IS RADIATION LESS HARMFUL THAN BEIR V REPORTS?

In an article in the August issue (page 34), Arthur C. Upton, the chairman of the National Academy of Sciences–National Research Council Committee on the Biological Effects of Ionizing Radiation, discussed the committee's recent report.[1] A major conclusion of the BEIR V report was that ionizing radiation is more damaging biologically than had been thought, since the effective exposure at Hiroshima was lower than had previously been calculated[2] because of an earlier overestimation of the neutron dose. The question should be addressed of whether the philosophy of the authors interfered with their choice of scientific studies to reference and with the accuracy of their reporting of those studies.

Let us consider first two areas in the medical use of radioisotopes where the report ignored or reported incompletely the appropriate studies. Radioiodine, ^{131}I, has been used extensively in the diagnosis and treatment of thyroid dysfunction. Until 1968, when the radioimmunoassay of thryoid-related hormones was introduced for the diagnosis of thyroid disease, ^{131}I uptake was the method of choice. The average thyroidal dose received during the uptake studies was of the order of 0.5 sievert (50 rem). By 1968 in our country alone an estimated 1–3 million people had received such studies. There has been no systematic follow-up of a significant fraction of this population. However, thyroid cancer remains a rare disease in the US, accounting for only about 1000 of the 500 000 annual cancer deaths, and mortality from it fell 10% from 1950 to 1980.[3] There was a 20-year Swedish follow-up of about 35 000 patients, 5% of whom were under 20 years old at the time of ^{131}I diagnostic testing, who received an average thyroidal dose of 0.5 Sv between 1951 and 1969.[4] This work revealed that among those studied for reasons other than a suspected tumor, the ratio of the observed number of thyroid cancers to that expected for a control group was 0.62. For those who received diagnostic tracer tests because of a suspected thyroid tumor the ratio was 2.7, suggesting that in some cases the physician's suspicions were justified. In discussing this paper, the BEIR V report states that "a total of 50 thyroid cancers were found in the ^{131}I group compared with an expected number of 39.37 cases, yielding an overall standardized incidence ratio of 1.27 observed to 1.0 expected cancers." The report does state that "the results of these studies do not support the conclusion that diagnostic doses of ^{131}I significantly increase the risk of thyroid cancer." However, the faliure to mention the difference in the results for the two groups of patients leaves the deceptive impression that there was an increase in thyroid cancer in the whole group, even if that increase is not statistically significant.

Probably the largest group of people receiving whole-body radiation doses of about 0.1 Sv are those treated with ^{131}I for hyperthyroidism. Table 4-3 of the BEIR V report predicts that total body exposures of 0.1 Sv would result in about an extra 20 leukemia deaths among 20 000 people so exposed. The report fails to mention a very important, widely accepted follow-up study of 36 000 patients with hyperthyroidism, approximately 22 000 of whom were treated with ^{131}I and the rest with surgery or antithyroid drugs.[5] No excess of leukemia was observed in the ^{131}I-treated group compared with those treated surgically. About 10% of these patients were subsequently followed for an additional 10–12 years.[6] No difference was observed between those two groups in total cancer incidence [observed/expected relative ratio (RR) = 1.0], breast cancer incidence (RR = 0.8) or leukemia incidence (RR = 0.6). A recent 15-year follow-up study of another group of over 10 000 ^{131}I-treated hyperthyroid patients given similar doses also failed to find an increase in leukemia mortality (RR = 0.94).[7] After the Hiroshima and Nagasaki bombings leukemia

started to increase at 2 years, peaked at 5–10 years and started to fall thereafter. Thus these studies of ^{131}I-treated hyperthyroid patients had sufficiently long follow-ups to have observed a leukemia increase if the BEIR V prediction were valid for whole-body radiation delivered at a lower dose rate. The absence of leukemia following this treatment for hyperthyroidism is sufficiently accepted by the medical community that ^{131}I was the treatment of choice for President and Mrs. Bush.

Probably the largest group of people surviving for many years after integrated whole-body doses of 1–10 Sv or more are those treated with ^{131}I for follicular or papillary thyroid carcinoma. A follow-up study of 258 such patients was recently reported.[8] The incidence of leukemia was much lower than would be predicted from studies of the atom bomb survivors.

Let us consider how the BEIR V report treats the case of the "atomic veterans," that is, those present at the nuclear bomb tests. It states:

> In 1980, Caldwell *et al.*[9] reported that among the 3224 participants of the nuclear test explosion Smoky, nine cases of leukemia occurred through 1977, compared with 3.5 expected cases.... Robinette *et al.*[10] expanded the study to include a cohort of 46 186 participants in one or more of five test series at the Nuclear Test Site (NTS) or the Pacific Proving Ground (PPG). The excess cases of leukemia among the participants of the Smoky test were confirmed.... On the other hand, associations may be real and reflect an underestimation either of the doses or of the risk per unit dose. This may be the case for the Smoky nuclear test, which was the highest-yield tower detonation at the NTS. Fallout was particularly heavy, 10 to 20 times greater than at other detonations in this test series.

