PriMera Scientific
Medicine and Public Health
Volume 2 Issue 6 June 2023
ISSN: 2833-5627

Promise of Low Dose Radiation in Fighting Cancer, Risk Assessment and in Treating Novel COVID-19

Type: Editorial
Received: March 25, 2023
Published: May 04, 2023

Citation:
KP Mishra. "Promise of Low Dose Radiation in Fighting Cancer, Risk Assessment and in Treating Novel COVID-19". PriMera Scientific Medicine and Public Health 2.6 (2023): 01-03.

KP Mishra*

Ex Bhabha Atomic Research Center, Mumbai, India & Foundation for Education and Research, 504, Neelyog Residency, Ghatkopar (E), Mumbai 400075 India

***Corresponding Author:** KP Mishra, Ex Bhabha Atomic Research Center, Mumbai, India & Foundation for Education and Research, 504, Neelyog Residency, Ghatkopar (E), Mumbai 400075 India.

Research on the low dose radiation (LDR) effects on living systems especially the doses in environmental ranges (< 200 mSV) has evinced increasing interest to meet the new health care challenges in present time. Low dose exposure situation is witnessed in diagnostic and therapeutic applications and in cases of mine workers, watch dial painters. In recent years, there have been increasing incidences of cancer globally after high dose radiation exposure endangering human health and causing deaths. Moreover, at this point of time, the world has faced a grave health danger due to novel CORONA-19 virus pandemic posing serious threat to human health and resulting in millions of deaths globally. It is fairly well known from cellular and animal researches that low dose irradiations suppress the incidence of cancer by subsequent acute radiation dose exposures (~ 1000 mSv), a phenomenon called adaptive response (AR) or hormesis. It is also widely accepted that LDR exposures stimulate immune responses offering protection from radiation and disease-causing pathogenic stress. Therefore, it seems reasonable to apply LDR in fighting cancer, evaluation of risk and COVID-19 virus onslaught on the vulnerable human population. The advantage can be derived from the externally applied radiation and other stressors induced anti-inflammatory cytokine storm in human body's immune system which goes into an overdrive to fight an infection or other forms of trauma.

The use of radiation in diagnosis and therapy is common but not without fear of detrimental risks and a general feeling of uneasiness. Effects of LDR have not been adequately elucidated and more research is needed to unravel the underlying mechanisms. However, LDR is known to cause stimulations in a variety of cellular processes resulting in beneficial effects which offer new opportunities to harness the protection to normal cells and therapeutic outcomes through toxic effects. It is pertinent to recall that billions of years ago the living organisms from bacteria to humans evolved in high ionizing radiation background and they armed themselves with complex protective machineries for survival against external stressors. In the present time, average annual natural environmental radiation is estimated ~2.4 mSv which, of course, varies at various locations on the earth ranging from about 1 mSv in Japan to 260 mSv in Iran. Most interestingly, it is found that people residing in such natural high background radiation (HBR) areas live a normal life and there are no reported significant health issues.

The living organisms exhibit adaptation offering protection against radiation exposure and learn to live below certain threshold dose. Furthermore, a low radiation dose causes stress to cells which turn on genes at specific threshold of radiation dose. The radiation activated genes up-regulate the protection systems which produce enhanced positive effects e.g. prevention of cancer, risk prediction and suppression of diabetes etc. Presumably, the LDR induced positive effects arise due to intracellular production of reactive oxygen species (ROS) which initiate production of endogenous antioxidants for its neutralization and signaling processes. More importantly, LDR activate repair of the damaged DNA, induce the mechanism of apoptosis causing the self-destruction of cancerous cells. LDR could modulate excessive inflammatory responses, regulating lymphocyte counts, and controlling bacterial co-infections in patients with COVID-19. Also, it is known to boost immunity which can annihilate cancer cells as well as reduce or counter virus assaults. Overall, LDR initiates recruitment and rescue operation in the injured cell which results in protection against radiation in normal cells or to the pathogenic agents including COVID-19 virus attack. On the other hand, a higher dose of ionizing radiation overstresses the organisms and the genes are turned on/off at specific radiation doses. It is known that different genes are activated by high and low doses. Thus, the built in protection system in cells is overtaken at higher doses and harmful effects are observed. That is to say, the low dose induced beneficial effects are generally marred by high dose radiation exposures. Another important finding in radiobiology is the observation of damage to non-irradiated cells called bystander effect. The DNA damage, apoptosis and other effects in non-irradiated cells show different patterns. It remains to be seen how bystander effect will modify cancer therapy outcome, risk estimates(carcinogenesis) and protection against radiation. Evidently, the promise of LDR in therapy of cancer and other diseases (e.g.cardiovascular) needs to be isolated, identified and tested in clinic. More importantly, a new opportunity is in the sight to optimize a window of LDR doses, say between 10 mSv to 200 mSv, that needs to be tested and optimized in the therapy of chosen lung cancers and novel COVID -19 infection which locates in the lower respiratory system and causes pneumonia symptoms leading to breath deterioration and eventually death.

In the evolution of life, organisms have harnessed the low dose stimulation to their survival advantage. It is no surprise that extensive LDR research in environmental ranges at molecular, cellular, and animal level has shown no adverse or detrimental effects. Thus, the concern for likely safety of health issue is critical. In fact, the safety concerns of scientists from LDR therapy seem to entail from the Reports of International Commission for Radiation Protection (ICRP) which believes in Linear-No- Threshold (LNT) model which is based on the assumption that no dose is safe however small. The ICRP prefers to ignore biological fact of intrinsic cellular repair machinery and hence believes in no threshold. Radiobiological studies on the surviving population from Hiroshima and Nagasaki atom bomb have shown that the cancer rate increases in proportion to the amount of exposure to radiation at acute high doses. However, there is no convincing data that shows the increase in cancer rate with a low level of exposure. On the contrary, there are even reports indicating that the cancer rate declines in high background radiation studies in China, India Brazil and Iran. The observed adaptability and the built in intrinsic protection system in living organisms against radiation are ignored for establishing the regulation and standards for radioprotection. In this context, the observed threshold of LDR dose at which genes are turned on and the dose at which they are turned off are important transition from beneficial to harmful effects of radiation. Of course, the dose thresholds and the amounts of benefit and harm observed are the characteristics for each organism. But, the remarkable demarcation of response of organisms from a LDR to acute radiation dose (ARD) is frequently observed which needs re-examination for the validity of LNT model.

In summary, the studies on low dose radiation effects on living organisms needs re-focus and role of LDR therapy in fighting cancer merits re-examination, a fresh look at carcinogenic risk evaluation/prediction (in view of Adaptive response and bystander effects) and developing novel tools for treating COVID-19 appear highly urgent and it's use in therapy deserves re-evaluation and rigorous analysis of the clinical data. International scientific community is divided on the carcinogenic risk of LDR but recent surge in publications on evaluation of low dose therapy in the treatment of pneumonia caused by the novel COVID-19 and cancer re-emphasizes the need for technical developments and brings new hope for saving human life.

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