Diagnostic Radiation: Are the Risks Exaggerated?

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The supposed increased risk of breast cancer from X-rays in annual mammograms has led John R. Lee, M.D., to recommend that women avoid them.[1]

John W. Gofman, M.D., estimated that mammograms combined with other medical sources of radiation cause 75 percent of breast cancers.[2] He also wrote a book whose purpose as stated on the flyleaf was: "...an expert who is independent of the radiation community provides the human and physical evidence proving that carcinogenesis from ionizing radiation does occur at the lowest conceivable doses and dose-rates."[3]

Eugene D. Robin, M.D., wrote that the relatively low doses of X-rays used for mammograms by 1984 cut the risk, but he implied that there was still some risk at any level.[4] Frank Rauscher, M.D., director of the National Cancer Institute in 1976, wrote that in women aged 35-50, each mammogram increased the chance of contracting breast cancer by 1 percent.[5]

Are these pervasive cautions justified?

The Linear No-Threshold Hypothesis

That large doses of radiation (>50 cGy acute, >250 cGy cumulative) produce a greater incidence of health problems has been shown by epidemiological studies. To estimate risks at lower doses in the absence of actual data, data were extrapolated in a linear mode to zero dose above the background level. This hypothetical relationship is called the linear no-threshold (LNT) model and is used to set limits of radiation exposure by all official and governmental associations.[6]

The Effects of Low Doses: What the Data Show

The actual relationship of radiation dose with health is not so simple as assumed by the LNT model. Below a certain level of exposure there are beneficial health effects–called radiation hormesis–which do not follow from extrapolation of the high-dose portion of the curve.[7-9]

For example, there is a 20 percent lower cancer death rate in Idaho, Colorado, and New Mexico, which have background radiation of 0.72 cGy/year, compared with Louisiana, Mississippi, and Alabama, with 0.22 cGy/year.[7] British male radiologists practicing after 1954, who were exposed to 0.05 to 5 cGy per year of X-rays, have a lower cancer and all-cause death rate than the most relevant peer group: other male medical practitioners.[10]

The Canadian fluoroscopy study[11] involved 31,710 Canadian women being examined and treated for tuberculosis with X-ray doses to the chest, beginning between 1930 and 1952 and followed for up to 50 years. The results from all provinces except Nova Scotia, for which too few low-dose data points were taken, are shown in Fig. 1. These are age-adjusted, since first exposure at ages 10-14 was considered four times as damaging as exposure over age 35.

The data chosen were breast cancer incidence (after 10 years from the first X-ray exposure of the patient) per million person-years of exposure. The relative risk of breast cancer at 10-19 cGy cumulative exposure was 0.66 compared with controls; the relative risk was 0.85 at 20-29 cGy; and it was not significantly higher at 30-69 cGy. This interpretation of this study has been faulted because two similar studies failed to show the beneficial effect of low-dose X-rays; however, one of those studies used 2-98 cGy as the lowest cumulative treatment dose range, showing no increase in breast cancer in this group.[12] The other study had no data below 60 cGy.[13]

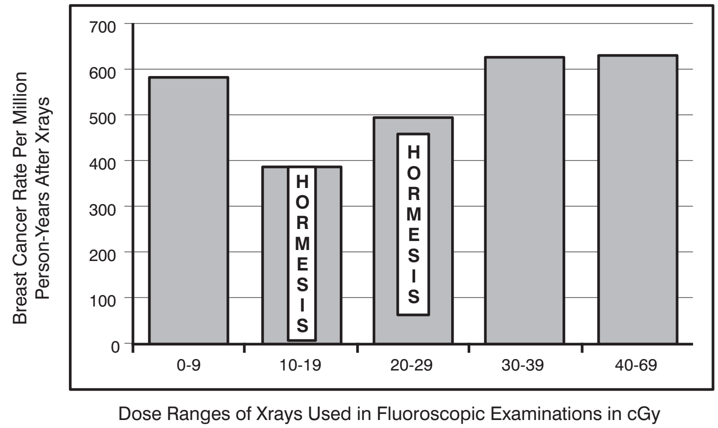

Figure 1: Breast Cancer Rates vs. Cumulative X-ray Doses in Canadian Fluoroscopy Study *ex* Nova Scotia. Adjusted for age of first X-ray exposure. Based on tabular data from ref. 11.

