

THE RESPONSIBILITIES OF THE MEDICAL PROFESSION IN THE USE OF X RAYS AND OTHER IONIZING RADIATION*

I. Introduction

1. The United Nations General Assembly, being aware of the problems in public health that are created by the developments of atomic energy, established a Scientific Committee on the Effects of Atomic Radiation. This Committee has considered that one of its most urgent tasks was to collect as much information as possible on the amount of radiation to which man is exposed today, and on the effects of this radiation. Since it has become evident that radiation due to diagnostic radiology and to radiotherapy constitutes a substantial proportion of the total radiation received by the human race, the Committee considers it desirable to draw attention to information that has been obtained on this subject.

2. Modern medicine has contributed to the control of many diseases and has substantially prolonged the span of human life. These results have depended in part on the use of radiation in the detection, diagnosis, and treatment of disease. There are, however, few examples of scientific progress that are not attended by some disadvantages, however slight. It is desirable therefore to review objectively the possible present or future consequences of increased irradiation of populations which result from these medical applications of radiation.

II. General Survey of the Irradiation of Human Beings

3. Man has always been exposed to some irradiation from natural sources. To this has now been added, as a result of modern discoveries and the applications of ionizing radiation and radioactivity, certain forms of artificial irradiation.

4. Natural irradiation is due to (1) cosmic radiation; (2) "background" gamma radiation from radioactive substances present locally in the earth, rock, or building materials, and from disintegration products of radon in air; (3) radiations emitted from natural radioelements such as potassium

40, radium, radon, and carbon 14, which are incorporated in the body.

5. The amount of this natural radiation varies with locality, but has been estimated as usually delivering between 70 and 170 mrems per year to the gonads. Of this total, the majority contributions are of about 45% from local gamma radiations, 30% from cosmic rays, and 20% from body potassium 40. These figures are based on reports sent by India, Sweden, the United Kingdom, and the United States of America.

6. Artificial irradiation is derived from (1) the contamination of the environment, the atmosphere, or water by radioactive waste from atomic industries or from users of radioelements; (2) the radioactive fall-out, at greater or lesser distances from the source, of radioactivity resulting from the explosion of nuclear devices; (3) the occupational exposure of certain groups of workers—medical practitioners, radiologists, dentists, nurses, atomic energy workers, uranium or thorium miners, and the industrial or scientific users of radiation generators or radioactive isotopes; (4) the medical use of x rays, other ionizing radiations and radioelements in the detection, diagnosis, investigation, and treatment of human diseases; (5) the use of certain devices which emit radiation, such as television receivers, watches with luminous dials, and the x-ray generators used for the purpose of fitting shoes.

7. The amount of artificial radiation must vary considerably in different countries and we have inadequate information on the overall significance of these factors. In certain countries where estimates have been made, it appears that the greatest gonad irradiation of the population is due to diagnostic radiological procedures, the amount from this source about equalling that from all natural sources in certain instances. The total present contribution from occupational exposure, from the products of atomic industries, from radiotherapy, and from the radiating devices mentioned above (paragraph 6, sub-paragraph 5) is likely to be very considerably smaller. That from radioactive fall-out to the gonads appears at present to be in the region of 1% of the natural gonad irradiation in most areas, according

* Submitted for publication in January, 1957, by the United Nations Scientific Committee on the Effects of Atomic Radiation.

to the reports sent by the United Kingdom and the United States of America.

8. Both the magnitude and the significance of these various sources are under review by the Committee. Since medical irradiation accounts for a substantial if not the major proportion of all artificial exposure, it is important that its magnitude should be known accurately for different countries and circumstances. The possibility of making such an assessment depends upon the help of the medical profession, and particularly on the adequacy and availability of records kept by doctors, dentists, and organizations responsible for the use of ionizing radiation.

III. Radiation Hazards

9. The medical use of radiation is clearly of the utmost value in the prevention, diagnosis, investigation, and treatment of human disease, but the possible effects of this irradiation of individuals require examination.

10. Generally speaking, the irradiation of living beings may produce radiobiological effects either on the irradiated individual himself or, through him, on his descendants, the former being termed somatic and the latter genetic effects. Somatic effects vary according to the different organs or tissues affected, and range from slight and reversible disturbances such as cutaneous erythema to the induction of leukaemia or of other malignant diseases. The possible reversibility of the somatic effects of radiation received in small doses or at low dose encourages the belief that there are permissible doses of radiation which will not cause completely irreversible or significant somatic damage. The threshold for occasional somatic damage may, however, prove to be low. In the case of genetic effects on the other hand there may be no threshold. These effects increase with a frequency corresponding to the total amount of radiation received by the germinal tissues, and, in the great majority of cases, are adverse.

