

1 Gofman 1972 paper

John Gofman was a anti-nuclear scientist who came out of Livermore where he participated in several big discoveries including U-233. I thought I'd look at one of his papers Gofman and Tamplin, Epidemiologic Studies of Carcinogenesis by Ionizing Radiation which was given at a symposium in 1972. I figured that someone with his background must have a good reason for his stance, and I was interested in what it was.

The tone of the paper is arrogant and dismissive, even by current standards. Hard to imagine what it sounded like to a 1972 scientific meeting. Maybe like Trump dropped into their midst. Gofman can't resist the argumentative and hyperbolic adjective. We are "committing ecocide", technical progress is "ostensible". People who argue that dose rate is important "spew forth cliches". And so on.

The paper argues against epidemiologic studies since we already know the answer. These studies have inherent uncertainties "The net result is that the controversy persists interminably. And we are condoning the continuing exposure of humans to a pollutant which is unethical. We must eschew the "treachery inherent in such studies".

Gofman takes LNT as a given (his Generalization 1). and then (Generalization 2) heroically assumes all cancers have the same mortality increase per rad. [I call this LNT squared.]

This leads him to looking at leukemia and then multiplying by 20 on the grounds that other cancers are 20 times as prevalent as leukemia. Just that leukemia shows up first. Gofman was writing in 1972, so this "generalization" was already not supported by the data. In fact, by 2006, 60 years after the bomb was dropped the data shows that essentially all the leukemia among the high dose (greater than 1000 mSv) cohort was caused by radiation, whereas in the same very high dose cohort less than half the solid cancers could be attributed to radiation. Of course, it is now mainstream that the leukemia curve is non-linear.

Throughout Gofman is adamant that all the data supports LNT down to very low doses. "These new data all point unmistakably to the correctness of Curve B, the linear relationship between excess cancer mortality and radiation dose,..." But to make his point, he cites ankylosing spondylitis patients whose bone marrow received 88 Gy, and developed cancers in nearby spots which received 6 Gy. He cites a study in which rats received down to 15 rads (150 mSv) of gamma. And another mouse study by Upton et al for thymic lymphoma down to 10 rads (100 mGy). But in fact the source cited only went down to 150 mGy. He cites two more sources but they only go down to 200 mGy. Finally, he gives a lot of weight to a study using radium-224 "on human adults and children" which resulted in the production of osteosarcoma. The data "extend down to 90 rads estimated dose". Ra-224 is an alpha emitter. 90 rads of alpha is 18 Sv. Most of these experiments/studies involved acute doses. In short, even if the studies say what Gofman says they do, and had no errors, they do not extend down to the dose rates of interest in NPP releases.

Gofman concludes:

There exists, however, no rational support for such an assumption, since it would require a fundamental change in the mechanism of radiation carcinogenesis in the region below the linearity region”

This is an obvious non-sequitur. All that is required is a non-linear repair process.

Gofman is an adamant supporter of strict LNT, but with some strange twists.

1. He heaps scorn on the idea that dose rate is relevant, suggesting any studies that show otherwise are the result of the animal aging during the protracted dose, and as the animals age they become more radiotolerant. But he goes on to say that, if results differ for different dose rates, the “the toxic effect should be assumed to be at least as high for any other dose rate”.

Adherence to such a public health principle might reduce the danger from those individuals all too ready to spew forth cliches, such as “Maybe the poison won’t be so bad if we give it slowly.”

2. In the discussion, Gofman casually uses non-linearity at the high end to explain why the Japanese high dose data does not match some of his other data.
3. He assumes that the increase in cancers is multiplicative on the incidence of other cancers. So as the irradiated population ages, you get a quadratic effect (although he objects to the word when he is called on this in the discussion).

At times, Gofman moves from shrill to just plain false. After admitting that the acute radiation syndrome curve is non-linear because it “relates to whether or not cell replacement can operate rapidly enough”, he dismisses the idea that a similar mechanism could apply to radiation induced cancer:

For carcinogenesis, not a shred of evidence has been adduced that cellular replacement can avert cancerous change.

This statement is manifestly false now; but it was also false in 1972, as Dr. Budinger of the Donner Lab pointed out in the discussion, saying

We now have ample biophysical data to show DNA breaks are repaired very efficiently by at least two cellular mechanisms.

Budinger goes on to cite 3 papers. Gofman’s response is telling

These [repair mechanisms] are very interesting phenomena that every knowledgeable scientist realizes do exist. But neither Dr. Budinger nor anyone else has suggested any relevance of these phenomena for the question of radiation dose rate and carcinogenesis.

In other words, cell repair mechanism exist; but for some unknown reason they don't apply to radiation damage. And by the way, Budinger did just suggest they do.

The main target of the paper is the allowable dose to the public. In 1972 when this paper was written, the allowable dose to the public from NPP's was 0.17 rads per year. (1.7 mGy). Using his numbers, Gofman calculates that the rule would kill at least 32,000 people per year, and quite possibly 104,000. These numbers would be in addition to the 303,000 "spontaneous cases" of cancer mortality in the US annually. In the latter case, the average life expectancy of everybody in the US would be decreased by 13 years.

The only thing that saving us is that the 0.17 rads per year is not being used up. Gofman admits that 1.7 mGy is about background level. And he also stipulates that there is no difference between natural and man-made radiation. So he is at least implicitly arguing that at least 10% and possibly one-third of the "spontaneous cancers" are caused by background radiation. ***If this were true, then we would see massive differences between the cancer rates in high background areas (e.g Denver) and those in low areas (e.g Florida.*** Apparently, nobody pointed this out in the discussion.

The only thing I learned from this paper is that Gofman, no matter how bright he was, was a lousy scientist:

1. His view of carcinogenesis is willfully simplistic.
2. The scornful dismissal of any possible repair mechanisms displays a clouded intellect.
3. The assumption that all cancers respond to radiation not only linearly but with the same slope not only defies common sense, but was unsupportable statistically when he made it.
4. And his hypothesis that an additional 1.7 mGy per year to all Americans would increase cancer mortality in the US by 10 to 30% (30,000 to 100,000 additional deaths per year) is easily testable.

Despite this, the discussion appears very muted. And it seems that Gofman was influential in the subsequent reduction in allowable man-made public exposure to 0.25 mSv/y.