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A Standardized Individual Dose System for Epidemiology of Public and Workers by "Universal Radiation Protection System Hypothesis"

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Epidemiologic studies of public or workers at low doses of ionizing radiation based on total effective dose a person receives as a member of public in daily life or as a worker with additional dose in radiation work can provide the necessary basis for estimating consistent human health risks for setting radiation protection standards. Efforts have been in progress over the past few decades by the world radiation protection and epidemiology experts on the estimates of human health risks at low doses of ionizing radiation to support either the linear-no-threshold (LNT) hypothesis or any other models such as hormesis model. Some major epidemiology studies have been performed or in progress such as on public exposure due to environmental natural background (NBG) radiation [1-5] or on occupational exposure from man-made sources for example on the US Million Nuclear Workers Study [6] and on the International Nuclear Worker Study (INWORKS) [7], as well as occupational ionizing radiation risk of basal cell carcinoma in US radiologic technologists (1983-2005) [8]. In particular the studies of Spycher et al. [5] on the risk of childhood cancer among 2,093,660 children <16 y in a census-based nationwide cohort study suggest that exposures from terrestrial gamma and cosmic ray may contribute to the risk of cancer in children, including leukemia and central nervous system tumors. In particular, this nationwide census-based cohort study in Switzerland claims an evidence of an increased risk of cancer among children exposed to external dose rates of NBG radiation of ≥ 200 nSv/hr compared with those exposed to <100 nSv/hr [5]. Kendall et al. [4] have also estimated for mother's residence at the child's birth from national databases, using the County District mean for gamma rays, and a predictive map based on domestic measurements grouped by geological boundaries for radon, 12% excess relative risk of childhood leukemia per millisievert of cumulative red bone marrow dose from gamma radiation; the analogous association for radon was not considered significant with excess relative risk of 3%. These studies on natural radiation overall provide the importance given to the major contribution of the NBG radiation dose to the risk of cancer in children; a dose risk which can be significant when integrated and extended lifetime. In addition, the children, as member of public, have also been exposed retrospectively to alpha particles from radon and progeny which should be considered as significant lifetime.

The recent epidemiologic studies of radiation workers, as stated above, have considered effective dose of external and internal occupational exposure in the US Million Nuclear Workers Study [6], only occupational external exposure in the International Nuclear Worker Study (INWORKS) [7], and only external x-ray doses in diagnostic radiology as occupational ionizing radiation to estimate the risk of basal cell carcinoma in US radiologic technologists (1983-2005) [8]. A radiation worker, being a member of public, in addition to occupational exposure, is chronically exposed to environmental internal and external exposures, indoors and outdoors, lifetime like any other members of the public. Therefore, the health risk estimates in epidemiological studies of radiation workers by not considering chronic unfractionated environmental exposures a worker receives can be overestimated values of human health risk, in particular since occupational exposure is highly fractionated. Further, if all doses a worker receives causing the effects and estimating the human health risks are not considered consistently in epidemiology studies of workers, the health risk values may not be consistently applied and complement each other to set acceptable radiation protection standards. Therefore, in order to obtain a consistent and standardized risks to be collectively applied for setting radiation protection standards, I like to share further a recent development made by this author on proposing a "Universal Radiation Protection System (URPS) Hypothesis" in order to further strengthen the scientific basis and consistency of radiation protection standards by applying a "Standardized Individual Dose System" (SIDS). The URPS Hypothesis considers the environmental doses in particular the NBG radiation dose as a highly significant portion of an annual effective dose a member of public or a radiation worker as a member of public, receives in daily life to be accumulated lifetime. The natural annual effective dose in fact plays an important role in setting radiation protection standards and in epidemiology studies of an individual in particular workers; what has not been considered in present radiation protection standards in general [9] and in epidemiological studies of workers in particular [6-8]. In fact, the epidemiology risk estimates on children based on natural radiation exposure [4,5], as discussed above, highly support the newly proposed URPS Hypothesis. In this context, some principle points on the philosophy, concept and methodology on the URPS are summarized to justify SIDS for setting radiation protection standards and for epidemiological studies of public and workers [10,11]. In summary, the URPS considers;

1. Health effects/risks per unit dose of NBG radiation exposure equal to those of a unit dose of exposures from man-made sources.
2. Definition of a "radiation worker" as "An individual member of public who receives additional occupational radiation exposure as an employee".
3. A "Standardized Individual Dose System" (SIDS) which integrates all doses an individual receives from natural and man-made sources as a member of public or as a worker including doses of existing exposure situations (mainly national mean environmental NBG radiation exposure, which might also include doses from past practices), planned exposure situations within the public dose limit of 1 mSv.y-1, the occupational exposure (external and internal only for workers) and emergency doses.

4. Equal standardized radiation "health risk limit" for workers no matter where they live and work in the world by also integrating the national mean environmental NBG radiation exposure into the dose limit.
5. The NBG radiation dose an individual receives as chronic, protracted and "unfractionated" to be integrated lifetime retrospectively and the occupational dose as highly "fractionated" for which a "dose fractionation factor" should be applied.
6. Integrating doses a worker receives from occupational exposure, national mean NBG and planned exposure situations within a dose limit to equalize radiation health risks worldwide.
7. For epidemiology studies of public, integrated doses including planned exposure situations within a dose limit (e.g. 1 $mSv.y^{-1}$), mean natural national effective dose due to internal and external exposure, and possibly the medical exposure which is quite significant.
8. For epidemiology studies of workers, it integrates all effective doses a worker receives as given for a member of public and occupational exposure due to external and internal exposure by also taking into account the fractionation effect.
9. A user-friendly universal system by a simple philosophy understandable by all including members of the public, workers and even a regulatory body to prevent radiophobia.
10. Bridging the gaps between the LNT and hormesis models to minimize controversies in the radiation protection communities.

The above URPS philosophy, concept and methodology for dose limitation of public and workers and for epidemiology studies have been discussed and formulated in recent articles [10,11]. To conclude, the presently practiced epidemiology methodologies for radiation workers may not end to meaningful results and new approaches are needed. The URPS is believed being novel, scientific, logical and consistent which make world radiation protection system universally standardized. The URPS epidemiology methodology based on SIDS is in particular a standardized approach which will result to scientifically-powered risk estimates, in the presence of so many unknown environmental and other confounding factors, which can be better justified and accepted in the scientific radiation protection communities, no matter what the epidemiological risk estimates results are. By taking into account the significant fractionation effects of occupational exposure, the present dose limit of workers can be increased significantly while the "risk limits" for workers even can be kept the same. The increase of the dose limit due to fractionation effects of occupational exposure might bridge over the gaps and inconsistencies between the LNT and the hormesis models, which might be a great achievement in this field. The last but not least, to fully be standardized, the mean national individual public dose from all radiation sources even medical exposure should be integrated at least for epidemiology studies.

The URPS provides many advantages for establishing a standardized radiation protection system. The URPS is expected to open a new horizon in radiation protection universally and is hoped to be seriously brainstormed with feedbacks on its disadvantages by the world leading experts, commissions, committees and organizations dealing with radiation protection decision making for its further development worldwide.

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