LETTERS TO THE EDITOR

WHITE PAPER ON LOW-LEVEL RADIATION

Let me start from the source of confusion, from the dilemma between the theory of the existence of a threshold dose, below which radiation is not supposed to be harmful, and the theory that there is no such threshold and that the radiation damage is proportional to the dose, no matter how small. These are diametrically opposed theories, but from the practical point of view there is no difference between them. If we recognize, as all known facts compel us to, that any organism is capable of repairing radiation damages up to a certain limit, it makes no difference whether a low dose of radiation causes no damage as long as it does not surpass a certain threshold, or whether it causes some radiation damage that has been subsequently repaired to the limit of the repair capability of the organism. In other words, it makes no difference whether we say that there is a threshold to radiation damage or that there is a threshold to radiation damage repair. Whether one or the other is valid, a small radiation dose leaves no trace after a certain amount of time.

A consequence of the fact that radiation damage in the organism is repaired is the fact that the damage depends not only on the total dose but also on the dose rate. For small radiation doses the recovery is so quick that no damage can be observed. The important point is that the repair limit is very high, which is the base for all radiation therapy. So, for example, a skin dose of 700 rem will produce a slight reddening of the skin of an average person if it is given in a short time, but will produce no effect at all if administered in fractional amounts during a period of one month. To produce the same skin reddening by intermittent irradiation over a period of one month, the total dose would have to be about three times larger. It is the intermittent radiation that makes possible the administration of high doses, without which the destructive effects on tumors could not be achieved. The good repair capabilities of the organism and the poor repair capabilities of tumors are thus clearly demonstrated. In conclusion, it is obvious that small radiation doses are easily repaired by the organism.

Another contradiction to the idea of damage caused by low-level radiation comes from the law of Begonie and Tribondeau, which states that the sensitivity of different cells to irradiation is directly proportional to their reproductive activity and inversely proportional to their differentiation. Since the entire development of any embryo takes place in some field of background radiation—no place on earth is free from it—low-dose radiation obviously does not interfere with the growth of the embryo even though it consists of rapidly multiplying cells. We do not exclude the fact that background radiation may cause some chromosomal damage which is, however, subsequently repaired, so that no harmful effect is left.

To substantiate the preceding, a few well-established facts are adduced:

1. In the states of Madras and Kerala in India people live on the surface of radioactive mozanite sand and are exposed to doses of 6000 to 15 000 mrem/yr, but they show no more cancers and genetic malformations that do the general population. The same can be said about the people of Guarapari, near Rio de Janeiro, who are exposed to 12 000 mrem/yr.
2. In Denver, Colorado, the background radiation is 250 mrem/yr, while in San Francisco it is only 115 mrem/yr. Yet in San Francisco there are twice as many cancers and genetic malformations per capita as there are in Denver, a clear contradiction of the linear dose-effect relationship.
3. No radiation cancer has ever been observed for doses below 100 rem.
4. Stewardesses on cross-country flights have been exposed to radiation doses of 300 to 400 mrem/yr, yet no cancers or genetic malformations have been noticed.
5. Television sets and wristwatches with luminous dials each give radiation doses of 5 mrem/yr, yet no harm has been noticed in the large number of people receiving these doses.
6. While the mean background radiation dose in the U.S. is 105 mrem/yr, this dose varies from state to state. It is 75 mrem/yr in Texas and Louisiana, and, as mentioned, it is 250 mrem/yr in Colorado, yet no correlation between background radiation and the occurrence of cancers and genetic malformations has been found.

These are key facts that cannot be swept aside to give way to some unwarranted assumptions. But, for the sake of argument, let us disregard these facts. Let us assume the opposite and disprove it. As is well known, all radiation effects have a latency period that is longer the smaller the radiation dose. If, as indicated before, the radiation dose of 100 rem does not produce an effect during the lifetime of an average

person, it is clear that the latency period of low-level radiation will be orders of magnitudes larger than the life span of an average person. This is even more so for the much shorter life spans of the affected cells.

