

# 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

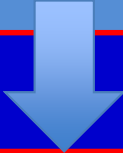
- **Recently published papers demonstrate:**
  - The importance of including AHS data
  - Heterogeneity among disease subtypes



**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

	<i>Cancer Risk (ICRP 103)</i>	<i>Non-Cancer Risk (ICRP 118)</i>
<b><i>Dose-response model</i></b>	Modeled such that probability of occurrence increases with dose(ERR).	Modeled such that the probability of occurrence increases with dose (ERR).
<b><i>Definition of severity</i></b>	Severity expressed by adjusting probability of occurrence for <u>reduced quality of life and length of life lost</u> .	Unclear
<b><i>Approximation of dose limits</i></b>	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.**