Units of Radiation

Calculation of Equivalent Dose and Effective Dose

Effective dose (sievert (Sv)) = Σ (Tissue weighting factor × Equivalent dose)

When the whole body is evenly exposed to **1 mGy** of γ-ray irradiation

Effective dose =
0.12 X **1** (mSv): bone marrow
+ **0.12** X **1** (mSv): colon
+ **0.12** X **1** (mSv): lungs
+ **0.12** X **1** (mSv): stomach
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+ **0.01** X **1** (mSv): skin
= **1.00** X **1** (mSv)

= 1 millisievert (mSv)

When only the head is exposed to **1 mGy** of γ-ray irradiation

Effective dose =
0.04 X **1** (mSv): thyroid
+ **0.01** X **1** (mSv): brain
+ **0.01** X **1** (mSv): salivary gland
+ **0.12** X **1** (mSv) × **0.1**: bone marrow **(10%)**
+ **0.01** X **1** (mSv) × **0.15**: skin **(15%)**
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= 0.07 millisieverts (mSv)

Methods for calculating an effective dose when the whole body is evenly exposed to 1 mGy of γ-ray irradiation and an effective dose when only the head is exposed to 1 mGy of γ-ray irradiation are compared.

Since the radiation weighting factor (W_R) for γ-rays is 1, the whole body being evenly exposed to 1 mGy means that the whole body is evenly exposed to 1 mSv (1 gray × 1 (W_R) = 1 millisievert). That is, equivalent doses are 1 mSv for all organs and tissues. To calculate effective doses, the equivalent doses for individual tissues are multiplied by their respective tissue weighting factors and the products are summed. Bone marrow, colon, lungs, stomach and breasts are given a high factor of 0.12 because these are organs with high risks of radiation-induced fatal cancer. The skin of the whole body is assigned a factor of 0.01. Thus, when the equivalent doses for all organs and tissues are multiplied by their respective tissue weighting factors and the products are summed, the result is an effective dose of 1 millisievert.

If only the head is exposed to 1 mGy in radiation inspection, the organs and tissues in the head, such as the thyroid, brain and salivary gland, are entirely exposed to radiation, so equivalent doses are 1 mSv for all these organs and tissues. For organs and tissues that are only partly present in the head, such as bone marrow and skin, equivalent doses are obtained by multiplying by the ratios of their areas exposed to radiation (bone marrow: 10%; skin: 15%). When their equivalent doses are multiplied by their respective tissue weighting factors and the products are summed, the result is an effective dose of 0.07 mSv.

(Related to p.35 of Vol. 1, "Relationship between Units")

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