But even if the preceding argument would not convince you, there is a further line of argumentation. Life has been exposed to radiation as long as there has been any living being on earth. In fact, at the beginning of life, background radiation was much more intensive than it is now since it has been decaying all that time. If low-level background radiation were harmful for life, there would be no living beings on earth, since the flux of background radiation continuously flows through all beings. Clearly, any radiation not exceeding the background radiation is absolutely harmless. Let me emphasize, however, that it has been abundantly proven that large doses of radiation, orders of magnitude larger than the background radiation, can induce cancers, leukemia, and genetic malformations. It is obvious that the severe radiation damages caused by these large doses are beyond repair.

Another line of reasoning is that living organisms that have spent their entire lives in the field of background radiation must have developed immunity to it. It is well known that cells damaged by radiation are removed by a special kind of leucocytes scavenging undesirable mutations. The production of these leucocytes is stimulated by the number of damaged cells present in the organism up to the limit at which the organism is swamped by a large number of damaged cells that cannot be removed. This has been corroborated by observations on radiation workers and radiation patients who developed some limited immunity to radiation.

The damage caused by radiation is due to ionization and to the production of free radicals. The radicals, as chemical species having an odd number of electrons, are highly reactive and attack DNA molecules at many sites. However, the fiber-like DNA consists of two redundant twisted strands, each carrying chemical units in a specific sequence, determining the structure of each protein in the body. If the radiation dose is small, the number of free radicals is small and, therefore, insufficient to sever both DNA strands in the same position. One broken molecule can be duplicated on the basis of the adjacent serving as a template. So, for example, it has been found that young animals exposed to x-ray doses sufficient to cause as much damage to their chromosomes as would take place during their entire lifetimes lived just as long as other control animals, a phenomenon that can be ascribed to the efficient DNA repair mechanism.

The linear dose-damage model is not only scientifically incorrect but also leads to morally unacceptable results. This can be seen in the computations representing an alleged cost-benefit analysis. The benefit is the availability of nuclear power; the cost is besides money a certain number of cancers, leukemias, and genetic malformations. The person making the computation then decides whether or not the trade-off is acceptable. His moral authority to make such a choice is highly questionable. It is questionable whether there is *any* authority that could trade a few human lives for the benefit of having nuclear power. What is most important, however, is that in actuality *the whole moral problem does not exist,* since low-level radiation doses can cause no harm at all. This has to be brought to the attention of the public.

The reader is likely to raise the natural question of why the linear dose-damage relationship was adopted in the first place, in view of all the evidence pointing to the contrary. The answer is that it was never "adopted." It has been always assumed as an approximation—a very conservative approximation—to be on the safe side. However, the assumption was never more than that—an assumption. But some people took it on the same footing as the law of universal gravitation. This would be harmless were it not for the disgusting computations in which some people try, by this linear approximation, to determine the number of cancer deaths and genetic deformities allegedly ascribable to low-dose radiation, without ever having proven that this relationship is correct or how it could possibly be correct while contradicting all know facts.

The elevation of the primitive dose-effect assumption to the dignity of a dogma did not happen by coincidence. It was done by people who, by extrapolating this assumption down to the smallest radiation levels, managed to get into the limelight and make "names" for themselves as alleged "defenders" of the public. There is very little some people would not do to get publicity, and in this situation the publicity was not too difficult to get. In view of the tremendous destructiveness of atomic weapons, the public was easily sold on the harmfulness of atomic power and was easily confused about the actual hazards of low-level radiation. The "scare computations" based on unwarranted assumptions played a major role in setting unrealistic environmental standards and in the delays of the construction of nuclear plants, contributing to the present energy shortage.

It is time to stop perpetuating the false and very costly dogma of low-level radiation damage that has distorted the sequence of our priorities and has caused the setting of unrealistic nuclear safety standards. While trying to prevent the nonexisting causes of deaths due to low-level radiation and spending large amounts of money for this purpose, we are doing very little about the very real causes of death, such as crime, automobile accidents, and drugs, not to mention cancer and heart disease.

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March 11, 1976