LIVERMORE: LAWRENCE RADIATION LABORATORY
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December 6, 1965

MEMO

TO: Charles L. Dunham, M.D., Director
Division of Biology and Medicine
U.S. Atomic Energy Commission
Washington, D. C.

FROM: John Gofman and Arthur Tamplin
University of California
Lawrence Radiation Laboratory
Livermore, California

SUBJECT: The Problem of Potential Thyroid Pathology in Washington County, Utah

Dear Chuck:

As you are, of course, well aware, we have been deeply interested in learning all we can relevant to the issues of dosimetry from weapons tests and possible effects of any doses of radiation that may be received.

Recently, as a result of the U.S.P.H.S. announcement of the thyroid nodule study in St. George, Utah and Safford, Arizona, the director of L.R.L., Dr. May, requested that we brief the laboratory directors on this entire problem and express some opinion concerning the final likely outcome of studies in St. George, Utah. One of us (Arthur Tamplin) had already been engaged in efforts concerning thyroid dosages from weapons tests, a full report of which will be sent to you in the early future(1). The other of us (John Gofman) reported to the directors that it was quite likely that the Utah situation will look worse before it ever gets to look better.

Dr. May was quite disturbed to hear that there existed a possibility that the worst news might yet be ahead of us and discussed some of our estimates with Chairman Seaborg. Dr. Seaborg, in turn, requested that Dr. May get us to

send you the basis for our concern and send him a copy of such material. This is the background for this memo to you.

We have noted that numerous references in the press and in other media have indicated that government officials lean in the direction of being critical of the Utah-Arizona studies and in the direction of finding numerous possible answers for the observations, alternative to radioiodine.

We prefer to view the entire question in a wholly different manner, disregarding, for the moment, the details of the current U.S.P.H.S. studies, and focussing attention upon 3 questions:

(a) What dose of radiation was delivered to thyroids of children in St. George, Utah?

(b) At such dosage, is cancer of the thyroid to be expected in any appreciable number of children?

(c) If cancer of the thyroid is to be expected, will it be possible to conduct unequivocal studies to demonstrate that cancer of the thyroid is or is not occurring there and that the findings are or are not related to radioiodine ingestion?

(a) What Dose of Radiation was Delivered to Thyroids of Children in St. George, Utah?

Directly, of course, we shall never know, since no thyroid or milk I^{131} measurements were made in the 1951 through 1955 period, when the probable exposure occurred. However, the possibility for reconstructing the dosimetry to individuals seem to be as good as was the case for

for Hiroshima, although clearly the uncertainties involved are of a very different nature.

It appears that children in St. George, Utah during 1953, and between the ages of 0-5 years, drinking a liter of fresh milk per day, must have accumulated a most probable dose of 1200 rads to their thyroids from radioiodine. The uncertainty in the estimate is not likely to be more than a factor of 2. The basis for this estimate is given in the attached pages, excerpted from the forthcoming report referenced above (1).

(b) At such dosage, is Cancer of the Thyroid to be expected in any appreciable number of children in the St. George area?

At present, the only evidence in humans concerning radiation induction of thyroid cancer arises

(a) from several studies of x-irradiated children

(b) from the study of the Rongelapese exposed to fallout. Unfortunately, the Rongelapese data are obscured by the fact that the exposure was a mixture of internal radioiodine exposure plus external total body irradiation.

(c) the relatively few cases reported concerning hyperthyroid children treated with radioiodine.

The x-irradiated children (group a) are by no means representative of the population-at-large, nor of the children in St. George, Utah. Further, tissues other than thyroid were in the radiation field. Lastly, the rate of exposure by x-rays was different from that for radioiodine deposited in the gland.

The hyperthyroid children (group c) are clearly non-representative, already having known thyroid pathology. Furthermore, the dosages are much higher than those relevant for St. George.

