ICRP: Challenges and Opportunities in the Next 20 Years

Nordic Society for Radiation Protection 2011 Conference

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Overview

- ICRP
  - Organisation
  - Mandate
  - Overview of programme of work

- Future Challenges and Opportunities
  - 0-5 years
  - 5-10 years
  - 10-15 years
  - 15-20 years

ICRP Structure

ICRP Main Commission

Scientific Secretariat

Committee 1	Committee 2	Committee 3	Committee 4	Committee 5
Effects	Doses	Medicine	Application	Environment

Task Groups

Working Parties

An independent, international community of experts in radiological protection

More than 240 experts in radiological protection science and policy
from 33 countries and six continents

Primary Aim

Contribute to an appropriate level of protection

for people and the environment

against the detrimental effects of radiation exposure

without unduly limiting the desirable human actions that may be associated with such exposure

Protection of Human Health

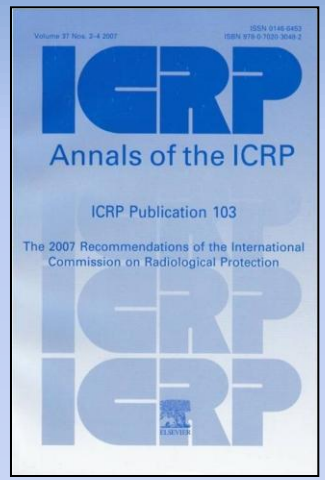
Manage and control exposures so that:

- Deterministic effects (harmful tissue reactions) are **prevented**

- The **risks** of stochastic effects (cancer or heritable effects) are **reduced** to the extent reasonably achievable

System of Radiological Protection

- ICRP develops and maintains the **System of Radiological Protection**
- Most recently updated in ICRP Publication 103
- Based on **science, value judgments, and experience**
- Forms the basis of radiation safety standards, legislation, guidance, programmes, and practice worldwide



ICRP Programme of Work

- **Support** and further **elaborate** the System of Radiological Protection of P 103
  - Provide technical information needed to implement the System (e.g. dose coefficients)
  - Elaborate within exposure types (occupational, public and medical) and situations (planned, existing, and emergency)

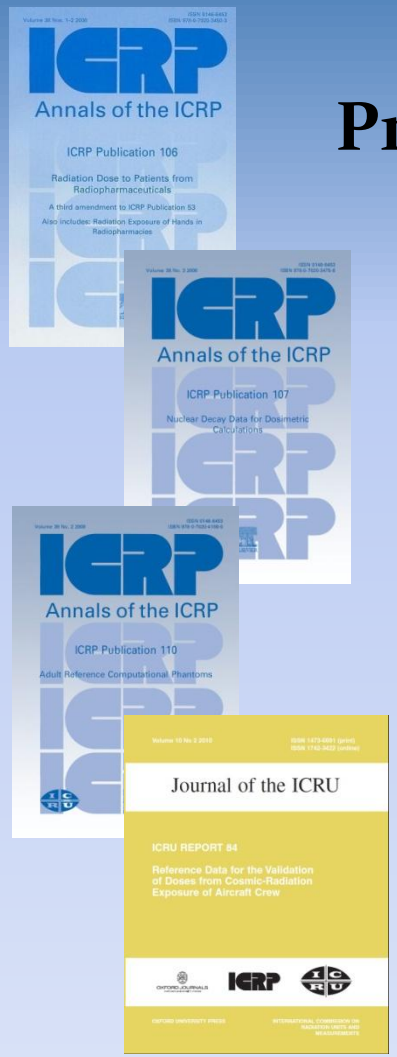
- **Assess** advances in scientific understanding and changing values that may influence evolution of the System
  - Science: e.g. revised radiation and tissue weighting factors
  - Values: e.g. greater emphasis on environmental protection

Since ICRP *Publication 103*

Elaborating on Specific Circumstances

- P 104 Scope of Radiological Protection Control Measures
- P 105 Radiological Protection in Medicine
- P 108 … Reference Animals and Plants
- P 109 … Emergency Exposure Situations
- P 111 … Living in Long Term Contaminated Areas
- P 112 … Radiotherapy with New Technologies

Since ICRP *Publication 103*



Providing Necessary Technical Information

- P 106 Radiation Dose to Patients from Radiopharmaceuticals
- P 107 Nuclear Decay Data for Dosimetric Calculations
- P 110 Adult Reference Computational Phantoms
- ICRU Report 84: Reference Data for the Validation of Doses from Cosmic-Radiation Exposure of Aircraft Crew (joint with ICRP)

