Extra Deaths

In Gillette's review (News and Comment, 1 Dec. 1972, p. 966) of the National Academy of Sciences (NAS) report on radiation standards, the estimated risks are represented in terms of "extra deaths." Could someone please tell me what is meant by that?

Logically, the notion of "extra death" is pure nonsense. As each person can die only once, and every person must die sometime, neither war, accident, murder, radiation exposure, or any other agent can cause "extra deaths." What they *can* do is cause *premature* deaths, no more and no less.

Therefore, the only relevant parameter in such discussions is how the average life-span of a person within a given population may be affected by radiation exposure. But how can 6000 "extra deaths" per year in the U.S. population be translated into reduced life-spans? Or rather, how did the NAS committee convert their estimate of the reduction in life-span caused by radiation, which must have been their starting point if their figures are to make sense?

If we take the simple case of zero population growth, and assume stationary conditions in all respects, then the total population is $N = n\tau$, where τ is the average life-span and n is the number of births or deaths per year. This also means that the probability of death within a year of some randomly chosen person will be $1/\tau$. Let us then assume that some extra radiation exposure of the long-term type is introduced, reducing the life expectancy of a newborn to τ', corresponding to a new stable level of population $N' = n\tau'$. The risk connected with the radiation exposure can then be represented by the extra death probability $P_r = 1/\tau' - 1/\tau$ due to radiation effects. Is "extra deaths," which I shall denote as ΔD, perhaps computed as the product of N and P_r? If so, and assuming $\tau \sim \tau'$, which implies that P_r is small compared with $1/\tau'$ or $1/\tau$, we have $\Delta D \sim -(N\,\Delta\tau)/\tau^2$, or $\Delta\tau \sim -(\tau^2\Delta D)/N$.

For an order-of-magnitude calculation referring to the U.S. population, I shall take $N \sim 2 \times 10^8$ and $\tau \sim 65$ years, which gives $\Delta\tau \sim -0.13$ year if we use the value of ΔD given as corresponding to an extra exposure of 170 millirems per year. With the present average dose of ~ 80 millirems per year of man-made radiation, $\Delta\tau$ would be about -1 month, if my understanding is correct. This is then what has to be weighed against the possible benefits of radiological examinations, not the intuitively horrible number of several thousand "extra deaths" per year.

On the other hand the extra risk should of course be minimized, but it seems absurd to demand even stricter standards for technical applications (nuclear reactors, and so forth), which contribute on the average only a fraction of a millirem per year to the average population exposure, while letting M.D.'s carry on unchecked as before. What competence does the average M.D. have in matters like these? Can he, for example, be relied upon to check his x-ray apparatus properly? I doubt it.

Therefore, could someone please answer the following questions:

1) Is my understanding of "extra deaths" correct? If not, what is it then supposed to mean?

2) What is the estimated increase in average life-span due to the present use of radiological examinations?

3) What is the estimated resultant net gain or loss in life expectancy?

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