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DEFENSIVE CONSIDERATIONS

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I. Modes of attack.

The effects of agents used in radioactive warfare may be expected to differ considerably, depending on the mode of attack.

A. Those which emit long-range beta rays or gamma rays may be effective externally, whether deposited on the person or garments or on the ground. It may be possible to contaminate the ground to the extent that a lethal dose of body radiation will be received in 1 to 5 hours with 1 g or less of long-life fission product (zirconium-columbium per square kilometer. The limiting factor would be the availability of a given quantity to the enemy, and the means of delivery.

B. Inhalation hazard depends on getting a given quantity of material deposited in the lungs for an acute effect. Probably more than 10mc of most materials would be necessary but we might expect late effects from very much less.

C. Ingestion. In this case effectiveness would depend to some extent on the absorption of the substance through the intestinal tract. Again acute radiation sickness might require 10mc or more of a substance readily absorbed while chronic effects (late bone tumors) might follow 1/1000 of this dose or less.

D. Introduction under the skin, as by contaminated missiles, would be very inefficient from the standpoint of acute radiation sickness, local burns, etc. Insoluble agents may remain in wounds long enough to produce malignant tumors, so this mode of warfare is conceivable and might have tremendous morale value.

II. Acute and chronic medical effects contrasted.

In our present state of knowledge, it appears that satisfactory recovery will usually occur from one-half of the single acute lethal exposure, although increased susceptibility to certain diseases and shortening of life may occur. On the other hand, chornic exposure to continuous radiation as in the case of long-lived isotopes deposited in the bone, may result in serious disease many years following dose which is 1/100 to 1/1000 below that producing acute effects. An estimate of exposure and consequent hazard depends on the life of the isotope in question.

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III. Genetic effects and sterility.

Permanent sterility, at least in the male, probably results only rarely from total-body exposure in a dose which has survived, although temporary sterility is often seen. The possibility of catastrophic genetic effects has been overrated in the public mind, partly through public statements by the British Communist J. B. S. Haldane. Such effects may occur in such numbers as to not be detectable in a population.

IV. New information required.

Most of the above information has been derived from inadequate observations in Japan. The acute lethal dose of total-body radiation for man (about 500 r), the acute dose of beta radiation required to produce wet desquamation of the skin (about 1000 rep.), and the low dose of absorbed radium required to induce human bone tumors have been well established. Many new angles of approach must be followed to complete the extrapolation from animal experiments.

V. The panic factor.

This cannot be overrated in connection with radioactive warfare in view of public interest in radioactivity and the mystery which surrounds it in the public mind. It is even possible that a threat of radioactive warfare might be much more effective on the American public than, for example, a threat of bacteriological warfare because of the familiarity of bacterial disease and the unfamiliarity of radiation effects in the public mind. Indecision on the part of defense authorities in the event of radioactive warfare, due to difficulties in assaying the extent of the hazard, would have an additional deleterious effect on public morale.

VI. Assaying the hazard and diagnosis of the contaminant.

At the present time inadequacies here would probably present the gravest danger in defense against radioactive warfare. Most survey instruments are adequate only for beta or for gamma irradiation so that a single series of readings will not give a measure of the hazard without judicious analysis. Also, without the advice of trained radiochemists who have devoted time to consideration of radioactive warfare, it would be impossible to distinguish between contaminating isotopes which were relatively dangerous and those which were relatively innocuous. For example, P^{32} and Sr^{90} or Na^{24} and zirconium-columbium. In the event of a sudden attack, decisions may have to be made in a matter of minutes. It would be well for schemes to be worked out for distinguishing the most likely contaminants.

VII. Evacuation.

Evacuation will be much more a problem with radioactive warfare than with any other sort of attack, except possibly bacteriological warfare. Routes of evacuation will have to depend on a rapid survey of the contamination and there will have to be rules regarding exposure for the civilian

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population and for military personnel under many different tactical conditions.

VIII. Therapy.

That of acute radiation sickness is inadequate at best, and it may become necessary to distinguish those individuals too heavily exposed to recover under any conditions.

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