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Is the Radiation Risk Model Flawed?

James Welsh, MD, MS, FACRO
******@***lumc.edu

Professor - Department of Radiation Oncology, Loyola University Stritch School of Medicine

Radiation safety is based on the belief that radiation from medical imaging can cause cancer. It is based on the linear no-threshold (LNT) model. But the authors of a study published in the American Journal of Clinical Oncology contend that risk estimates based on this model "are only theoretical and have never been conclusively demonstrated by empirical evidence".

Corresponding author James Welsh, MD, MS, FACRO, and colleagues from Loyola University's department of radiation oncology, Chicago, argue that use of the LNT model amounts to scaremongering and wastes money that is spent on unneeded and wasteful safety measures. They maintain that fear of cancer risk may prevent clinicians from using imaging.

In their paper the authors re-examined the original studies that led to adoption of the LNT model. In the model, the well-established cancer-causing effects of high doses of radiation are extended downward in a straight line to very low doses and the assumption is that there is no safe dose of radiation. However, the human body has evolved the ability to repair damage from low-dose radiation that naturally occurs in the environment. The original studies were conducted in the 1940s on fruit flies exposed to various radiation doses. However, these early studies were not done at truly low doses, and when a study that exposed fruit flies to low-dose radiation was conducted in 2009, it did not support the LNT model.

Corresponding author, Dr. Welsh, responded to *HealthManagement.org's* questions in an email.

Why did you and your colleagues decide to examine the basis of the LNT model?

It has been clear for decades that the linear no-threshold hypothesis (LNTH) was flawed at low doses/dose rates to the point of fallacy. Indeed, we have noted that there has never been a defence of the LNTH that has offered any verifiable biological science, either underlying its tenets or supporting its usage in any way. LNT model advocates try to show that the LNT model's history supports the validity of the LNTH, and then they rely upon epidemiological investigations using flawed, frequentist statistical analysis, with the a priori assumption that the model is true, to "prove" the LNT model is true (circular reasoning). The extensive evidence from biological laboratory experimentation and/or observation points towards a linear threshold (LT) model – ie, linear down to a threshold, below which there is either no harm or actual benefit.

Importantly, we see that this unsupported and unsupportable scientific assumption, even admitted by its advocates as such, contributes to a significantly harmful outcome for large numbers of people when it becomes a policy guideline, as it has all over the world. Many people have died or had their lives and livelihoods ruined as a result of LNT-derived forced evacuation policies around Chernobyl and Fukushima. Many people refuse to avail themselves of needed CT scans out of fear of radiation driven by LNT's daughter, ALARA (as low as [is] reasonably achievable), that not infrequently encourages radiologists to lower radiographic exposures below an adequate diagnostic level, with all the harmful consequences of false or uncertain diagnoses. It has produced misguided aversions to clean and sustainable nuclear energy, and has truncated funding sources for further research into salutary low-dose radiation effects.

Given these factual observations, we have taken a further step in thoroughly rebutting the LNT model, beginning with a refutation of the common assumption that the early leaders of the hypothetical LNT model, Muller and Stern, had demonstrated its validity. By examining their original research from some seven decades ago, we have shown instead that they did NOT demonstrate the validity of the LNT model, but, in fact, demonstrated the validity of the LT (linear threshold) model, proving, as it turns out, that the LNT model was false from its beginnings. Sadly,

several generations of scientists have missed this evidence from the Muller/Stern published research, indicating how inadequately science self-polices and self-corrects with respect to published research, especially from famous and respected experts (Muller received the Nobel Prize for his work in 1946.
It is now appropriate that we move to refute the epidemiological methods and bases of the groundless support for the LNTH.

What reaction have you had to your papers both in the American Journal of Clinical Oncology (Siegel et al. 2015) and Technology in Cancer Research & Treatment (Siegel and Welsh 2015)?

