

IONIZING RADIATION RECORDS FOR INDIVIDUALS

C. Sharp Cook
Department of Physics
University of Texas at El Paso
El Paso, Texas 79968

Abstract

Even though many people have expressed alarm over possible effects of the ever-increasing amounts of ionizing radiations in our environment, no records exist from which the cumulative dose for any individual adult in the United States can be tabulated. Rather than stop the construction of new nuclear power stations and limit the use of other radiation sources, such as for medical purposes, simply because we are not sure of the effects, it is time that we determine the nature and magnitude of the effects in such a way that they can be correlated with accurate measurements of radiation dose. Suggestions are made as to how a record-keeping system can be established, without undue involvement of the general populace and with a minimum of monetary cost.

Ionizing Radiation and Public Concern

During the 20th century the magnitude of our ionizing radiation environment has increased slowly but steadily. The primary factors contributing to this increase have been commercial use of radionuclides, use of nuclear fission for nuclear weapons and for nuclear power, and an increased use of medical and dental radiology¹.

Gross effects of ionizing radiations are well known and, based on these gross effects, standards have been developed limiting the dose an individual should receive². However, some people have concluded that adverse effects may also ensue from very small doses³. For example, Stewart has found⁴ that relatively small doses delivered to the fetus may induce an excess cancer risk during the first ten years of life. Gaulden⁵ has pointed out that chromosomal changes, especially in the fetus, may be induced by small amounts of ionizing radiation. A positive correlation has been found by Mole⁶ between incidence of cancer in uranium miners and relatively small doses of ionizing radiation. These specific studies cover a very limited portion of the general population. Other studies, which appear to be based on insufficient data, have created controversy over the relevance of their findings^{7,8}. Determination of the cause of selected biological effects and whether ionizing radiations have a role in the production of these effects is difficult because of the large number of variables that must be considered.

As long as controversy exists, public concern is justified. This concern has appeared for example as opposition to nuclear power plants, a sometimes emotional issue that leads to extensive hearings, delays and conflict, such as those associated with the application of the Long Island Lighting Company to build a nuclear power station at Shoreham, New York⁹. Concern over fallout radiation and its effects was a primary factor that led to a moratorium on

atmospheric testing of nuclear weapons, moreso than a concern about the tremendous destructive power or the havoc these weapons would cause if used in a combat situation.

Record Keeping As It Exists Today

Despite public concern, no adult in the United States really knows the magnitude of the total dose he has accumulated from exposure to ionizing radiation. Part of the reason for this lack of data is the complexity of the situation. However, another relevant factor is an apathy toward proper record keeping and sometimes outright opposition. Many reasons are cited for this inaction but the end result is always an unknown factor that allows scientists to argue indefinitely over the effects of ionizing radiations. The same or similar problems exist in other parts of the world. However, since the information I am using comes primarily from U.S. sources, I shall limit my suggestions to those applicable to the United States. I believe many other parts of the world can use them with little or no modification.

Some ionizing radiation exposures are actually excluded from record-keeping requirements. For example, although regulations of the USAEC mandate record keeping for all persons who receive, possess, use or transfer by-product material, source material or special nuclear material and establish standards for protection against radiation hazards arising from activities under licenses issued by the USAEC¹⁰, these same regulations specifically state that nothing in them "...shall be interpreted as limiting the intentional exposure of patients to radiation for the purpose of medical diagnostics or medical therapy." Although it does not really so state, both the medical profession and record keepers have generally interpreted the quoted statement as meaning that permanent record keeping of ionizing radiation doses received for medical purposes is not necessary. Without this information, complete and permanent records of individual doses is impossible.

Many people apparently do not realize the magnitude of medically produced radiations, largely because of the lack of individual records. However, studies by the Atomic Bomb Casualty Commission¹¹ of people exposed to radiations from the nuclear detonations at Hiroshima and Nagasaki show that they were further exposed between 1946 and 1963 to a cumulative bone-marrow integral dose from medical X-rays comparable to or greater than the dose they received because of radiation from the respective nuclear detonations. These people are among the few and may be the only group of people in the world for whom accurate records of all radiation dose has been kept over a realistically long period of time.

