2.1 Uncertainties - RP challenges in science and application

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NEA 2016 Report

- Radiological Protection Science and Application - OECD 2016 NEA No.7265
  - Biological and epidemiological research
  - Societal aspects of radiological protection
  - Implementation of RP system
  - International standards
  - Overall way forward
Which challenges?

1. Radiation effects at low dose & dose rate
2. Epidemiology, biological mechanisms, “bio-markers”
3. Individual protection
4. Is it safe? → Communication
Which challenges?

4. Non-cancer effects e.g. cardiovascular effects
5. Radon
6. Secondary primary cancer
7. Environment – is it protected?
Effects at low dose and dose rate

1. Low dose (<100 mGy) & rate (dD/dt <5 mGy/hr)
2. Cancer risk described as linear to ~ 50-100 mSv (of an equivalent or effective dose)
3. Extrapolation of excess absolute/relative risk - LSS-studies, medical exposures, workers - Average over populations, age, sexes etc.
4. Broad consensus: RP system does not critically under- or overestimate the risks
Epidemiological studies

UNSCEAR 2017

• Criteria for epidemiological studies
• Epi-studies of cancer risk, low dose-rate radiation from environmental sources
• On-going up-date: Selected health effects (leukaemia, solid cancer, thyroid cancer, cardiovascular effects)
• New pooled study - leukaemia (< 21 y)
  Little, Wakeford et al. July, 2018
Biomarkers

- No validated biomarkers of either tissue or stochastic effects identified (breast cancer?)
- Studies of functional assays and candidate SNPs have been largely inconclusive

SNP
single nucleotide variation
More "individual” protection

- RP system averages over age, sex etc. but
- We account for children, unborn child etc. by specific regulation → should more be done?

Some 15 rare disorders (< 10^{-4}) extra sensitive
Ataxia telangiectasia, Nijmegen breakage syndrom…- impaired DNA repair capacity

(Murray D., Parliament M. 2013)
More "individual" protection

- (Epi-)Genetic testing – personal decision
- Radiosensitive workers
- Radiotherapy, astronauts

→ Ethical and legal issues
- Screening tests (chromosomal aberrations, still search for "radiation" bio-markers)
- Society → prepare to manage the situation
What is safe, LNT, weighing risks

• UNSCEAR 2012 - Attributing effects, Inferring risks

• By nature of stochastic effects, limited statistics, individual attribution is not possible
  – Cause for a new RP regime? Weighing?
  – No → LNT + optimisation accounting for ”prevailing circumstances” + dose limits is still good enough!
What is safe, LNT, weighing risks

- Accidents - Focus on 20–100 mGy. Higher doses in general not acceptable.
- What is ”safe” → communication and perception issue
- Cultural issue
- Prevailing circumstances → Stakeholder process
Non-cancer effects

• Disturbances of haematopoietic system, adverse skin effects, fertility impairment, hypothyroidism, lens opacity and cataract, neurological impairment, cardiovascular diseases

• More attention but mechanisms and induction at low doses (< 0.5 Gy) and dose rates are still uncertain
Lens of the eye

- ICRP - lower threshold for cataract absorbed dose of 0.5 Gy
- New EU dose limit: 100 mSv over 5 years, 50 mSv in a single year
- S Bernard et al., Br J Radiol. April 2016; 89(1060) – review of medical workers

→ More research, epi-studies → mechanism?
→ Monitoring techniques refined and possibly standardized – advice for fulfil compliance
Radon

• Radon exposure universal (1.2 of 2.4 mSv)
  2014 ICRP 126 *RP against Radon Exposure*
  2017 ICRP 137 *Occupational intakes*
  2018 ICRP Recom. on Radon 18 Jan. 2018
• National reference level 100 – 300 Bq m\(^{-3}\)
• 300 Bq m\(^{-3}\) → 4 mSv work, 14 mSv home
UNSCERAR developing new report on radon exposure and effects
• Communication (risk not higher… but dose)
SPC Secondary primary cancer

- New primary cancer in person who had cancer in the past – 16 % (1 in 6)
- Chemo- or radiation therapy (>50 % RT)
  - Dose response relationship of SPC after radiotherapy (RT) → dosimetry!
  - Radiosusceptibility (genetic, children, repair mechanisms, syndromes)
- Several studies (Boice 1985, Ng 2012)
- Planned UNSCEAR work
Environment – is it protected?

• Major progress since ICRP 103 (2007)?
  – ICRP has developed a system, involving reference animals and plants, to protect the environment ICRP 108, 114 and 214
  – ERA, STAR, COMET – promote dialogue and radioecology, maintain expertise
    → Laboratory vs. field studies, better end-points, understand exposure situations
    → Ecosystem approach, ecological functionality
Social Sciences

Communication about radiological protection issues, uncertainties etc. important → training

• Promote awareness of the RP system
• Societal and political demands
• Interdisciplinary dialogue – common learning – stakeholder process
→ Education, training, broad decision basis
Summary

• RP system works well – improvements
• Low dose (rate) mechanisms – incomplete picture – research progress, bio-markers?
• Epidemiological studies still crucial
• NORM (radon), non-cancer effects in focus
• Individual protection, protection of the environment (Utilitarian/Deontological)
• Education, communication & dialogue