Extracts from CERRIE Majority Report
Uncertainties in Internal Radiation Risks

19 With internal emitters, more uncertainties need to be added to those affecting external radiation. These arise from the assumptions made in deriving doses from internal radionuclides using biokinetic and dosimetric models and from the RBEs used for internal radionuclides. A key issue is the correctness of using risks derived from external, acute, large doses of high energy gamma and neutron radiation from the A-bomb blasts to derive the risks for internal, low level, chronic exposures to alpha and beta emitters. In a general sense, the Committee was concerned that reliable estimates of uncertainties were required for the many steps and parts of steps used to estimate dose coefficients of internal emitters. A number of members were also concerned that published analyses of uncertainties in dose coefficients showed large ranges for some radionuclides. Although the Committee did not attempt to quantify uncertainties in dose coefficients, it was noted that ranges for equivalent doses to organs and tissues may vary from factors of two to three above and below the central estimate for radionuclides for which good data were available to well over a factor of ten for other radionuclides. These uncertainties are additional to those applying to risk estimates.

20 Uncertainties in risk estimates and variability both have implications for the reliability of risk estimates used in radiological protection, particularly in the regulation of practices that result in exposures to radiation.

p 32 in Annex 2A microdosimetry

A useful working definition of 'microdosimetry' has been suggested as 'the study of the physical microscopic properties of ionising radiations, their interactions and their patterns of energy deposition, with particular emphasis on the inhomogeneities and stochastic nature of the interactions. This is in contrast to conventional dosimetry, which is based on average macroscopic quantities such as absorbed dose. In many situations absorbed dose is totally inadequate to describe radiation action in biological, or other, material because the mechanisms and effects are dominated by the inhomogeneous microscopic properties, especially at cellular or subcellular dimensions' (Goodhead, 1987).= Goodhead DT (1987). Relationship of microdosimetric techniques to applications in biological systems. In: *The Dosimetry of Ionizing Radiation,* Volume II (eds KR Kase, BE Bjarngard and FH Attix). Academic Press, New York, pp 1–89.

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11 The ICRP has not published information on uncertainties in dose coefficients, but it is clear that the reliability of derived doses and risks is an important factor in relation to the intended applications (see section 2.7). Uncertainties will arise at each stage of the dose calculation: in the use of biokinetic and dosimetric models; in the assumptions made to try to equate different types of radiation (through RBEs); in summing contributions from the irradiation of different tissues to give a whole-body dose (using tissue weighting factors); and deriving the total risk. Uncertainties in dose estimates will vary substantially between radionuclides, depending on their types and energies of radiation emission, their chemical form, the complexity and knowledge of their behaviour in the body, and the availability of data on which to base model parameters. There are important concerns with respect to the heterogeneity of dose delivery within tissues and cells from short-range charged particle emissions, the extent to which current models adequately represent such interactions with biological targets, and the specification of target cells at risk. Indeed, the actual concepts of absorbed dose become questionable, and sometimes meaningless, when considering interactions at the cellular and molecular levels.

12 Finally, a central concern is the question of the applicability of risk factors derived largely from the A-bomb survivors, who received a homogeneous, high dose, short (high dose rate) external exposure to mainly gamma radiation. A basic assumption is that these risk factors can be applied to heterogeneous, low dose, internal exposures to charged particles. [CERRIE final report p 13]