Facilitating the End of the Linear No-Threshold Model Era

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The linear no-threshold (LNT) model, which asserts that any level of ionizing radiation increases cancer risk, has been the basis of global radiation protection policies since the 1950s. Despite ongoing endorsements, a growing body of evidence challenges the LNT model, suggesting instead that low-level radiation exposure might reduce cancer risk, a concept known as radiation hormesis. This editorial examines the persistence of the LNT model despite evidence favoring radiation hormesis and proposes a solution: a public, online debate between proponents of the LNT model and advocates of radiation hormesis. This debate, organized by a government agency like Medicare, would be transparent and thorough, potentially leading to a shift in radiation protection policies. Acceptance of radiation hormesis could significantly reduce cancer mortality rates and streamline radiation safety regulations, fostering medical innovation and economic growth.

Key Words: cancer; LNT model; NCRP; radiation hormesis; radiation safety

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The linear no-threshold (LNT) model, which posits that even minimal exposure to ionizing radiation increases cancer risk, has been the cornerstone of global radiation protection policies since the 1950s, driven largely by recommendations from advisory bodies such as the National Council on Radiation Protection and Measurements (*1*). Despite repeated endorsements from such bodies, including the latest one by the National Council on Radiation Protection and Measurements in its commentary 27 (*2*), my critical examination of the evidence presented revealed a lack of support for the LNT model (*3*). Conversely, a body of evidence (*4–10*) supports an alternative perspective known as radiation hormesis (*11*), suggesting that low-level radiation exposure might actually decrease cancer risk. I had hoped that review of such evidence would prompt a reevaluation of the LNT model by advisory bodies, signaling the end of the LNT model era (*3*). However, after more than 5 y since the publication of my article (*3*), and despite numerous other publications questioning the adoption and validity of the LNT model (*12,13*), its widespread recommendation (*14*) and application (*15*) persist. In this editorial, I will explore the factors contributing to the persistence of the LNT model era and offer a suggestion for resolving this contentious issue.

In a burgeoning scientific field, researchers naturally propose and explore various hypotheses, even contradictory ones. However, as time elapses and a significant body of evidence accrues, it becomes untenable for scientists to continue supporting conflicting hypotheses. The scientific community's role is to scrutinize these hypotheses rigorously, discarding those that fail to align with accumulating evidence. This process is especially crucial when hypotheses carry significant public health implications. It is paramount for the scientific community to identify the correct hypothesis to guide public policy, because adhering to erroneous hypotheses can result in substantial harm.

Consider the long-standing use of the LNT model by the global community since the 1950s. If evidence confirms the validity of radiation hormesis—an opposing concept to the LNT model—indicating that low-dose radiation exposure actually reduces cancer risk, the implications are profound. Data suggesting a notable decrease in cancer risk, ranging from 20% to 40%, after exposure to low-dose radiation (*16*) underscore the potential major impact.

Had the scientific community not adhered to the LNT model but instead explored radiation hormesis in clinical trials when it was proposed in the 1980s by Luckey (*17,18*), adoption of radiation hormesis might have led to reduction in cancer deaths by around 20%. This would have translated to preventing nearly 2 million cancer deaths in 2022 alone, given the staggering global toll of 9.7 million cancer deaths that year (*19*). Thus, the decision of advisory bodies to persist with the LNT model, despite published evidence supporting radiation hormesis, may have contributed to millions of preventable cancer deaths over recent decades.

The tendency of advisory bodies to overlook or discount evidence for radiation hormesis raises questions about their decision-making processes. When I brought to the attention of the authors of the National Council on Radiation Protection and Measurements commentary the substantial evidence supporting radiation hormesis (*20*), their response (*21*) was concerning. They argued that much of the evidence I cited was not robust because it involved "comparisons of risks between study cohorts and the general population" and that "occupational cohorts tend to be selected for good health compared with the wide range of health status in the general population." However, this critique does not hold up under scrutiny. None of the studies I referenced involved comparisons of occupational cohorts with the general population. Instead, these studies examined cancer rates among cancer patients (*4,5*), radiologists (*6*), tuberculosis patients (*7*), and residents of apartment buildings compared with the general population (*8,9*). Therefore, the authors' criticism lacks validity.

The persistent refusal of advisory bodies to acknowledge evidence supporting radiation hormesis raises questions about potential conflicts of interest that these organizations may have. Acceptance of radiation hormesis would show that they have been wrong for decades because of their consistent support for the LNT model, tarnishing their reputation and diminishing their credibility, influence, and funding. Do these factors influence the reluctance of advisory bodies to recognize the validity of radiation hormesis? This issue merits investigation by an impartial government agency to ensure transparency and accountability.

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The prolonged impasse between the LNT model and radiation hormesis stems from the refusal of the LNT proponents to acknowledge the validity of evidence supporting radiation hormesis, often instead offering unfounded criticisms. To address this deadlock, I propose a solution: a public, online debate between supporters of the LNT model and advocates of radiation hormesis should be organized by a government agency, such as Medicare, which spent over $1 trillion on cancer treatments in 2023 (*22*). When announcing the debate, it should be made clear that if one side fails to participate, it would be considered the losing side.

In this debate, each side would present its most compelling evidence. This would be followed by rebuttals from the opposing side and responses from the first side. These back-and-forth rebuttals and responses would continue until each piece of evidence is assessed as being valid or invalid. All the arguments and counterarguments would be conducted transparently in the public domain, ensuring that interested parties can access the reasoning and evidence presented and call out any invalid arguments. Once completed, this transparent process would enable rejection of invalid evidence and establishment of the ground truth on the contentious issue, paving the way for evidence-based decision-making in radiation protection policies. If the debate concludes with validation of the LNT model and rejection of radiation hormesis, the status quo for radiation protection policies would continue. On the other hand, if it results in validation of the concept of radiation hormesis, the debate would lead to the adoption and application of the radiation hormesis concept to prevent cancer and could significantly reduce Medicare's cancer treatment expenses.

If the scientific community accepts radiation hormesis and rejects the LNT model after such a debate, society stands to gain numerous benefits. Embracing radiation hormesis would pave the way for extensive research and application of low-dose radiation in cancer prevention and treatment, potentially resulting in a significant reduction by 20% or more in cancer mortality rates. Additionally, the efficacy of low-dose radiation in treating various noncancerous diseases (*23*) would be further explored and used in medical practice.

Rejecting the LNT model would also lead to a reduction in radiation safety regulations, simplifying operations in radiation-related fields such as nuclear power and nuclear medicine. This would also alleviate concerns among patients and parents regarding radiation exposure from medical imaging procedures. Although there would be a decrease in jobs related to radiation safety, the emergence of new job opportunities in supporting applications of low-dose radiation in medicine would more than offset this decline. Overall, the adoption of radiation hormesis promises to usher in a new era of medical innovation and improved patient care while fostering economic growth in related industries.

It is my fervent hope that the proposed online debate takes place soon, validates the evidence for radiation hormesis, and leads to the end of the LNT model era so that society can benefit fully from the many applications of radiation.

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