It would seem that the x-ray data, (group b) inadequate as they are, represent our best guide at this stage. You are, of course, familiar with the final estimate of the U.N.S.C.E.A.R.(2), placing the risk at between 0.5 and 1.5 cases/10^6/year/Rad, with the risk operating over 15 to 20 years, for doses in the range of 100-300 Rads. The Federal Radiation Council has not seen fit to argue this estimate.

The middle point of the x-ray data leads to an estimate of a lifetime incidence of about 15 cases of thyroid cancer per 10^6 exposed children per rad to the thyroid, for the 100-300 rad exposure range. Our problem this time is not over extrapolating to low doses, but rather extrapolating to high doses.

We are mindful of the Dolphin and Beach(3) suggestion that x-rays may be 10 times as effective as I^{131} in carcinogenic power. Considering the dependence upon data in the rat and the tenuous nature of their arguments, we don't believe that this suggestion offers a reliable basis for reducing our estimate of the likely outcome in Utah.

Therefore, assuming x-rays and I^{131} to be equally carcinogenic per rad absorbed, we have

Expected incidence of thyroid cancer at St. George

$$= (\text{Risk}) \times (\text{Dose}) \times (\text{No. Exposed})$$
$$= \frac{15}{10^6} \times 1200 \times 2000$$
$$= 36 \text{ expected cases of thyroid cancer}$$

While we hope this estimate is too high, as realists, we will not be surprised if it is just right or even if it is low by a factor or two.

(c) If Cancer of the Thyroid is to be expected, will it be possible to conduct unequivocal studies to demonstrate that cancer of the thyroid is or is not occurring and that it is or is not related to radioiodine ingestion?

How perfectly the present study is being carried out, or how accurately the findings will be reported by the current investigators is really not the most relevant issue. Least profitable would be debates concerning what ultimately will be minor epidemiologic issues.

The point we are making is that options are available to ascertain the truth unequivocally. Two such study options are the following:

(1) Determine the incidence of thyroid nodules in the parents of all children in St. George, Utah. This incidence should then be compared with that in the children. Since the thyroid gland of the parents should have been 10 times larger at the exposure time than that of the 0-5 year old children, the dosage to the parents' thyroids should have been 1/10 as large. If the children

show a higher incidence than their parents now, it will indeed be difficult to blame heredity, geography, climate, iodine supply, etc. If the children show the same or a lower incidence than the parents, it might be argued that the parents have had a longer period in which to develop nodules, and that, at a comparable age, the incidence in the children will possibly exceed that in the parents. Therefore, a second study is also suggested.

(2) Based upon the dosimetry estimated to be detailed in(1), it appears that

Children, 0-5 years of age in 1953 in Salt Lake City, Utah received of the order of 100 rads or less than 1/10 the St. George dosage;

Children, 0-5 years of age in 1953 in Albuquerque, N. M. received half the Salt Lake City dosage;

Children, 0-5 years of age in 1953 in Safford, Arizona or Los Angeles, California received less than 1/10 the Salt Lake City dosage.

Therefore, the incidence ratio for children to parents now for these additional communities should be compared with the ratio for St. George, Utah. In view of the very large range of estimated dosage thus encompassed, a dose-effect relationship operating on this incidence ratio will probably not be equivocal.

Of course, such studies will only refer to thyroid nodules. Resolution of the implication with respect to cancer requires biopsy, time, or both.

References:

(1) Tamplin, A. and Fisher, L. Estimation of Dosage Delivered to Thyroids of Children for Nuclear Device Tests in Nevada during the Years 1952 through 1955 (Tumbler-Snapper, Upshot-Knothole, and Teapot Series) UCRL In Print

(2) Report of the United Nations Scientific Committee on the Effects of Atomic Radiation. III. Thyroid Neoplasms, p 91693. Also Table XVI. "Thyroid Cancer Following Therapeutic Irradiation" p 105, General Assembly. Official Records: Nineteenth Session, Supp. No. 14 (A/5814) 1964

(3) Dolphin, G. W. and Beach, S. A. "The Relationship between radiation dose delivered to the thyroids of children and the subsequent development of malignant tumors." Health Physics 9, 1385-1390, 1963.

copies to:

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