Publication in 2011

- *Publication 113*: Education and Training in Radiological Protection for Diagnostic and Interventional Procedures
- *Publication 114*: Transfer Factor Values for Estimating Exposures of Reference Animals and Plants in Environmental Modeling Contexts (in press)
- *Publication 115*: Lung Cancer Risk from Radon and Progeny and Statement on Radon (in press)
- Dose Conversion Coefficients for External Radiation Sources (joint ICRP/ICRU)
- Tissue Reactions and Other Non-cancer Effects of Radiation

Consultation

- Radiological Protection in Paediatric Diagnostic and Interventional Radiology (consultation completed Aug 6)
- Patient and Staff Radiation Protection in Cardiology (consultation completed Aug 19)
- Radiological Protection in Fluoroscopically Guided Procedures Performed Outside the Imaging Department (consultation completed Aug 19)
- Radiological Protection in Geological Disposal of Long Lived Solid Radioactive Waste (comments due Nov 4)

Watch www.icrp.org … or register for e-mail or Twitter notification

Other Current and Near-Future Efforts

Specific Circumstances

- Radon
- NORM
- Air and space crew
- Security & legal exposure
- Diagnostic imaging in asymptomatic individuals
- Ion beam radiotherapy
- Secondary cancers in radiotherapy
- Environmental protection

Technical Information

- SAF values
- Computational phantoms
- Dose coefficients
- Non-human biota: dosimetry, w_R,

Advances in Epistemology (Science)

- Stem cell biology
- Cancer risk from α emitters
- Non-targeted effects

WARNING!

The rest of this presentation is speculative, representing the personal thoughts of the presenter

PREDICTING THE FUTURE

The System of Radiological Protection is based on

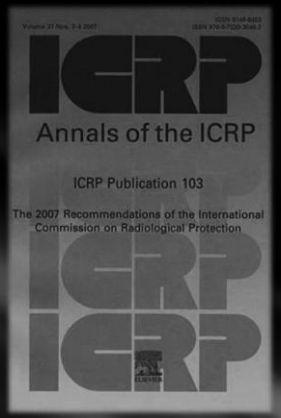
- Scientific understanding
- Value judgments
- Experience

For example, changes in P 103:

- New w_T based on new epidemiological information
- New emphasis on environmental protection based on modern societal expectations

Looking ahead towards the 100th anniversary of ICRP…

0-5 YEARS: IMPLEMENTING P 103

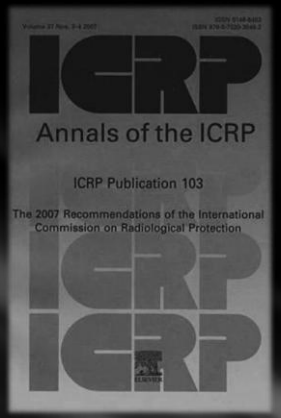


Supporting technical information

- **Revised dose conversion factors**
  - Updated radionuclide transformations (P107) ✓
  - New voxel reference phantoms: adult (P110) ✓ and others
  - SAF values
  - Revised biokinetic models

- **Reference data for Reference Animals and Plants (RAPs)**
  - RAP characteristics (P108) ✓
  - Environmental transfer factors for RAPs (P114) ✓
  - Improved dosimetry for RAPs including radiation weighting factors

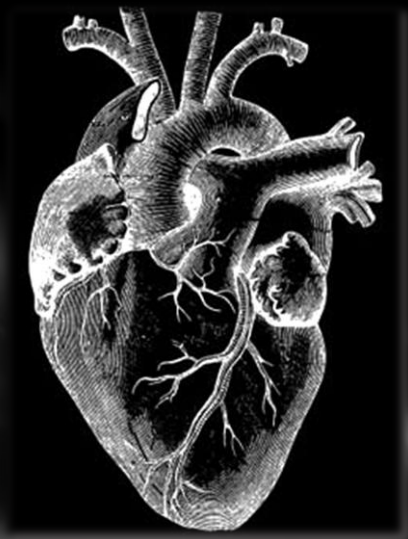
0-5 YEARS: IMPLEMENTING P 103



Elaboration

- RP in Medicine (P105, P112, P113) ✓ and more to come
- Emergency exposure situations (P109) ✓
- Existing exposure situations post-accident (P111) ✓
- NORM, waste disposal, radon, air crew, security screening, etc.
- Leaning from experience e.g. review of emergency and existing exposure situations based on Fukushima NPP accident