Suggested Procedures

On numerous occasions suggestions have been made that records be kept of all individual radiation doses. Eason and Brooks recently reviewed¹² the history of some suggestions to maintain permanent records of cumulative radiation dose to individuals. They also discussed selected court and review board cases in which compensation was awarded for supposed exposure to ionizing radiation, even though there was no way of knowing the true radiation history of the concerned individuals. Cameron¹³ has even proposed a unit for measurement of medical radiation exposure.

One reason often cited for not requiring permanent record keeping of medical radiations is the psychological effects on the individual if he knows that records are being kept. Another argument has been that the general public will not wear film badges or other radiation measuring devices. In my opinion both arguments evade the basic issues. The wearing of film badges or other personal dosimeters is not required, except for those working in an industry subject to USAEC regulation¹⁰, since almost all exposures of significant magnitude can be

recorded from other available information, maybe even more reliably than from personal dosimetry readings. After discussions with many individuals who can be classified as part of the general public, I have come to the conclusion that record keeping of ionizing radiation doses might produce a greater psychological effect on members of the medical profession than on the general public.

If records are to be kept, a system must be established that allows reasonably good controls and a minimum of bookkeeping and interference with the lifestyle of the individuals involved. To accomplish these goals, ionizing radiations and the methods of measurement need to be divided into three categories, general-area radiations, industrial radiations and medical radiations (including dental).

Background radiations form one type of general-area radiations. Although the magnitudes of these radiations vary from locality to locality, depending both on altitude and the amount of natural radioactivity in the vicinity, they should not fluctuate in any one area, except for effects caused by solar storms on cosmic-ray intensities^{14,15}. Other general-area radiation sources are the airborne radioactivity that has been produced by atmospheric nuclear weapons tests and airborne releases of radioactive material from nuclear power plants. The radionuclides from these and possibly other man-made sources are distributed over the entire earth by atmospheric movements. The radionuclide ^{85}Kr is of especial significance in the gaseous releases of nuclear power plants, since its intensity is expected to build up over the years¹⁶, as more nuclear plants go into operation. Regional records of these radiations can be maintained without requiring the wearing of dosimeters by individuals if central monitoring stations are placed in selected locations, provided appropriate surveys are made of nearby areas, to map expected variations in radiation exposure levels relative to those at the central station. Readings from these monitoring stations would become part of the record for individuals living in the area.

Industrial radiation records need to be kept in much the same manner as they are now. However, they must be maintained throughout the lifetime of each individual, as part of his permanent record. All too often records have not followed individuals when they change employment, making compilation of cumulative dose records impossible. I can cite several specific instances where records have been lost or destroyed.

Record keeping of medical radiology presents a problem of its own. Generally, doses are not uniformly distributed over the body. Also radiation energies vary considerably among different diagnostic and therapeutic sources. For this reason some basic records indicating the size and shape of the radiation field and any variations in radiation energies over this field must be kept for each treatment. Also, the dose to selected regions of the body must be kept as part of the record for each individual. Only in this way can a true correlation ever be made between cumulative effects of ionizing radiations and any subsequent observation of diseases that may be linked to radiation exposure, of the type cited by Eason and Brooks¹² as having been considered in selected court cases. Such records of dose to individual organs of the body should not present as much of a problem as it may at first appear. Doses for radiation therapy are now carefully calculated, generally by computer, to be able to place the maximum dose in the appropriate region of the body. There is no reason why such computerized calculations cannot be made for diagnostic work as well, so that the dose to specific body organs can be recorded for each radiation¹⁷.

Since we currently have no record of cumulative dose for any adult in the United States, the best way to establish a valid record-keeping system is to begin with children who have a known past history of medical radiation, most probably none. The system therefore need not be an elaborate full-scale system

in its initial stages, but can be built up over the years as more and more children's records are added. The system need not necessarily be established everywhere at once. A pilot system could be established in an area covering up to a few states. Such a system could provide enough information within about 10 years or so to allow us to determine its feasibility and to decide how far and how fast it should be expanded. Unless we start somewhere we will continue to argue about the merits of any system and, because of the size of the project, probably never do anything.

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