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CONFERENCE AT DIVISION OF BIOLOGICAL AND MEDICAL RESEARCH, ARGONNE NATIONAL LABORATORY, ON THE EPIDEMIOLOGY OF THE RADIUM WATER PROBLEM - AUGUST 26, 1959

SYMBOL: BMM:HDB

I first introduced Drs. Rodney R. Beard, John Rizzolo, and Thomas Francis, Jr. of the Armed Forces Epidemiological Board to the group and set the scene by sketching the situation according to the following outline:

1. Introduction: Reasons for this conference in very general terms.

2. Sources of pressures for this study: Internal and external.

3. Reasons for emphasis on the epidemiology of the problem.

4. Data which comprise the skeleton of the problem.

   a. Ra^{226} in Galesville sandstone aquifer ($\sim$1 to 40 x 10^{12} c/l) while surface waters are $\sim 10^{-14}$ c/l.

   b. Drinking this water increases Ra^{226} content in man as proved by radon breath determinations.

   c. Expected effects of chronic osteal radiation.

      1. osteogenic sarcoma
      2. carcinoma
      3. leukemias
      4. chronic microscopic and/or radiologic bone damage

   d. Difficulties encountered thus far.

      1. retrospective procedures
      2. low incidence of effects
      3. selection of control population
      4. irregularities in sources of data

   e. Epidemiological techniques perhaps not yet adequately developed.

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Dr. Brues emphasized the problems of low-level effects and the size of effort required. There was the possibility that these studies would lead to data for computing "safe levels".

Dr. Beard asked to be reassured that the problem was radiation, not chemical toxicity. The evidence offered was negative and eliminative in type rather than direct and positive.

Dr. Rose then described how they happened to begin work on the problem, namely, the verification of the MPL for Ra^{226} for the Handbook. He then described the fact that there are several means of measuring Ra^{226} in man, water, and bone. He claims that 10^{-9}c is the limit for whole body counter detection in man. He described in a general way the difficulties of measuring accurately the levels of Ra^{226} and Ra^{228}, the isotopes of interest, since they behave like Ca^{++} and are absorbed from the gut and go to the bone.

Dr. Lucas then described the detection and measurement of Ra^{226} in well waters and the significance of this as a source of Ra^{226} for people. The aquiferous snadstones run from 4 to about 40 uug/liter--the 100 uug being the limit for 168-hour occupational exposure. The range of concentrations is due in part to the fact that well walls are not sealed and water comes in from all strata through which the well is bored.

Because the larger cities need more water, they have to bore into deeper strata which have lower Ra^{226} contents; the highest levels are found in the sandstone strata just below the capping layers. Also, when a city grows above 3000 or so, it drills deeper and hence its water changes to a lower Ra^{226} content, but more Fe^{+++}, NaCl, etc. They have not really looked for correlation of Ra^{226} with the other elements present in the water. They have run a number of single samples of water but have not done much in the way of repeated samples or spread out into other states. It looks as if the water samples were taken on the basis of convenience rather than a systematic plan. Their method of collecting these data leaves something to be desired as it is done by mail with a questionnaire.

The samples are analyzed by separating off the Rn^{222} and determining this by scintillation counter. They can do about 1000 water analyses per technician per year, but have actually only about 500 water analyses. They have done only 25 Ra^{228} analyses and about half have enough Ra^{228} to be important, but its occurrence is not predictable. Since Ra^{228} dosage per unit is greater than that of Ra^{226}, this lack of Ra^{228} analyses makes the simple Ra^{226} data equivocal. It is true, however, that Ra^{228} is not found in the absence of Ra^{226}, but because only 25 samples have been analyzed, I feel it is unwise for them to generalize on the <u>total</u> radiation dose to bone.

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Dr. Stehney eliminated all methods of analyses for accurate total body burden of Ra^{226} except the Rn^{222} method for burdens which would result from ingestion of these waters.

In order of increasing unreliability of computation:

1. Ra^{226} in whole body ash, portions from cadavers, biopsy material, or amputated parts.

2. Whole body Rn breath samples.

3. Bone samples)
4. Tooth samples) We do not have factors to compute total body data from these.

5. Rate of intake of Ra^{226}--compute total from the equilibrium data.

6. Content of Ra^{226} in food and water as measured, assuming in addition the rates of ingestion.

(Whole body counting is not good for this purpose as they claim that 10^{-9}c is the threshold for detection.)

Obviously they prefer the method utilizing the Rn^{222} breath sample technique using the 70% excretion figure and Rn-free air for breathing-collection. They have been trying to work up correlations between these various methods of estimating body burden.

In general, the people drinking these waters at 10 uuc/liter have total body contents of the order of 3.5×10^{-10} curies of Ra^{226} compared to 0.1 to 0.5 x 10^{-10} (maybe up to 1.0 x 10^{-10}) for other people drinking 1 uuc/liter water. Water seems to be the major source of Ra^{226} for the Illinois population.

Dr. Asher Finkel discussed the problems of bone collection. He emphasized that a physician is needed who can speak as a colleague to medical societies, etc., but most important to make personal visits to the pathologists of hospitals in the interesting areas; personal contacts are the key. Still he does have troubles in collection, and he described some of his problems, one of which is securing a large enough sample, as 10 grams of bone is the least amount which is useful for analysis.

