results clearly showed a significant response of hormone synthesis in rabbits by radon spring water, about adrenaline, insulin, methionine-enkephalin, beta-endorphin, etc.

3 Incurable diseases

Most of the incurable diseases are caused by loss of cells under the attack of reactive oxygen species. Based on the data obtained in animal tests on the health effects of low-level radiation, the rationale, as following, can be considered for the therapy of incurable diseases.

As a first step, pain and stress relief can be obtained to a certain extent, by the enhancement of the synthesis of many kinds of hormones such as methionine-enkephalin, beta-endorphin, and adrenaline.

As a second step, the causes of diseases that kill cells by reactive oxygen species are to be suppressed or prevented by the increase of anti-oxidant enzymes.

As a third step, recovery from these diseases can be expected through the enhancement and vitalisation of positive gene activities for the repair of the DNA and cells.

4 Cancer

Immune system enhancements were found. For example, helper-T cell and NK cell activities were increased after low dose whole body irradiation.

Protein P53 in the cells of various organs clearly increased, following 10–25 cGy whole-body irradiation on mice and rats.

Professor Sakamoto showed successful results in the therapy of human cancer.

The Tamagawa radon spring in Japan is very popular for therapeutic visits by cancer patients. In the case of the Tamagawa spring, the combined effect of radiation hormesis and hyperthermia could be the rationale.

5 HIV

Human Immuno-deficiency Viruses catch helper-T cells and begin chemical control to produce a large amount of reactive oxygen species. Under the high level of reactive oxygen species, helper-T cells are gradually damaged and destroyed.

- The conventional methods of chemical medicines in making effects on cells through blood could hardly be successful in obtaining an adequate increase of the enzymes such as SOD, GPx, and catalase in cells. However, 20–25 cGy whole-body brought out 50% increase of those anti-oxidant enzymes that would suppress the reactive oxygen activities.
- The increase of helper T cells by whole-body low-dose irradiation had been already reported by Sakamoto, Makinodan, and Liu, through research processes, independent of each other. These positive responses were explained by the increase of interleukin, the decrease of suppressor-T cells, and the concerned gene responses. The enhancement of immune systems is also expected by the vitalisation through the increase of the synthesis of various hormone.
- However, adequate care should be taken with regard to the activity of the virus itself. The Human Immuno-deficiency Virus could be stimulated by low dose radiation and could be activated. The University of Texas reported the results of appropriate X-ray tests on the activation of HIV by using MT-4 cells in vitro. The data showed a clear increase of the activity of reverse transcriptase of HIV in the range above 30 cGy and strong activation by 3 Gy.

- The estimated dose in cells could be 20–30 cGy by alpha-ray of radon in cells after the inhalation of radon containing air in the radon cave or in the radon spring. An analytical estimation of the alpha-ray energy from radon 222 visiting a cell gave a figure of 20–30 cGy.
- We have to perform a suitable test by using human helper-T cells before judging whether low dose radiation is good or not for therapeutic application to HIV patients.

6 Closing remarks

Formation of ions, free electrons and free radicals by ionising radiation enhances and creates many comprehensive bio-chemical reactions, followed by significant biological responses.

Animal test results give us remarkable information about wide-spread biological effects including a certain scientific synopsis on the positive effect of low dose against carcinogenesis and malignant tumour, suppression of cell ageing and activation of biological defence mechanisms.

We have an impression that a certain low dose, radiation raises some vitalisations of basic biological functions. The recent progress of analytical technique on the observation of DNA structural responses greatly contributes to the unbelievable success of our research on the adaptive responses of low-dose radiation.

Analyses of the history of the evolution of living materials through billions of years show us that all kinds of environmental conditions were put to extreme and positive use, without exception, in our physical processes; air, water, sunlight, temperature, salt, radiation, and so forth. This pursuit of the extreme in the positive utilisation of the all kinds of environmental factors, through the process of evolution, results in the development of life itself. It is obvious that the natural radiation back ground on the earth, in the past, was fairly higher than the present situation. So radiation was one of the essential factors for the development of life.

In this sense, adaptive response is obviously the fundamental characteristics of life. All kinds of damages caused by environmental influence, diseases, and loss of power are naturally to be overcome by enhancement of DNA repair and apoptosis activities. This is the essential method of adaptive response of living materials to the environment.

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