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The Dose Response Relationship for Radiation Carcinogenesis[1]

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Recent surveys show that the collective population radiation dose from medical procedures in the U.S. has increased by 750% in the past two decades. It would be impossible to imagine the practice of medicine today without diagnostic and therapeutic radiology, but nevertheless the widespread and rapidly increasing use of a modality which is a known human carcinogen is a cause for concern. To assess the magnitude of the problem it is necessary to establish the shape of the dose response relationship for radiation carcinogenesis. Information on radiation carcinogenesis comes from the A-bomb survivors, from occupationally exposed individuals and from radiotherapy patients. The A-bomb survivor data indicates a linear relationship between dose and the risk of solid cancers up to a dose of about 2.5 Sv. The lowest dose at which there is a significant excess cancer risk is debatable, but it would appear to be between 40 and 100 mSv. Data from the occupation exposure of nuclear workers shows an excess cancer risk at an average dose of 19.4 mSv. At the other end of the dose scale, data on second cancers in radiotherapy patients indicates that cancer risk does not continue to rise as a linear function of dose, but tends towards a plateau of 40 to 60 Gy, delivered in a fractionated regime. These data can be used to estimate the impact of diagnostic radiology at the low dose end of the dose response relationship, and the impact of new radiotherapy modalities at the high end of the dose response relationship. In the case of diagnostic radiology about 90% of the collective population dose comes from procedures (principally CT scans) which involve doses at which there is credible evidence of an excess cancer incidence. While the risk to the individual is small and justified in a symptomatic patient, the same is not true of some screening procedures is asymptomatic individuals, and in any case the huge number of procedures must add up to a potential public health problem. In the case of radiation oncology, modern innovations such as Intensity Modulated Radiation Oncology or Proton Therapy both result in a substantial total-body dose to the patient, which must result in an increased incidence of second cancers. The technology exists to reduce these total body doses and the problem needs to be addressed.

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