Appropriate Use of Effective Dose and Organ Dose in Nuclear Medicine

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When discussing the evaluation of radiation dosimetry for nuclear medicine, we may consider individual organ absorbed doses (in Gy, a physical quantity) or equivalent doses (in Sv, a derived quantity), including the dose to the highest exposed organ (sometimes called the critical organ) as well as other relevant tissues, such as active red marrow. For diagnostic and therapeutic nuclear medicine, it is relevant to know the absorbed doses to individual organs, particularly those that receive the highest doses. Absorbed doses are estimated using standardized reference models of the human body. Individual organ doses may be reasonably assessed for a patient using measured biokinetic data and organ masses.

The risk-weighted equivalent dose to whole body or "effective dose" (in Sv) may also be considered. Effective dose represents the potential risk from stochastic effects of radiation, and thus allows different procedures involving ionizing radiation to be compared for radiation protection purposes. The International Commission on Radiological Protection (ICRP)[1] originally developed the effective dose concept for use in protection of workers and the public. Effective dose may reasonably be applied to medical exposures, remembering that effective doses (used in package inserts and the ICRP compendia) are based on population-averaged kinetic models and reference individuals (e.g. a 70 kg adult).[2,4,6] However, it is not appropriate to apply effective dose to individual patients because patient-specific parameters may vary substantially from the assumptions used in generalized models. Also, effective dose is not applicable to therapeutic uses of radiation, as it treats only stochastic risks of radiation exposure.

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Some have suggested tracking internal doses for individual nuclear medicine patients. If put into practice, which doses would be tracked? Keeping track of long lists of organ doses could be cumbersome and not very useful. The effective dose would be a more convenient single dose quantity, but it is important to (1) understand the uncertainties inherent in its calculation, and (2) to appreciate that the quantity effective dose is only applicable to populations and not to individual patients.

For any calculation of effective dose, the tissue weighting factors must be specified (whether from ICRP 26, 60 or 103).[1,3,5] Effective dose should also not be used to estimate numerical risks of cancer from nuclear medicine

procedure. Risk models provided by the BEIR VII Report [7] were based primarily on instantaneous external gamma and neutron exposures and follow-up data from the Lifespan Study of Japanese atomic bomb survivors, rather than from low dose levels and dose-rates typically delivered by internally deposited radiopharmaceuticals in nuclear medicine patients. Also, no statistical demonstration of observable risks at low doses, such as those in diagnostic nuclear medicine, has been demonstrated.

Choosing one clinical procedure over another because it is associated with a slightly lower effective dose should also be discouraged, given the uncertainties in any dose estimation, particularly for effective dose, because it incorporates the additional uncertainties inherent in the organ risk weighting factors. Instead, the most appropriate nuclear medicine procedure should be selected for the patient, based on an individual's medical needs, as we know that the benefits of a needed medical exam performed in the right patient with the right dose far outweigh any potential risks at these low dose levels.[8,9]

The most appropriate nuclear medicine procedure should be selected based on an individual's medical needs. Choosing one clinical procedure because it is associated with a slightly lower effective dose is discouraged.

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