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RADIATION ENVIRONMENT PARAMETERS AND THE BIOPHYSICIST

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In this conference it was planned that you, the health physicist, would hear papers summarizing our current knowledge of the biological effects of radiation. By now you should know some of our problems; there has been much talk about dose, dose rate, dose distribution, LET distribution, oxygen effect, strain differences, and so on. There have been discussions about the physical aspects of the dose distribution, FLET, slowing-down flux, macro- and micro-dosimetry, dosimetry at an interface. By now you may be asking yourself the question, "How does this affect me, the health physicist?"

I feel that you, who are in charge of the measurement of the radiation environment, have the responsibility for furnishing the biophysicist with the dosimetric information he needs to evaluate the effects of various exposures to accelerator-produced radiation.

Today there are probably only three things that a biophysicist will want to know about the dosimetric features of an exposure:[1] (a) the absorbed dose at all points of interest, (b) the time distribution of the dose, and (c) the variation on a microscopic scale of the local energy density. Other information is very useful, regardless of the details with which these fundamental dosimetric data are given; this would include the type or types of radiation emitted by the source, the relative intensity of each type, their energy distributions, any filtration or moderation, the effective size of the source, the distance between the source and the irradiated object, and the angular distribution of the radiations. I don't think a biophysicist would ask for more today, but several years from now the questions a biophysicist would ask may be different. Then the questions might be, what was the momentum transfer? or the dose at a bone—bone-marrow interface, or the FLET distribution, using either a sliding cutoff or a fixed cutoff energy?

I think that the point Dr. Madey was trying to make is that at this time we cannot become fixed in our thinking about the cutoff energy for a delta ray. There are not enough biologic data available to say what should be used. There probably are different cutoffs for different biologic effects, and there may be different cutoffs for ions having different velocities, but we may not know until after much more work.

So what should you measure? My answer is that anything you measure, if you do it accurately, will probably be of help. But the most useful measurements will be those from which you can derive the other quantities of interest.

*This work was done under auspices of the U. S. Atomic Energy Commission.

I think you should measure the basic physical parameters. These would be the type of radiation, the flux of each radiation, the effective source size, the angular distribution of the radiation, the energy distribution of the radiation, the distance from the effective source to the object being irradiated, certain parameters that would specify the object being irradiated, any intervening filtration or moderation, and appropriate time factors. These are the measurements which I think are the most useful, and from these basic physical exposure parameters the information desired by the biophysicist could be calculated.

The radiotherapist has access to computer programs which enable him to obtain depth dose distribution from rather complicated limited-field exposure by cobalt-60 sources.[2] These same programs have been modified to calculate dose distributions from electron accelerators. These programs even account for macroscopic inhomogeneities in tissue density. There are programs for calculating range and dE/dx for heavy charged particles,[3] and programs for calculating the dose due to the transport of nucleons through matter.[4]

When you consider the magnitude of the responsibility that has been entrusted to you it does not seem such a large problem to put these programs together so that any of the dosimetric features of an exposure that a biophysicist might want would be available. With this approach it would be easy to include RBE values for estimate of exposure, or QF values to estimate the hazard of a particular environment, or to include inactivation or malfunction cross sections for the appropriate cells in different parts of the body and to also calculate fractional cell lethality.

Now if a computer program were assembled so that when you supplied information about the radiation environment the computer could calculate the dosimetric features of the exposure, then your problem would be supplying the necessary radiation environment parameters. I think the input to such a program, if it were to be a general program, would be:

- The types of radiations
- For each type, the angular distribution and the energy distribution
- The effective source size
- The distance from the effective source to the object of interest
- Any filtration or moderation of the radiations occurring between the effective source and the object of interest
- Parameters that would specify the object of interest
- Appropriate time factors.

The final decision as to what measurements are to be made is yours, but remember to think about the future. The quantities of interest tomorrow may be different from what they are today, but if you have made the right measurements, you should be able to calculate all the desired quantities.

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