S6-191

Total Risk Management for Low Dose Radiation Exposures

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Our civilization is witnessing about century of nuclear age mixed with enormous promises and cataclysmic threats. Nuclear energy seems to encapsulate both potential for pure good and evil or at least we humans are able to perceive that. These images are continuously with us and they are both helping and distracting from making best of nuclear potentials for civilization. Today with nuclear use significantly present and with huge potential to further improve our life with energy and medical use it is of enormous importance to try to have calmed, rational, and objective view on potential risks and certain benefits.

Because all use of nuclear energy proved that their immediate risks are negligible (i.e., Three Mile Island and Fukushima) or much smaller than from the other alternatives (i.e., Chernobyl) it seems that the most important issue is the amount of risk from the long term effects to people from exposure to small doses of radiation. A similar issue is present in the increased use of modern computational tomography and other radiation sources use in medicine for examination and therapy. Finally, extreme natural exposures are third such potential risk sources. Definition of low doses varies depending on the way of delivery (i.e., single, multiple or continuous exposures), and for this paper usual dose of 100 mSv is selected as yearly upper amount.

There are three very different scientifically supported views on the potential risks from the low doses exposure. The most conservative theory is that all radiation is harmful, and even small increments from background levels (i.e., 2-3 mSv) present additional risk. This view is called linear no threshold theory (LNT) and it is accepted as a regulatory conservative simple approach which guarantees safety. Risk is derived from the extrapolation of the measured effects of high levels of radiation. Opposite theory to LNT is hormesis which assumes that in fact small doses of radiation are helpful and they are improving our health. This view is supported with numerous evidences, and explained with beneficial effects from the increased activity of immune system activated with small radiation exposures. Finally, theory in between is that small doses are less than linearly proportionally harmful and that they are presenting a much smaller risks than according to the LNT. This view is derived from the use of different evidences.

Difficulties to find one single theory about effects of small radiation doses are related to existence of huge variability and uncertainty in the evidence data. This is very hard experimental and theoretical problem. It will require lots of additional research to reduce these uncertainties and find final theory. This might be too late for the number of people affected in different ways with current single most conservative LNT approach.

The problem with the conservative LNT regulatory approach is resulting in enormous additional costs of nuclear energy and medical applications. Which is reasonable and acceptable during the regular operation when source is high and concentrated. But, this becomes unreasonable huge economic burden after accidents and for cleanups with nuclear facilities. Similar problem arises with restriction of medical examinations and treatments based on over conservative risk estimate. Special circumstances are with evacuated people from contaminated areas where they are on the one side saved from small radiation exposures, and on the other side exposed to years of life away from their home and with numerous direct and indirect additional risks (i.e., stress, social problems, etc.).

It seems reasonable that some alternative (total) risk management approach might be much more suitable for this situation. Evacuation of people from contaminated area with small doses sources should not be done when that induces larger risks from even what is expected from radiation based on LNT. Similar total risk management could be also applied for with medical examination and treatments.

This paper is proposing estimate of all potential additional evacuations related risks in order to implement total risk management. A preliminary illustrative estimate with uncertainties stands against evacuation. Much further work is needed to make this risk management approach applicable. However, preliminary illustrative results are clearly showing that much of the long term evacuation is not justified. This approach seems appropriate before scientific uncertainty is reduced and better decision base is established.

With additionally more honest, transparent and scientific approach to risk communication and management small doses of radiation might not be used any more as fuel for anti-nuclear activism. Without proper understanding of priorities we are not just wasting our limited resources but also missing great opportunities and increasing total risk.

***Keywords**: nuclear energy radiation, medical radiation, NLT, hormesis, total risk management, induced risk*