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Subject Death from Radiation Burns

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DEATH FROM RADIATION BURN

A United Press dispatch, dated August 22, 1945, and appearing in the Knoxville News-Sentinel, gives excerpts from a Japanese broadcast of the same date pertaining to "casualties and sufferers" in the Hiroshima and Nagasaki areas after the atomic bomb raids. The source of information was given as Tokyo propaganda broadcasts and a technical report made to the Japanese Government by Suteso Torri.

The bomb dropped August 8th, 1945 on Nagasaki is said to have taken a toll of "more than 10,800 persons killed, more than 200,000 wounded and more than 90,000 rendered homeless in the city". More than 60,000 were reported killed in Hiroshima on August 6th, 1945. It is stated, "Furthermore many persons are dying daily from burns sustained during the course of the raids", and that "the number of dead are mounting as many of those who received burns cannot survive their wounds because of the effects the atomic bomb produces on the human body". "Even those who received minor burns looked quite healthy at first only to weaken after a few days for some unknown reason and frequently die.

Aside from the damage due to falling debris, there are at least four agents which contribute to injury and death: (1) the concussion wave, (2) heat, (3) flash radiation (especially neutrons and gamma rays) at the time of the blast, and (4) radiation from radioactive materials in the area following the blast. Undoubtedly all of these contributed to the deaths and other casualties in most instances, but it is of interest to determine if possible whether radiation alone may have exerted lethal action.

The statement underscored above, together with the time interval involved and the effects seen in animals, make us believe this may have been the case.

Mice given 600 to 800 r of x-rays or gamma rays, or 90 to 100 n of fast neutrons die at 10 days to 3 weeks after exposure. If the doses are higher the percentage that die is higher and the interval between treatment and death is shorter; correspondingly, if the doses are smaller relatively fewer animals die and the interval is longer. The lethal doses for other laboratory animals are in the same range, some being less (guinea pigs and dogs) and some higher (rats and rabbits). It seems reasonably safe therefore to assume that the lethal dose for human beings is in the range not more than twice or less than half that for mice.

The broadcast made on the 22nd states that people were still dying. This observation was probably made one or two days previous to the announcement so that there is a direct time correlation between the effects described for humans and those seen in animals.

The broadcast states further that the victims frequently die for some "unknown reason". If only cursory examinations had been made of the animals studied, a similar statement would apply for them. Animals, too, remain apparently healthy for several days after a lethal exposure to radiation before undergoing rapid emaciation and death. For the animals it is known: (1) that the gastro-intestinal mucosa begins to slough several days after exposure, resulting in diarrhea and inadequate nutrition; (2) that there is a fall in leukocytes to dangerously low levels; and (3) that disintegrating tissue products lead to a generalized toxemia. The physiological total of these effects is death. It seems not unlikely that such changes may have occurred in persons who died without showing outward signs of injury.

It may be stated here also that animals receiving slightly less than the acute lethal dose recover after a brief cachexia at two weeks, but show a reduced ability to do work and die prematurely, usually in a state of atrophy or with neoplasia. Hence, there is reason to expect that further information is to come from the bombed area regarding irradiation damage.

Estimation of Radiation Intensities and Correlation of Radiation and Other Types of Damage to Human Beings in the Bombed Area.

It has been mentioned that four types of effect produced by the blast might contribute to death.

(1) Concussion Wave

It would be easy to over-estimate both the range and homogeneity of the distribution of deaths produced by this effect.

It is a matter of record that concussion waves from a severe explosion may produce, by interference or selective direction effects, areas of greater or less extent which could act as "islands of safety". Further, the resistance of the human body itself to concussion may easily be under-estimated. Perhaps the major share of fatalities, except in the region very near the initial blast, would be due to building collapse and flying debris, rather than to direct concussion effects. The distribution of fatalities from this effect would, with some probability, be quite far from uniform, and "survivors" might be expected at quite small distances from the blast. In this connection, it must be noticed that current Japanese reports of the immediate death toll seem surprisingly low; especially in Nagasaki where the bomb allegedly fell to the ground before exploding.

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(2) The Heat Wave

Little or no information is available on this point; if the heat energy is largely radiant, we might expect very small amounts of shielding to screen some areas almost completely from this effect. If, however, a good share of the heat energy is molecular, the blast of hot air would presumably be somewhat independent of small variations in terrain, but would have some tendency to be influenced by gross topography. These considerations, on present information, might either reinforce or weaken the conclusions of Section 1. Published reports that in many instances the bodies of those killed were burned more severely on the side facing the blast might be significant here.

(3) Flash Radiation

Preliminary calculations on the basis of the emission of ~1.2 excess neutrons per fission, and the assumption of 1 - 10 moles of fissionable material destroyed, point strongly to the conclusion that the neutron blast is perhaps the most important single factor in producing lethal radiation effects, and with due attention to air absorption and scattering, might well be calculated to be lethal at distances in the order of 1 - 2 kilometers. It appears, in fact, that 1 mole destroyed would produce a lethal neutron dosage at 10 km, neglecting air absorption. Similar calculations, on the basis of 5 - 1 (Mev) "prompt" gamma rays per fission show that the gamma-ray effect would be about 1/10 the fast neutron effect, except at fairly large distances, where it would be of similar magnitude.

It must be said, however, that the tremendous scale of the explosion would undoubtedly lead to the production of floods of x-rays, Grenz rays, ultra-violet, visible and infra-red radiation. The effect of massive combined doses of these is purely a matter of speculation. An important factor is that all these soft radiations would be quite strongly absorbed by air and also by very small thickness of shielding materials.

(4) Radiations from Radioactive Substances

It seems reasonable to accept, as a preliminary interpretation, the view that the tremendous quantities of heat released would remove by far the major portion of the fission and other bomb-produced activities to the high stratosphere and beyond.

Another effect which might require attention is the activation effect of the neutron blast. Roughly, one might expect about 1/4 of the neutrons released finally to produce radio-isotopes of varying kinds. This activity would largely be concentrated in the ground at

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various depths, due to variations in local geometry. It would seem that these activities would be mainly produced at depths in the ground forbidding escape of the induced radiations. This would not hold in areas at which the primary neutron beam struck the earth at a small angle of incidence. On the other hand, the neutron beam at such points would presumably be quite attenuated by distance. Nevertheless, a small electroscope would, with fair probability, be an indispensable accessory to any salt-shaker (Na $[n,\gamma]$ reaction). It seems plausible, however, that only under very special conditions could this effect produce a measurable hazard.

(5) General

In all these considerations, it must be remembered that any shielding, for any or all radiation effects, will have served its purpose, even if the concussion wave later destroyed the structure which furnished the shielding.

Summary and Conclusion

From the considerations of concussion and heat effects, and also from the first direct reports on the effects of the bomb, it seems highly plausible that a great many persons were subjected to lethal and sub-lethal doses of radiation, in areas where direct blast effects were possibly non-lethal. Hence, it seems very probable that radiation may have produced, and may continue to produce increments to the death rate over that produced by primary effects of the blast, and even more probable that a great number of cases of sub-lethal exposures to radiation have been suffered, and await possible study.

The viewpoint that current Japanese reports of the effect of the explosion are, in the main, trustworthy is implicit in some of the statements above; that the contrary may be true (and, in particular, that effects may be so reported as to create just such opinions as are here recorded) is fully realized. Nevertheless, the close correlation of the factual picture and the arguments advanced here seem much too significant to be neglected.

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