5-10 YEARS: NON-CANCER EFFECTS

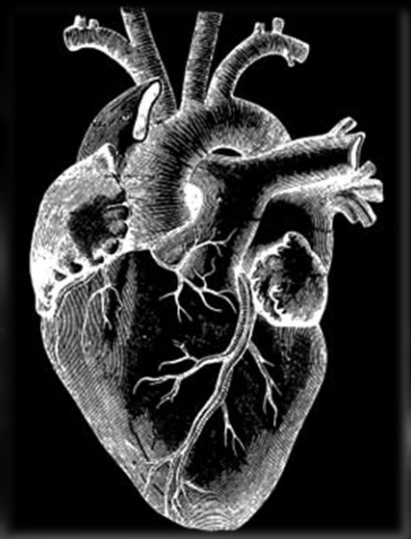


- Earliest "ICRP" recommendations (1928) based on non-cancer effects:
  - "Injuries to the superficial tissues"
  - "Derangements of internal organs and changes in the blood"

- Since the 1950's the primary focus has been cancer (and heritable effects) aka stochastic effects, with deterministic effects also taken into account

- **Tissue reactions** are the subject of a major ICRP publication now in press

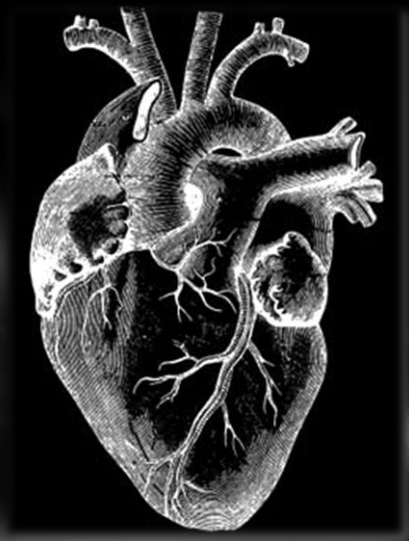
5-10 YEARS: NON-CANCER EFFECTS



Tissue reactions

- Dose-response
- Thresholds and detriment
- Philosophy of protection

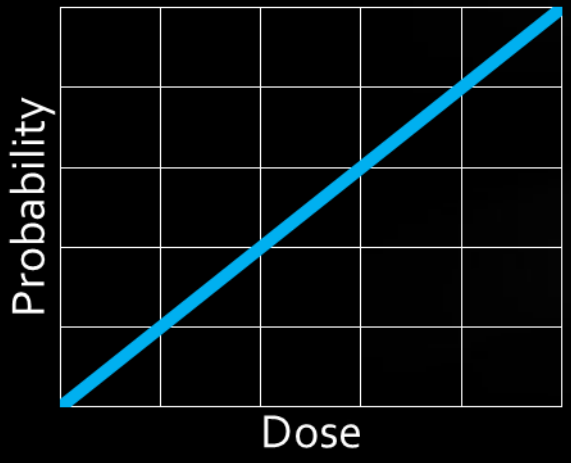
5-10 YEARS: NON-CANCER EFFECTS

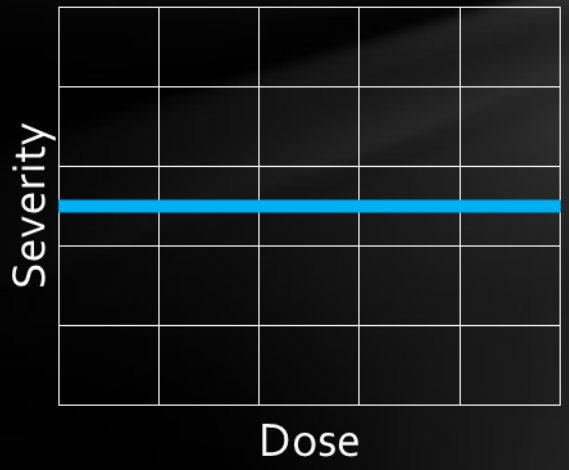


The radiological protection paradigm

Stochastic effects

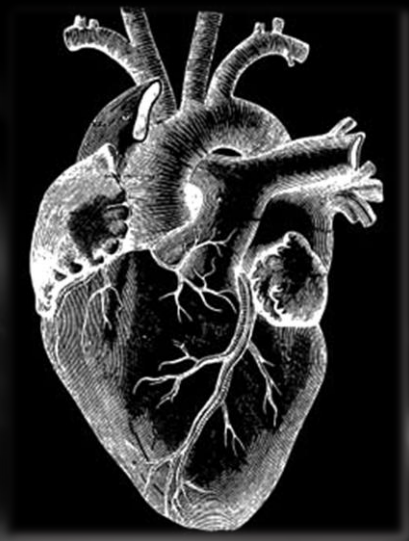
- "Linear no-threshold" (LNT) model for probability
- Slope is ***nominal detriment***
- Severity does not depend on dose