11. Many other factors complicate the interpretation of radiobiological effects. The differences between whole and partial body radiation, between a single exposure and continuous irradiation, or between the effects of different types of radiation are still imperfectly understood. Biological differences in the radiosensitivity of various tissues, or of the tissues of people of different age or sex, obviously influence the nature of radiation hazards. It is clear, however, that any radiation of gonads, and any substantial irradiation of other tissues, involves a chance of significant damage which requires assessment.

IV. General Recommendations Regarding the Medical and Occupational Irradiation of Human Beings

12. The radiological profession, through the International Commission on Radiological Protection (1954), has undertaken a valuable and responsible duty in defining maximum permissible limits of exposure for the main radiation hazards.

13. The establishment of these maximum permissible levels for those who are occupationally exposed to radiation depends on the view that there are doses which, in the light of our present knowledge, do not cause detectable somatic injury in the individual irradiated; and on the consideration that the number of individuals concerned is small enough for the genetic effects on the whole population to be negligible. For the gonads, or for irradiation of the whole body, the levels are such as to exclude doses greater than 0.3 rem in any week or 3.0 rem in any 13 weeks, or a sustained irradiation rate greater than 5 rem per year. These values imply that no total dose of over 50 rem will have been received by the gonads by the age of 30, or of over 200 rem by the whole body by the age of 60, in any occupationally exposed person (International Commission on Radiological Protection, 1954).

As regards irradiation of the whole population, it is considered prudent to limit the average dose to germinal tissues from artificial sources to the order of magnitude of that received from all natural sources.

14. In considering the extent to which the population is irradiated for medical purposes, it is essentially the genetic hazard which is involved although it seems possible that in certain circumstances somatic injury may occur occasionally after low doses of radiation. Otherwise, the relevant dose is that indicating the mean gonad irradiation among the population as a whole up to the end of the average reproductive period.

15. The extent of such genetic irradiation from diagnostic procedures has been found to be equal to at least 100% of all natural radiation in Sweden and the United States of America and that from the United Kingdom equalled at least 22% of this figure. Even before obtaining more exact values for these and other countries, it is clear that the exposure can be substantial in countries with extensive medical facilities, and that it is essential to consider any ways in which this exposure could be reduced without detriment to the existing or developing value of medical radiology.

16. The Committee is therefore anxious to obtain the help of radiologists in suggesting through appropriate governmental channels any methods by which this total exposure could be reduced and in

estimating the amount of reduction that might be expected from any such methods. In particular it would be valuable to know how much the radiation to the gonads could be reduced (*a*) by improved design or shielding of equipment; (*b*) by fuller training of any individuals using radiographic or fluoroscopic equipment; (*c*) by any local shielding of the gonads that is practicable, especially during abdominal or pelvic examination; (*d*) by the use of techniques involving radiography rather than fluoroscopy when full information can be obtained by this means; (*e*) by improvement of administrative arrangements designed to obviate unnecessary repetition of identical examinations of the same subject; (*f*) by a general study of certain medical conditions such as that of peptic ulcers, to identify the circumstances in which the establishment of a radiological diagnosis has or has not a definite influence upon the treatment or prognosis given.

Summary

1. The Scientific Committee on the Effects of Atomic Radiation established by the United Nations General Assembly accepts the view that the irradiation of human beings, and especially of their germinal tissue, has certain undesirable effects.

2. Information received so far indicates that, in certain countries (Sweden, United Kingdom, United States of America), by far the most important artificial source of such irradiation is the use of radiological methods of diagnosis and that this may be equal in importance to radiation from all natural sources. It is possible that such radiation may be having a significant genetic effect on the population as a whole.

3. The Committee is fully aware of the importance and value of the medical use of radiations but wishes to draw the attention of the medical profession to these facts and to the need for a more accurate estimate of the amount of exposure from this source. The help of the medical profession would be most valuable to make it possible to obtain fuller information on this subject.

4. The Committee would be particularly grateful for information through appropriate governmental channels on ways in which the medical irradiation of the population can be reduced without diminishing the true value of radiology in diagnosis or treatment.

REFERENCE

Recommendations of the International Commission on Radiological Protection (*Brit. J. Radiol.*, Suppl. No. 6), 1955.