There has been high interest in both papers from the media, and we have received more than a few private comments from radiation professionals, colleagues, and other researchers expressing strong support and thanks for these publications in getting this information to professionals serving in the front lines of therapeutic and imaging efforts. There has been a lot of positive feedback from readers, who previously were under the false impression that all radiation, no matter how low, was dangerous. Several individuals we have spoken with were surprised to learn that the conventional wisdom that is taught at all grade levels from high school to post-doctoral levels might not be as scientifically rooted as we have been led to believe. Several individuals who have read the articles chave commented that they brought this issue up with their radiation safety committees for discussion – and some of those discussions have grown lively. At the very least, the papers encourage many people to explore the subject on their own rather than rely solely on the unilateral perspective presented to them by conventionally-trained and uncritical educators and authors. There is ample objective evidence that contradicts this conventional viewpoint, and people are now beginning to avail themselves of that data.

Isn't it better to err on the side of caution when it comes to radiation dose?

For the very reasons listed in our paper and summarised above, lowering radiation dose is not, in fact, erring on the side of caution. Rather it produces unwarranted fear on the part of governmental agencies, radiologists, and patients, as well as parents of paediatric patients, that leads to very harmful outcomes. Erring on the side of caution in any situation can only be relevant when there is only one direction for harm, but when either direction is harmful and when there is a beneficial zone between too little and too much, there is no such thing as a side of caution on which to err. In such cases, as is true with radiation effects, specific and accurate knowledge and understanding of the true biological effects is critical to enable adherence to the dictum "above all do no harm." Blind adherence to the unsupported and unsupportable assumption that all radiation is harmful, an essential feature of the LNTH, leads to the assumption that there can be no such thing as too little radiation or ranges of exposure that are beneficial. This is, in fact, false, and furthermore, that assumption produces mass radiophobia, fostered further among the lay public by the failure of most radiologists, nuclear medicine physicians, and many radiation scientists and regulators to understand the science behind radiobiology. More people died as a result of the needless forced evacuations in the aftermath of the Fukushima accident than as a result of the low radiation exposures involved; in addition, predictions of cancer deaths yet to occur in 20-30 years are only imagined and will likely not occur at all, since they are based on the erroneous LNT model.

Curiously, the U.S. Federal Aviation Administration and the airline industry seem to have implicitly asserted that very low doses of radiation are not harmful when they initiated the backscatter x-ray screenings at airports. The fact that these very low-dose security screening units have disappeared from many airports might have more to do with a failure of the vendor to meet the demanded privacy requirements (eg, portraying a cartoon representation of the individual instead of a genuine image of the naked body) than a fear of radiation.

Since one, in fact, cannot err on the "side of caution" when it comes to accepting, promulgating, and, indeed, promoting false science that generates strong public fear, with its concomitant, harmful behavior, caution is not the correct word to describe the response by physicians and patients to this needless and unfounded (after 70+ years) LNT hypothesis. It is better to "err" on the side of honesty in all things and avoid dealing in false science to achieve ends that bolster careers of the few at the cost of harmful behavior, born out of fear, by the many, all in the illusory name of "erring on the side of caution."

Do you have any proof that fear of cancer risk is preventing referrals and patients from getting needed imaging exams?

There are a growing number of studies that measure such fears and their resultant effects. See for example:

- Pandharipande PV, Reisner AT, Binder WD et al (2015) CT in the emergency department: a real-time study of changes in physician decision making. Radiology, Sep 24:150473. [Epub ahead of print].
- Parker MW, Shah SS, Hall M et al (2015) Computed tomography and shifts to alternate imaging modalities in hospitalized children . Pediatrics, 136(3): e573-e581 36(3).
- Medical Press (2015) Children's hospitals shift from CT scans for common childhood health problems , August 24.

Patient ignorance results not only from their misinformed physicians, but also from the media, politicians, and the radiation regulators. There have been many stories in the media dealing with radiation effects at low doses that have been massively overblown. One need only look at the fact that the American Association of Physicists in Medicine (AAPM) issued a Position Statement on Radiation Risks from Medical Imaging Procedures , as reported in the media, to see that one of the professional associations has heard that people are becoming more fearful of medical imaging. Indeed, the site says that "The [AAPM] statement was issued because of concern that papers in scientific journals, warning against dangers from CT scans, were finding their way into the popular media, and 'people became fearful and said they were not going to have the exams,' said William Hendee of the Medical College of Wisconsin, lead author of the AAPM statement. That was particularly true of parents of children slated for exams."

Image credit: Loyola University Medical Center

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