By cooperation with the AFIP and the Mayo Clinic, samples of bone tumor are being analyzed in comparison with the nearby normal bone; apparently they are not doing autoradiography.

Dr. Brues discussed the problem from the standpoint of a continuum of dosages from Ra or Th deposited under different conditions, and with relation to problems of threshold and linearity or non-linearity of the dose-effect curves.

Dr. Hasterlik described the human high-level materials available for study. Included were the 44 patients in the Elgin State Hospital who had received Ra^{226} for therapy or who were dial painters. He has gone out searching for people, especially those with low body burdens who don't get into clinical trouble and hence do not come to anyone's attention; he thinks there may be some thousands of such people. He has now some 120 people with burdens of 0.1 uc or less; his total roster is about 163. The chief effects seen are aseptic necrosis and reabsorption of weight-bearing bones, coarse trabecular patterns, and thickening of the cortex of the femur. He has seen minimal bone lesions at 0.001 uc, and definite changes at 0.01 to 0.049 uc. Malignancies have shown at the 0.5 to 0.99 uc level. Bone tumors have the highest incidence in the northeastern states and lowest in the western states. The osteogenic tumors run about 50% in most surveys, Ewing's are 5 to 30%, multiple myelomas are 2 to 50% (the wide variation is due to classification--bone or leukemia?), and Paget's disease makes up almost all the rest. Osteogenic tumors are more common in males than females, about 5 to 1, and the femur is the most frequent bone.

Dr. Auerbach described his efforts to get the bone tumor data from Illinois corrected for accuracy and classified as to bone diseases, race and sex. The artifacts in these records are so large as to destroy one's confidence in death certificates; some differences are based on the criteria of disease as used for registration purposes since the nosology may change every 10 years. (In 1940 the new nosology reduced the bone tumor rate from 2.3×10^{-5} to 1.2×10^{-5} overnight!)

Inclusion of jawbone tumors makes the rates very irregular and causes divergence of the male and female rates. Many, if not nearly all, of these are due to extension or metastases of tumors originating elsewhere. Also, "jawbone tumor" frequently means a tumor of the "area of the jaw." He feels that true bone tumors make up only about 40-60% of the total reported as "bone tumor." Working with the National Office of Vital Statistics (Department of HEW), he plans to study the variations in Illinois hospital diagnoses by pathologists. It seems clear that Auerbach is more interested in why death certificates are what they are rather than the Ra-bone problem per se.

The data do not allow one to identify the location of differential rates of bone tumor incidences during the past 11 years. That they have to go back and correct for the uncertainties of the death certificate data is only one of the major headaches. Thus, there is no

correlation of high levels in well water with high bone tumor areas on a county or other political unit basis. (Note that there has also been a shift in the composition of the water supply composition as some towns enlarged. Dr. Auerbach also uses years at risk to multiply incidence rates in order to get conveniently large numbers for statistical purposes; but because his years at risk are arbitrary, starting from 1940, he must assume stability and a large enough population to give an average age-of-death rate distribution.

Dr. Auerbach discussed the difficulty of applying statistical tests to data of this kind where the natural rate of incidence was so very low. He felt, however, that the population was large enough to overcome this defect.

Then I shifted the line of thought by suggesting that we should examine contaminated persons for radiological changes and histological changes and relate these to the Ra^{226} water consumption, that a bone tumor was not the best end point.

Teeth from Joliet and Chicago are being analyzed for Ra^{226} to see whether they will be of any use for screening purposes. So far they don't seem to be of value, but they may be.

Dr. Francis suggested fertility, abortions, miscarriages, or congenital abnormalities (Gentry) might be a more useful end point.

The group eliminated length of life and leukemia as end points for the Ra water effects. (The radiation from the Ra^{226} in the Rockport boys gives about 30 mrad to the bone, in addition to the 120 mrem from all other sources--90 mr from cosmic and earth radiation; 25 mr from internal K^{40}; and 6 mr from C^{14}.)

Finally, after much discussion it was agreed that the technical aspects of the radiometric procedures were well developed, but that the epidemiological (demographic) aspects of the problem needed assistance and clarification. Dr. Francis, with the assistance of Drs. Beard and Rizzolo, indicated that they will try to come up with a statement as to the feasibility of carrying out the necessary epidemiological procedures to complement the radiological measurements. They will forward this by letter to us.

On the whole it appears that things went relatively smoothly, although everyone seemed to sense the undercurrent of question about the future of the existing ANL programs. Drs. Rose and Lucas continued to express the attitude that they knew all there was to know about the problem and were not receptive to questions and comments. Drs. Brues and Auerbach were more receptive but clearly intended to pursue their own interests. Drs. Finkel and Hasterlik presented a very convincing picture of the effects in people with burdens of 0.001 to 1.0 uc of Ra^{226}.

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A curious fact which came out was that Auerbach in developing the incidence of bone cancer by county had not correlated these data with the different levels of radioactivity in the water samples.

Dr. Francis gave him a hit of a hard time for using the highly artificial county boundaries instead of a grouping meaningful to the needs of the study. This is an example of the disconnected piece of work which cropped up several times. It is the sort of oversight that would not have happened had a single person been responsible for the direction of all phases of research on this problem.

I can't really say that the total presentation was something to be proud of, but if looked on as preliminary data it is not too bad. It at least is sufficient to allow one to plan the final big experiment in a reliable way.