General Tissue Reactions and Implications for Radiation Protection

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Impacts of the System of Radiological Protection

- **ICRP publications:**
  - Greatly impact systems of radiological protection
  - Implications for society
  - Should be understandable, practicable and scientifically based
- **Objectives:**
  - Develop a radiological protection system based on scientific information
  - Create a consistent radiological protection system by harmonizing detriment for cancer and non-cancer effects

Tissue Reactions and Non-cancer Effects of Radiation

- **January 2011** – publication of ICRP draft report on tissue reactions.

- **April 2011** – draft report led to ICRP *Statement on Tissue Reactions.*
  - Immediate influence on the IAEA BSS in dose limit reductions to lens of eye

ICRP Publication 118

- **ICRP Publication 118**, *ICRP Statement on Tissue Reactions / Early and Late Effects of Radiation in Normal Tissues and Organs – Threshold Doses for Tissue Reactions in a Radiation Protection Context*, issued in 2012.
- **Three critical points**, especially in new circulatory disease analysis:
  - Epidemiological analysis
  - Detriment
  - Mechanisms for damage

Epidemiological Analysis

- Epidemiological analysis used to find excess relative risks (ERR) for non-cancer effects such as circulatory disease and cataract; depends greatly on the **shape of the dose-response curve**.
- In ICRP Publication 118, ERR for circulatory disease estimated based on **linear dose-response** assumptions.

Epidemiological Analysis – Developing Discussions

- **Several papers published following Publication 118 indicate a potentially non-linear dose-response relationship for circulatory disease:**
  - **Epidemiological analysis:** *Suzuki, G. 2012. Review of epidemiological studies of non-cancer diseases.* Presentation at the 2012 OECD/NEA Science and Values Workshop.

Epidemiological Analysis – Developing Discussions

– **Epidemiological analysis:** *Ozasa, K. 2012.*

Non-cancer Effects in the Life Span Study

(Cardiovascular Diseases: CVD) Presentation at the 2012 OECD/NEA Science and Values Workshop.

- Demonstrated that a linear dose-response for CVD may be artifact of combination of heterogeneity of disease subtypes and analysis period. **Non-linear dose response with possible threshold may be more accurate model for CVD.**

Epidemiological Analysis – Developing Discussions

- **Discussion of AHS data:** *Takahashi, I., et al. 2012. A prospective follow-up study of the association of radiation exposure with fatal and non-fatal stroke among atomic bomb survivors in Hiroshima and Nagasaki (1980-2003).*

- **Discussion of Epidemiological data:** *Conference and Workshop Report. RERF International Workshop on Radiation and Cardiovascular Disease on February 5 and 6, 2013.*

Epidemiological Analysis – Summary

- **Recently published papers demonstrate:**
  - The importance of including AHS data
  - Heterogeneity among disease subtypes

Likely non-linearity in the low-dose region

Detriment Adjustments – ICRP Publication 103

(1) Site-specific excess risks determined from LSS cancer incidence data; used to estimate lifetime attributable risks.

(2) Portion of risk attributable to fatal cancer determined; portion of risk attributable to non-fatal cancer adjusted for reduced quality of life.

Nominal risk adjusted for lethality and quality of life in (2), further adjusted for length of life lost if harm occurs.

Detriment Adjustments – Cancer and Non-Cancer Risks

	Cancer Risk (ICRP 103)	*Non-Cancer Risk (ICRP 118)*
Dose-response model	Modeled such that probability of occurrence increases with dose(ERR).	Modeled such that the probability of occurrence increases with dose (ERR).
Definition of severity	Severity expressed by adjusting probability of occurrence for reduced quality of life and length of life lost .	Unclear
Approximation of dose limits	Dose limits based on variety of considerations in addition to calculated fatal cancer risk estimate.	Threshold dose judged to be dose that causes 1% incidence of disease above background.

Detriment - Summary

- **Further discussion is needed to clarify non-cancer risk assessments**
  - Use of incidence value
  - Metric to account for severity
- **Defining detriment for non-cancer effects may be used to harmonize risk assessments for cancer and non-cancer effects**

Mechanisms

- **Some indication mechanisms for damage may be different at low vs. high doses.**

- **Research into mechanisms of response could:**
  - Contribute to better interpretation of dose-response curves
  - Provide basis for future harmonization of cancer and non-cancer risks estimates

Conclusions

- Recommendations and Publications from the ICRP carry great weight within the worldwide radiation protection community.
- Because of this, discussions within ICRP regarding epidemiological data and the dose-response curve should be on-going.
- It is important to explore definitions of severity and detriment, and potential harmonization of cancer and non-cancer risks estimates.