International Commission on Radiological Protection

Task Group 91: Radiation Risk Inference at Low-dose and Low-dose Rate Exposure for Radiological Protection Purposes

Introduction

The detriment-adjusted nominal risk coefficients recommended by ICRP have been based, to a large extent, on data obtained from the atomic bomb survivors in Japan.

- Because their exposure was a single acute exposure, and because it was thought that the most plausible biological model for the dose response relationship should be linear quadratic (which implies a larger slope at high doses than a low doses), many international and national relevant bodies, such as UNSCEAR, BEIR, and also ICRP have used over the years a Dose and Dose-Rate Effectiveness Factor (DDREF) for estimates of these coefficients at low doses.

- A value of 2 was used by ICRP for low-dose and low-dose rate exposures, which are typical in radiation protection.

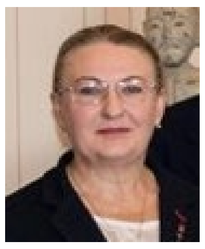
- With more epidemiological information becoming available, UNSCEAR 2006 has recently re-evaluated the mortality data of Japanese atomic bomb survivors using a flexible class of Bayesian models that accounted for dose response curvature and has estimated risk coefficients that are similar to the ICRP estimates using high doses and a DDREF value of 2.

- However, in their 2006 report the BEIR committee (BEIR VII) used a different Bayesian approach and recommended a DDREF of 1.5.

Publications: Members of the Task Group have published the following papers during the development of the work.

- Haley, B., et al. (2015) **Animal mortality risk increase following low-LET radiation exposure is not linear-quadratic with dose**. PLOS One, 10(12).
- Rühm, W., et. al. (2015) **Dose and dose-rate effects of ionizing radiation: a discussion in the light of radiological protection**. Radiat Environ Biophys 54(4), 379–401.
- Rühm, W., et. al. (2016) **Dose-rate effects in radiation biology and radiation protection**. Proceedings of the Third International Symposium on the System of Radiological Protection. Ann. ICRP 45(1S).
- Rühm, W., et al. (2017) **Biologically based mechanistic models of radiation-related carcinogenesis applied to epidemiological data**. Int J Radiat Biol 93(10), 1093-1117.
- Shore, R., et al. (2017): **Risk of solid cancer in low dose-rate radiation epidemiological studies and the dose-rate effectiveness factor**. Int J Radiat Biol 93(10), 1064-1078.
- Tran., V., and Little, M.P. (2017) **Dose and dose rate extrapolation factors for malignant and non-malignant health endpoints after exposure to gamma and neutron radiation**. Radiat Environ Biophys 56(4), 299-328.
- Rühm, W., et al. (2018) **Typical doses and dose rates in studies pertinent to radiation risk inference at low doses and low dose rates.** J Radiat Res 59(S2), ii1-ii10
- Wakeford, R., et al. (2019) **The dose and dose-rate effectiveness factor (DDREF)**. Health Phys 116(1), 96-99.


Werner Rühm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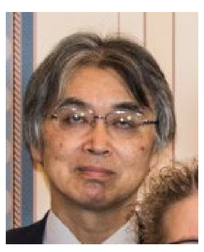
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Scope

The Task Group reviews the currently available information on the estimation of risk coefficients and recommends:

- Whether it is desirable to continue to estimate risk at low doses by assessing the slope of the dose response at high doses and then applying a DDREF reduction factor.

- The alternative is to adopt the UNSCEAR approach of inferring the risk coefficients at low doses by using a flexible class of dose response models fitted using Bayesian methods.

- Whether such coefficients are applicable to acute, protracted and prolonged exposure or need additional correction.

- The Task Group will develop a report for publication in the Annals of the ICRP that presents a review of the current science relevant to the estimation of risk at low doses and dose rates, and provides recommendations on how this risk should be estimated for radiological protection purposes.