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Submitter Information

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Attachments

Public Comment Pam Vu

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November 11, 2015

Secretary, U.S. Nuclear Regulatory Commission
11555 Rockville Pike
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Docket ID NRC-2015-0057

To Solomon Sahle:

I am writing to you because I am in agreement with the three petitioners, Dr. Carol S Marcus, Mr. Mark L. Miller and Dr. Mohan Doss. I am in favor of the request to amend the "Standards for Protection Against Radiation" regulations and to change the model of the basis of those regulations from the linear no-threshold (LNT) model to the radiation hormesis model. I will be addressing how changing to the radiation hormesis model can fix the widespread and irrational fear of low levels of ionizing radiation.

The LNT model has been part of the cause for this exaggerated fear of low levels of ionizing radiation. Many studies have shown that low dose radiation is beneficial to the health of humans. For this reason alone, the radiation hormesis model can be a cure for this irrational fear.

Sincerely,

Pamela Vu

The Radiation Hormesis Model: A Cure for Fear

Pamela Vu

West Chester University of Pennsylvania

On June 23, 2015, the United States (U.S.) Nuclear Regulatory Commission (NRC) requested public comment on three petitions for rulemaking (PRM) that requested the NRC to amend its "Standards for Protection Against Radiation" regulations and to switch from the linear no-threshold (LNT) model of radiation to the radiation hormesis model as the basis of changing those regulations. The LNT model states that any dose of radiation, even close to zero is harmful to the health of humans (Doss et al., 2013). This model also postulates that the risk is linear with the dose and is independent of dose-rate (Myslobodsky, 2001). The radiation hormesis model provides that exposure to low-dose radiation (LDR) has beneficial health effects for humans (Doss et al., 2013). The position that will be taken and discussed in this response to the call for public comment is in agreement with the three petitioners. Currently, regulations are based on the LNT model. The NRC should change its regulations in favor of the radiation hormesis model for many reasons. One of the main reasons that will be addressed in this response is that the radiation hormesis model should be the basis for regulations because it can be a remedy for radiophobia and other mild fears to varying levels of exposure to radiation. Reasons why the LNT model should be rejected in favor of the radiation hormesis model will be discussed as well.

In order to understand how the radiation hormesis model can be a remedy for fear, the origin of radiophobia has to be explored first. Radiophobia is an abnormal fear of ionizing radiation (Myslobodsky, 2001). Radiophobia affects mental health and radiation protection standards (Myslobodsky, 2001). Many regulations such as the permissible exposure of 1millisievert a year (mSv $year^{-1}$) were made based on the LNT model (Myslobodsky, 2001). The LNT model is partly responsible for the abnormal fear of low levels of radiation because the model assumes that at even extremely low doses of radiation, people are still at a health risk (Jaworowski, 2010). Cancer risks have been estimated by the LNT model using the Chernobyl

and atomic bomb survivor data (Doss et al., 2014). Many scientists go by the LNT model because it has been established much longer than the radiation hormesis model (Jolly et al., 2009).

There are many situations, and examples that describe the origin of radiophobia. Previously, women who were of reproductive age were not allowed to enter nuclear submarines or areas that radiation was present (Myslobodsky, 2001). There is still debate among radiologists whether pregnant doctors should be able to practice angiography and nuclear medicine (Myslobodsky, 2001). Andrei Sakharov, the founder of the Soviet A-bomb stated that the reason why the nuclear power industry has been removed from the global economy is because of fear (Myslobodsky, 2001). People are exposed to natural background radiation every day. Someone flying in a jet at 10,000 meters altitude to Greece will be exposed to twice the yearly permissible dose of 1mSv a year more than a nuclear plant employee (Myslobodsky, 2001). Many would presume that the nuclear plant employee would be exposed to a much greater amount of ionizing radiation. A study was conducted over a span of 40 years from 1944 to 1984 on the cancer mortality rates among nuclear researchers and the general U.S. population. It was discovered that there was a 51 percent reduction of cancer incidents among nuclear researchers and a 49 percent increase among the general U.S. population (Myslobodsky, 2001). These examples and situations aid in understanding the origin of radiophobia.

Since the radiation hormesis model postulates that LDR is beneficial to the health of humans, this model could be an effective remedy for radiophobia (Jaworowski, 2010). Jaworowski (2010) describes the testing of nuclear weapons during the Cold War period and how it is believed to have caused the emergence of a psychologically widespread and irrational fear of exposure to small amounts of ionizing radiation. Radioactive materials from atmospheric

tests spread all over the world (Cuttler, 2014). This fear that arose so long ago still has decision makers and scientists relying on the LNT model. This reliance on the LNT model has caused many to dismiss the radiation hormesis model. After radiophobia became prominent, the radiation hormesis model was dismissed (Jaworowski, 2010). The public began to fear small and large doses of radiation from the fallout of atmospheric tests of nuclear weapons leading to an end of these tests in 1963 (Jaworowski, 2010). The irony is that this fear was essentially instilled in the public by the scientists who invented these nuclear weapons (Cuttler, 2014). Radiation should not be feared by the public because from 1944 to 2001, only 134 deaths occurred in all radiation incidents (Jaworowski, 2010). Radiation is not always harmful, especially in small doses. If the public understood the benefits of the radiation hormesis model and why the LNT model should be dismissed, there would not be a widespread fear of radiation.