According to the Robinette study[10] the radiation dose for the 3500 Smoky participants averaged 6 mSv; only 1% received more than 50 mSv. The radiation doses for participants at a test in the South Pacific, Operation Greenhouse, averaged 13 mSv, with 3% receiving more than 50 mSv. Yet in this group 4.43 cases of leukemia were expected and only 1 occurred. Why was Operation Greenhouse not mentioned in the BEIR V report? The report suggests that the apparent increased leukemia from the Smoky test might be due to underestimation of dose. However, to be completely honest it should have noted the possibility that the Smoky increase and Greenhouse decrease in leukemia were simply consequences of small-number statistics. It does mention that among the 46 000 participants in one or more of five test series only 46 leukemia deaths were observed among participants in tests other than Smoky, although 52.4 were expected.

In this short letter it is impossible to document all the examples of selective or erroneous reporting in the BEIR V report. If one believes that "exposure to any amount of radiation may carry some risk of harm," as Upton writes in his PHYSICS TODAY article, one may be influenced to neglect data inconsistent with this philosophy. Perhaps one should be reminded of an earlier statement about radiation protection philosophy by the National Council on Radiation Protection:[11]

> The indications of a significant dose rate influence on radiation effects would make completely inappropriate the current practice of summing of doses at all levels of dose and dose rate in the form of total person-rem for purposes of calculating risks to the population on the basis of extrapolation of risk estimates derived from data at high doses and dose rates.... Undue concern, as well as carelessness with regard to radiation hazards, is considered detrimental to the public interest.

The scientific question of major importance is whether the radiation currently being received by radiation workers, airline crews, nuclear medicine patients and others exposed at low dose rates is harmful. This question will not be answered by overattention to the survivors of the atom bombings, who received instantaneous exposures, but rather by studies of large groups of people who received moderately high doses at low dose rates, such as the ^{131}I patients who were virtually ignored by the BEIR V report.

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UPTON REPLIES: Rosalyn Yalow faults the BEIR V committee's review of the study by Lars-Erik Holm and colleagues[1] for failing to note that the risks of thyroid cancer were higher in patients who had been given diagnostic doses of iodine-131 because they were suspected to have thyroid tumors than in those who had been given the radionuclide for other diagnostic purposes. The criticism is unfounded. In its discussion of these patients, the committee stated: "Sixty-eight percent of the cancers occurred among [the] 31% of the subjects who had received a diagnostic dose of ^{131}I because of suspected thyroid cancer. Of these 34 cases, 15 cancers (44%) became clinically apparent 5–9 years after exposure, suggesting that they were occult at the time of the ^{131}I diagnostic procedure. In summary, the results of these studies do not support the conclusion that diagnostic doses of ^{131}I significantly increase the risk of thyroid cancer."

Yalow also criticizes the BEIR V committee for not citing the 1968 report by Eugene L. Saenger and colleagues,[2] who observed no excess of leukemia in patients treated with iodine-131 for hyperthyroidism. The BEIR V committee was charged with updating rather than duplicating earlier reviews and was asked not to attempt an inclusive summary of the entire literature. The Saenger study had been discussed by the BEIR I committee in its 1972 report.[3] Moreover, the BEIR I report pointed out that the Saenger study "did not have the power to detect an increase in acute leukemia of 1–2 cases per 10^6 per rad, independent of underlying risk."

Yalow's criticism of the BEIR V committee's review of studies on the occurrence of cancer among participants in nuclear tests overlooks the committee's conclusion that "the most likely explanation is that the observed excess cases of leukemia are random overestimates of the risk coefficients." Thus Yalow's assertion that the report should have noted the possibility that the excesses "were simply consequences of small-number statistics" is unjustified.

Finally, Yalow's implications to the contrary, the BEIR V report states explicitly that accumulation of a given dose of low-linear-energy-transfer radiation over a period of weeks or months, as opposed to minutes or hours, can be expected to reduce the resulting risk "appreciably, possibly by a factor of 2 or more," and that "there may be no risks from exposures comparable to natural background irradiation." Furthermore, the report explains in detail the rationale for the committee's risk estimates and the attendant uncertainties. The use of nonthreshold dose–response models for mutagenic and carcinogenic effects of radiation is not unique to the BEIR V risk assessment but has been general practice throughout the world for many years.[3,4]

In summary, therefore, Yalow's criticisms are unwarranted and perplexing.

I should add that I have discovered, to my distress, that I made an error in my August article. In the last column of the first row of table 4, the number should be 4, not 17; that is, the 790 deaths from cancer projected to result from a single, brief exposure of 100 000 people to 0.1 sievert constitute approximately 4% of the roughly 20 000 cancer deaths from other causes that would be expected to occur "naturally" in the same population within its lifetime.

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Nuclear Regulation and Public Perception

John H. Gibbons and Peter D. Blair state in their article "US Energy Transition: On Getting from Here to There" (July, page 22) that in addition to the cost of nuclear power relative to other alternatives, "three major obstacles stand in the way of a new generation of nuclear power plants in the US: slow licensing procedures; sluggish commercial development, along with a notable lack of acceptance of advanced reactor designs by industry, government and the public; [and] stalled decisions relating to nuclear waste disposal." I suggest there is another obstacle.

First, however, I disagree with the statement that slow licensing procedures are one of the obstacles to the new generation of nuclear power plants. In 1989 the US Nuclear Regulatory Commission (of which I am a commissioner) issued its new Part 52 rule, "Early Site Permit; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants." The new standard reactor design certification process is similar in concept to the Federal Aviation Administration's airframe design certification procedure and differs significantly from the commission's earlier, Part 50 licensing process. In place of the two-step Part 50 process, the Part 52 rule adopts a one-step licensing process that results in the issuance of a