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Brief Report

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Leukemia and Ionizing Radiation Revisited

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Abstract

A world-wide radiation health scare was created in the late 1950s to stop the testing of atomic bombs and block the development of nuclear energy. In spite of the large amount of evidence that contradicts the cancer predictions, this fear continues. It impairs the use of low radiation doses in medical diagnostic imaging and radiation therapy. This brief article revisits the second of two key studies, which revolutionized radiation protection, and identifies a serious error that was missed. This error in analyzing the leukemia incidence among the 195,000 survivors, in the combined exposed populations of Hiroshima and Nagasaki, invalidates use of the LNT model for assessing the risk of cancer from ionizing radiation. The threshold acute dose for radiation-induced leukemia, based on about 96,800 humans, is identified to be about 50 rem, or 0.5 Sv. It is reasonable to expect that the thresholds for other cancer types are higher than this level. No predictions or hints of excess cancer risk (or any other health risk) should be made for an acute exposure below this value until there is scientific evidence to support the LNT hypothesis.

Keywords: Leukemia; Ionizing radiation; LNT model

Introduction

While trying to better understand the basis for the present conception that any ionizing radiation exposure, no matter how small, is linked to an elevated risk of cancer, the authors re-examined the early articles in Science that triggered the regulatory changes and the propagation of this hypothesis. Two articles dating back to the 1950s stand out. The first was the June 29th 1956 paper by the Committee on Genetic Effects of Atomic Radiation of the National Academy of Science (NAS) [1]. It recommended the application of a linear no-threshold (LNT) model for assessing the risk of radiation-induced mutations in germ cells [1]. The second was the 1957 paper by Lewis [2] that recommended the LNT model be used for calculating the excess risk of cancer due to any radiation exposure.

Recently, several articles have been written exploring exactly what led to the 1956 NAS paper and its subsequent wide acceptance. It appears there was significant misunderstanding and misinterpretation of the scientific data, and one such analysis even goes as far as asserting that the promulgation of the LNT model was deliberate scientific misconduct [3]. An UNSCEAR report has stated, "Radiation exposure has never been demonstrated to cause hereditary effects in human populations" [4]. Hundreds of papers on medical treatments of many thousands of patients with low to moderate radiation doses make no observations of excess cancer incidence nor genetic effects [5].

Evidence of a Threshold Dose for Excess Risk of Cancer

This brief article revisits the Lewis study [2] on leukemia and identifies a very serious error in his analysis. It was missed by all the international radiation protection organizations and regulators who accepted the recommendation to use the LNT model to evaluate cancer risk following any radiation exposure. In his analysis of the incidence of leukemia among the populations of Hiroshima and Nagasaki, Lewis did not properly account for the incidence of leukemia among the "control populations" (the people who were not significantly exposed). His Table 2 gives the number of confirmed cases of leukemia in four zones, and his Table 3 gives the average dose in each of these zones [2]. This data are summarized and shown in Table 1 below.

Zone	Distance from hypocentre (m)	Dose (rem or cSv)†	Persons exposed	Number of cases of leukemia	Total cases per million
A	0 - 999	1300	1,870	18	9,626
B	1000 - 1499	500	13,730	41	2,986
C	1500 - 1999	50	23,060	10	434
D	2000 and over	5	156,400	26	166

Table 1: Incidence of leukemia among the combined exposed populations of Hiroshima and Nagasaki, January 1948 - September 1955 (adapted from Lewis, Tables 2 and 3) † 1 centisievert (cSv) = 10 mSv [2].

To address the leukemia incidence among the control population, Lewis stated, "Since the majority of the population in zone D (from 2000 meters on) was beyond 2500 meters, the average dose is under 5 rem and is thus so low that zone D can be treated as if it were a "control" zone." In his Figure 1, the dose is about 10 rem at 2000 metres and about 1 rem at 3000 metres [2]. These are significant amounts of radiation, corresponding to about a hundred plain x-rays or up to ten abdomen/pelvis CT scans. We contend that the people who were in the range from 2000 to 3000 metres should not have been combined with the non-exposed people who were located beyond 3000 metres. Scott has pointed out that averaging the data in several low dose intervals is an epidemiological trick [6] or approach [7] that is employed to

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conceal evidence of a dose threshold, which would contradict and invalidate the LNT model that Lewis recommended for calculating the excess risk of cancer due to radiation.

The 1958 UNSCEAR report [8], Annex G, Table VII provides the leukemia data for the ~ 96,000 Hiroshima survivors, including ~ 33,000 who were in zone E, from 3000 metre and beyond. These human data, are shown in Table 2 and in Figure 1 [9]. (Note that both the vertical and horizontal axes are logarithmic, in order to present the data on one page and avoid congestion in the low-dose, low-incidence ranges.) The footnote for zone C in Table VII states, "almost all cases of leukemia in this zone occurred in patients who had severe radiation complaints, indicating that their doses were greater than 50 rem" [8]. In Figure 1, we added a point at 100 rem or 1 Sv to account for this observation of severe radiation complaints regarding the zone C leukemia patients. The dashed line through this point strengthens the evidence that there is a threshold dose for excess risk of leukemia. The total number of cases per million for the controls, 273 over 8 years, corresponds to an annual incidence of about 3.4 per 100,000.

Zone	Distance from hypocentre (m)	Dose (rem or cSv)	Persons exposed	Number of cases of leukemia	Total cases per million
A	0 - 999	1300	1,241	15	12,087
B	1000 - 1499	500	8,810	33	3,746
C	1500 - 1999	50	20,113	8	398
D	2000 - 2999	2	33,692	3	92
E	over 3000	0	32,963	9	273

Table 2: Leukemia incidence for 1950-57 after exposure at Hiroshima (adapted from UNSCEAR-1958, Annex G, Table VII) [8].

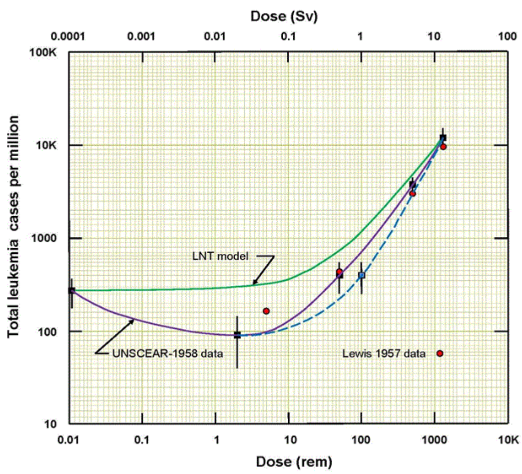

Figure 1: Leukemia incidence among the Hiroshima atomic bomb survivors, 1950-57.

Conclusions

The UNSCEAR data and the data that Lewis analyzed contradict his recommendation to use the LNT model to predict the excess risk of leukemia (and cancer in general). These substantial data, on about 96,800 humans, suggest there is an acute radiation threshold at about 50 rem (500 mSv) for excess leukemia incidence. It is reasonable to expect that the radiation thresholds for initiation of other cancer types are higher than the 50 rem or 500 mSv threshold for leukemia.

No predictions or hints of excess cancer risk (or any other health risk) should be made for an acute dose below 50 rem or 500 mSv until there is scientific evidence to support the LNT hypothesis.

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