ICRP Publication 150

Cancer Risk from Exposure to Plutonium and Uranium

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ICRP Committee 1

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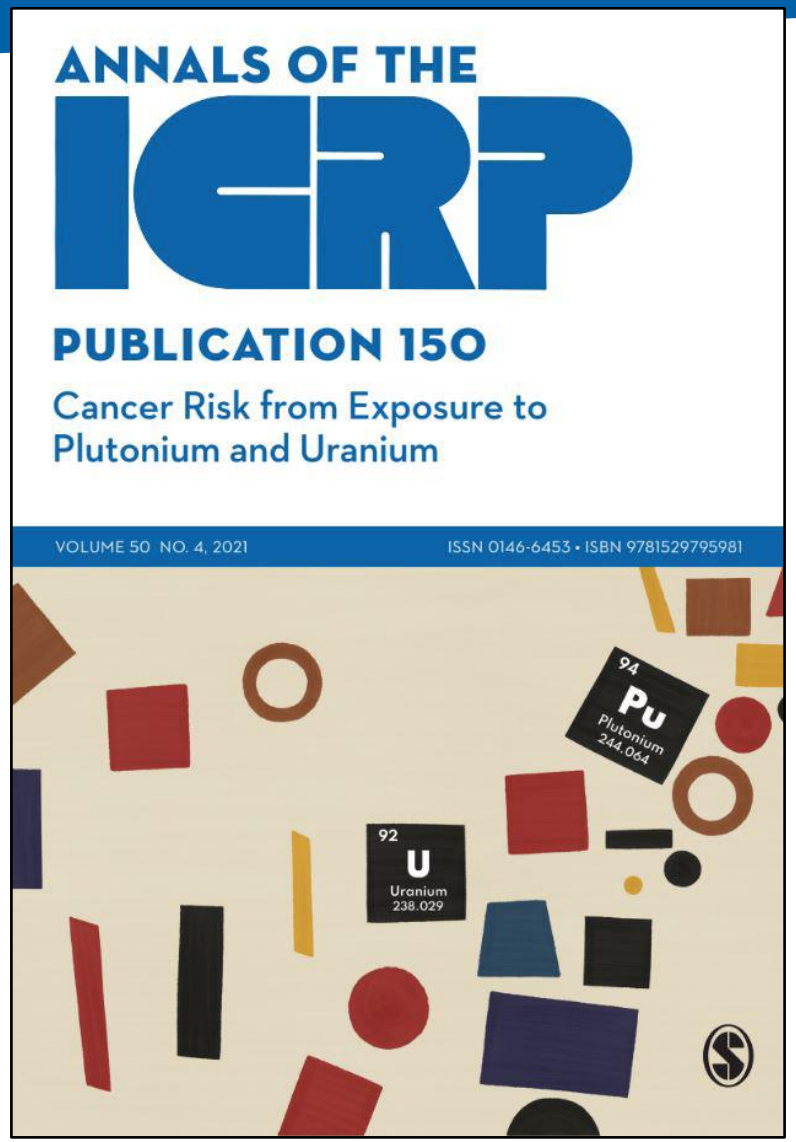

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- "For plutonium, the two main studies are of the cohorts of workers employed at the nuclear installations at Mayak in the Russian Federation and at Sellafield in the UK."

- "The analysis of the Mayak worker cohort provides an estimate of the slope of the dose–response curve for the risk of lung cancer, while at lower levels of plutonium exposure, the Sellafield worker cohort provides results that, within relatively large confidence intervals, are consistent with those for the Mayak worker cohort."

- "Results from the Mayak worker cohort also show an association between plutonium exposure and the risk of liver and bone cancers, but not the risk of leukaemia."

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- "This publication [ICRP Publication 150] details the recent Mayak Worker Dosimetry Systems (MWDS-2008 and MWDS-2013) and the system developed for the joint analysis of Mayak and Sellafield plutonium workers as part of a European Union SOLO (epidemiological studies of exposed Southern Urals populations) project."

  (SOLO Mayak- Sellafield study results published by Gillies *et al.*, *Radiat Res* 2017; **188**: 645-60)

- "Lifetime risk was calculated using ICRP baseline rates for a composite Euro-American male population, as provided in *Publication 103* (2007), and the risk model derived from the SOLO project analysis of Gillies et al. (2017)."

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- "For the same intake, the cumulative doses to lung tissues from plutonium oxide are higher than those from plutonium nitrate, but the lifetime excess risk of lung cancer mortality per mGy varies little, with estimates between 1.4 and 1.7 per 10,000 persons, depending on the solubility (plutonium oxide or plutonium nitrate) and exposure rate (acute or chronic intake). In comparison, the lifetime baseline risk of lung cancer mortality is 631 per 10,000 persons for a Euro-American male population."

- "For comparison, exposure to ^{222}Rn progeny under the scenario considered in *Publication 115* (2010) of 7.1 mJ h m^{-3} (2 working-level months) per year from 18 to 64 years of age, when converted to lung dose, leads to a lifetime excess risk of lung cancer mortality per mGy of 1.6 per 10,000 persons."

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- "A comparison of the lifetime excess risk of lung cancer mortality from exposure to an external source of gamma radiation (based on the Life Span Study of the Japanese atomic bomb survivors) and from internal exposure to plutonium (based on the Mayak workers study) indicates that, for the same absorbed dose to the lung and dose distribution, the risks from plutonium exposure are larger than those from external gamma exposure by a factor of approximately 16."

- "The risk for radon progeny exposure appears to be consistent with that from plutonium exposure, and larger than that from external gamma exposure by a factor of approximately 14, despite the very different distribution of alpha-particle dose within the lung."

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- "These comparisons suggest a biological effectiveness of alpha particles relative to high-energy photons of approximately 14–16 for lung cancer. These values are compatible with the current radiation weighting factor, w_R, of 20 used by ICRP [*Publication 103* (2007)] for alpha particles in the calculation of equivalent and effective doses."

- "It should be noted that this comparison is based on lung absorbed dose and lifetime excess risk of lung cancer mortality, with application of a dose and dose-rate effectiveness factor (DDREF) of 2 to the risk derived from the Japanese Life Span Study. Not applying a DDREF would lead to relative biological effectiveness of approximately 7–8 for lung cancer."

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In conclusion

- Analysis of mortality data from plutonium workers at Mayak and Sellafield (mainly from Mayak workers), together with estimates of alpha particle absorbed doses from deposited plutonium, has permitted
  - The derivation of the risk of lung cancer mortality in terms of the absorbed dose from plutonium
  - A comparison with the previously derived risk of lung cancer mortality in terms of the absorbed dose from radon-222 decay products
  - The derivation of the lifetime risk of lung cancer mortality per milligray
  - An estimate of the relative biological effectiveness of alpha particles emitted by plutonium in relation to lung cancer mortality, and a comparison with the w_R of 20 currently used by ICRP

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