Scientists and practitioners discovered that low acute doses or low dose-rate long-term exposures to radiation are beneficial to the health of humans (Cuttler, 2014). High, short-term exposures to radiation were found to be harmful (Cuttler, 2014). The overall health benefits of LDR are that it improves immune system response and reduces the risk of cancer as well as noncancerous diseases (Doss et al., 2014). There is a vast amount of research, including animal studies and epidemiological studies that support this claim (Doss et al., 2014). Cancer risks are reduced because LDR boosts the immune system (Doss et al., 2014). Other health benefits of LDR include cancer cures, curing of pneumonia, treatments of inflammations and arthritis and accelerated healing of wounds and infections (Cuttler, 2014). LDR is known to cure pneumonia in many hospitals (Cuttler, 2014). The radiation hormesis model is also known as ‘adaptive response’ (Jaworowski, 2010). This model is also termed ‘adaptive response’ because LDR has adaptive protective responses such as reducing DNA damage following exposure to LDR (Doss

et al., 2014). There is opposition of the radiation hormesis model as well. A mathematician named Mark P. Little believes that research supports the claim that LDR is not beneficial to the health of humans because there is a positive linear effect to the dose response (Doss et al., 2014). Little describes evidence on how increased childhood leukemia is caused from natural background radiation which is LDR (Doss et al., 2014). These claims are supportive of the LNT model. There are issues regarding epidemiological studies that support the radiation hormesis model. Epidemiological studies are based on statistical models that inevitably produce error (Jolly et al., 2009). Many of the literature reviews on the benefits of the radiation hormesis model recognize that there is not enough evidence that can bring about substantial changes to the regulations on protection against radiation (Jolly et al., 2009). The LNT model is the chosen model because it has been established much longer than the radiation hormesis model.

The study of childhood leukemias that Little was referencing does not consider confounders such as breastfeeding (Doss et al., 2014). In addition to this, the study did not have a control group for comparison (Doss et al., 2014). Little has mentioned that LDR is not beneficial to the health of humans. Many publications of studies and reviews have shown that LDR is not harmful but is actually beneficial to the health of humans because it prevents cancer and noncancerous diseases (Doss et al., 2014). There is not much valid support that the radiation hormesis model is harmful to the health of humans. Scientists and decision-makers have stood by the LNT model because they believe it is the safe route and it has been established much longer than the radiation hormesis model. They have refrained from studying or even recognizing the existence and validity of the radiation hormesis model even though there is evidence that the radiation hormesis model is beneficial to the health of humans (Jaworowski, 2010).

Data from the atomic bomb survivors is considered the gold standard for using the LNT model to estimate radiation effects in humans (Cuttler, 2014). Recent studies from further evaluation of the data are supportive of the radiation hormesis model (Doss et al., 2014). The atomic bomb survivor data show that a threshold does exist, thus making the LNT model invalid (Doss, 2013). A study of the dose threshold analysis on the atomic bomb survivor data showed that it was too restrictive, resulting in the determination of a zero dose threshold (Doss, 2013). Reanalysis of the data indicated that there was a reduction of excessive relative risk for cancer mortality of the atomic bomb survivors for doses in the range of 0.3 to 0.7 Gray (Gy) when using the linear fit to the data (Doss, 2013). What this indicates is that the data do not follow the linear dose-response pattern of the LNT model. This deviation at lower doses describes the curved dose-response of the radiation hormesis model. Since the existence of a threshold does exist, this threshold for negative health effects must be determined. A large set of epidemiological and experimental data determined an accepted threshold for recognizing harmful health effects due to a short-term exposure to ionizing radiation to be 0.1Gy (Cuttler, 2014).

Currently, there is an ongoing debate about whether regulations on "Standards For Protection Against Radiation" should be based on the LNT model or the radiation hormesis model. The radiation hormesis model states that exposure to LDR has beneficial health effects. These health benefits include: improved immune system response, reduced cancer and noncancerous risks, curing of pneumonia, treatments of inflammations and arthritis and accelerated healing of wounds and infections (Cuttler, 2014). The LNT model is not valid because recent reanalysis of the atomic bomb survivor data showed that the data described the radiation hormesis model (Doss et al., 2014). The radiation hormesis model proves that radiation thresholds exist, thus the LNT model is not valid (Jaworowski, 2010). The LNT model

contributes to the irrational fear of radiation. The radiation hormesis model can be an effective remedy for this fear called radiophobia because LDR is beneficial to the health of humans.

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