Other organs also have lower cancer rates as a bio-positive effect of low-dose radiation. For example, for half of all US counties, representing 90 percent of the US population, lung cancer rates decrease by about 35 percent as the mean radon level in homes, by county, increases from 18 to 110 Bq/m^3, and by 25 percent at 110 to 220 Bq/m^3.[14] Similar smaller studies in England and France confirm these findings.[15]

Radiation hormesis is hypothesized to be a moderate overcompensation to its disruption of homeostasis; it is a stimulus to the biological repair mechanisms that cope with non-radiation damage as well, so that the overall effect is a health benefit.[8,16] Acute whole-body doses of 1 to 50 cGy are beneficial, and 10 cGy/year appears to be the optimum chronic hormetic dose.[7]

Radiation Doses from Medical Imaging Procedures

What are the doses of typical diagnostic X-rays? Gofman estimated that the entrance dose of X-rays in a typical mammogram was about 2 cGy before 1985.[17] Another estimate is that the dose decreased from 1.5 to 2 cGy in the 1970s to 0.4 to 0.8 cGy by 1989. Mammography routines in the 1990s are now claimed to deliver as little as 0.2 cGy, apparently for each pair of views of each breast, totaling 0.4 cGy per total examination.[18,19] If a woman of 50 began in 1990 to have annual mammograms until age 75, the cumulative dose would be 10 cGy, which is within the optimum hormetic dose range (Fig. 1), so avoiding mammography because of the radiation is not justified. Furthermore, the mean relative risk of breast cancer death for the treatment group in trials is 0.80, falsifying Gofman's assertion of causation. The unchanged all-cause mortality rate, due to aggressive treatment of the many false positives, justifies avoidance.[20]

The dose from a single chest X-ray now is 0.025 cGy, while a CT (or CAT) scan of the head uses 2 cGy, and a CT scan of the body, 6 cGy (Baraldi R, personal communication, Jan. 14, 2003). The dose to the thyroid for imaging is 3-5 cGy with iodine-123, 5-10 cGy with iodine-131, and 1 cGy with technetium-99.[19]

In the 1970s the mean exposure from a single dental X-ray was about 0.6 cGy per view.[17] Faster film had cut the dose considerably by the year 2002. A single dental exposure now delivers only 0.0009 cGy, and a full-mouth series of 19 exposures delivers only 0.017 cGy to the head and neck (Acker S, Eastman Kodak Co., personal communication, Aug. 15, 2002). A lifetime annual dose at this low level, from age 20-80, would be 1 cGy, which is in the hormetic range.

Ample evidence has been given to show that diagnostic X-rays and nuclear medicine scans at modern dose levels actually can be beneficial to health, contrary to the risk/benefit ratios given in a leading gynecology text[21] based on the LNT model, which are also used in a leading textbook of medicine.[22]

Patients should not be dissuaded from screening with X-rays, PET scans, or radioisotopes unless the doses are excessive (see Table 1), or the diagnostic benefits nonexistent. More consideration should be given to providing optimal, rather than minimal, radiation doses for everyone, which means keeping track of all doses in patients' records.[9, 20]

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Table 1. Doses from Typical Radiation Sources in USA

Background[9,23]	cGy/yr
AL, LA, MS	0.22
CO, ID, NM	0.72
^{40}K adult human	0.026
UK Radiologists[10]	0.05-5
Technological[23]	
nuclear power	0.0003
nuclear fallout	0.004
nuclear devices[a]	0.005
Medical Imaging	
	cGy
mammograms[18,19]	0.4
chest X-ray[b]	0.025
dental, full-mouth[b]	0.017
CT scan, head[b]	2
CT scan, body[b]	6
thyroid scan[19]	
^{131}I	5-10
^{123}I	3-5
^{99}Tc	1

[a]smoke alarms, pacemakers, gauges
[b]see text

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