Reanalysis of cancer mortality risk in association with organ absorbed dose for Japanese nuclear workers 1991-2010

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ABSTRACT

Background: Japanese Epidemiological Study on Low-Dose Radiation Effects (J-EPISODE) has analyzed health effects in association with photon exposure assessed in $H_p(10)$ since 1990. However, it is under way to estimate cancer morbidity and mortality risk evaluated in organ absorbed dose, which is recommended by ICRP.
Aim: To reconstruct organ absorbed dose during 1957 to 2010, and reanalyze cancer mortality risk for J-EPISODE 1991-2010.
Materials and methods: The reconstruction method of organ dose principally followed the approach adopted in the IARC 15-Country Collaborative Study. However, the method was modified considering recent usage practice of dosimeters in Japan and body size of Japanese. Despite the IARC's framework with $H_p(10)$ being the common quantity, it was simplified using air kerma as common quantity (Figure 1).
[1] The preceding studies on Japanese NPPs in 1980s were found to confirm that the assumptions of distribution of energy and geometry of photon exposure in IARC study were applicable for J-EPISODE.

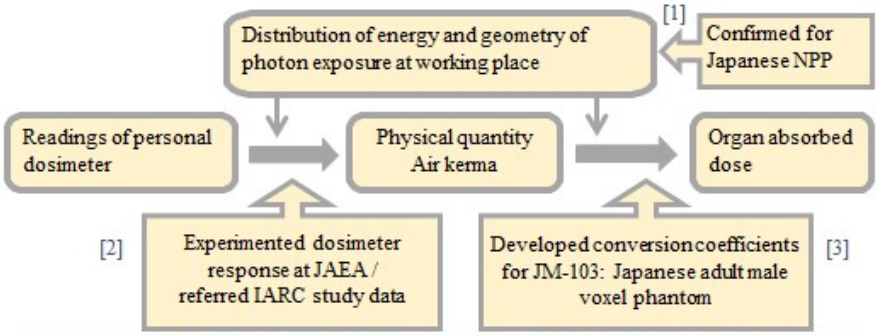

Fig. 1. Framework converting readings of personal dosimeter to organ absorbed dose

[2] Dosimeter response data , defined as readings per air kerma, under combinations of a specific photon energy; 119, 207 and 662 keV, and a specific geometry; antero-posterior geometry and isotropic geometry, were newly experimented in the same way as IARC study for recently used three types of dosimeters; glass badge (GB), electronic personal dosimeter (EPD) and optically stimulated luminescence (OSL) dosimeter, while those for film badge (FB) and thermoluminescence dosimeter (TLD) referred IARC study data.
[3] Conversion coefficients from air kerma to organ absorbed dose were developed for Japanese adult male voxel phantom (JM-103) in order to compare with Caucasoid phantom.
[4] Finally, conversion coefficients from readings to organ absorbed dose were computed using the above data on dosimeter response as well as coefficients from kerma to organ absorbed dose for each year and each site where workers were exposed to photon, followed by reconstruction of organ absorbed dose for subjects of J-EPISODE during 1957 to 2010. Then, Poisson regression method was applied for estimating ERR (Excess Relative Risk) for cancer mortality.
Results: 1) The IARC assumptions of energy and geometry distribution were applicable.
2) Dosimeter response among dosimeter types demonstrated small differences.
3) Conversion coefficients for JM-103 revealed small differences from Caucasoid.
4) Conversion coefficients from readings to organ absorbed dose (Gy/Sv) were around 0.7 to 0.8.
5) Organ absorbed dose for several tissues was reconstructed from the recorded dose during 1957 to 2010.
6) ERRs for cancer mortality were estimated in terms of organ absorbed dose.
Conclusion: Evaluation method of cancer morbidity and mortality risk in association with organ absorbed dose, which is recommended by ICRP, became applicable for Japanese nuclear workers.
Keywords*: Epidemiology, Organ absorbed dose, Nuclear worker*
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