Set ***limits*** and ***optimise*** to reduce risks to as low as reasonably achievable

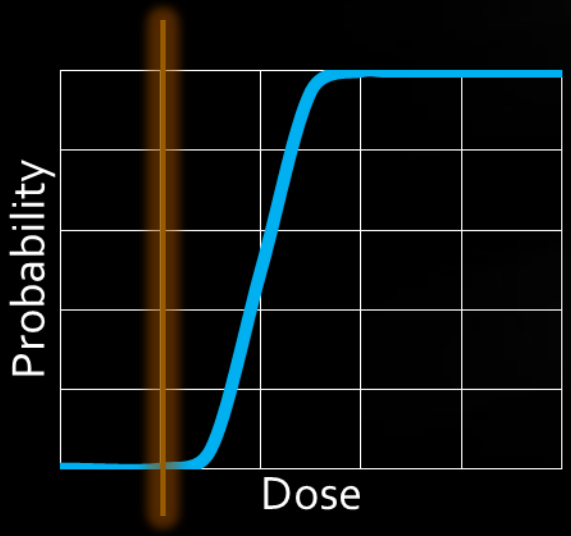
5-10 YEARS: NON-CANCER EFFECTS

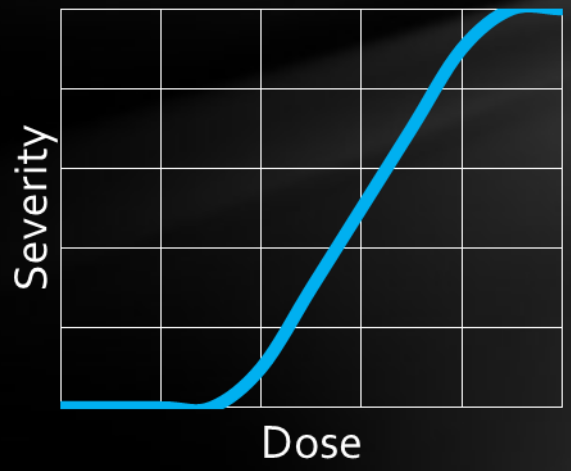


The radiological protection paradigm

Tissue reactions

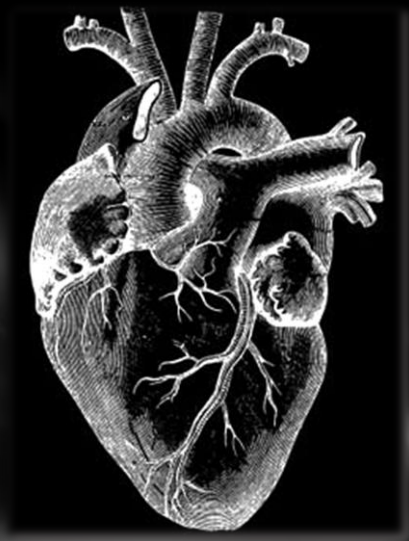
- ***Threshold*** below which no effects are observed
- Severity increases with dose above the threshold





Set ***limits*** to ***prevent*** tissue reactions

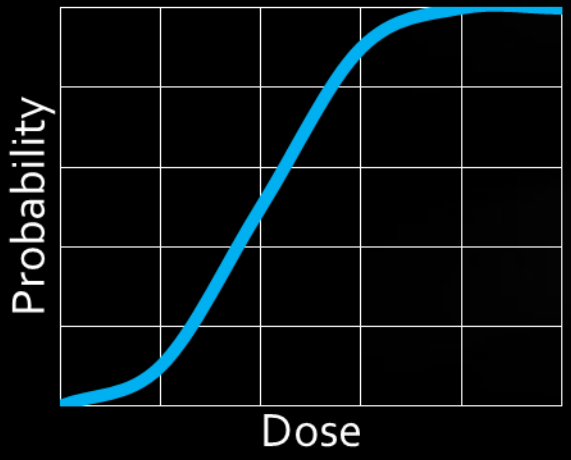
5-10 YEARS: NON-CANCER EFFECTS

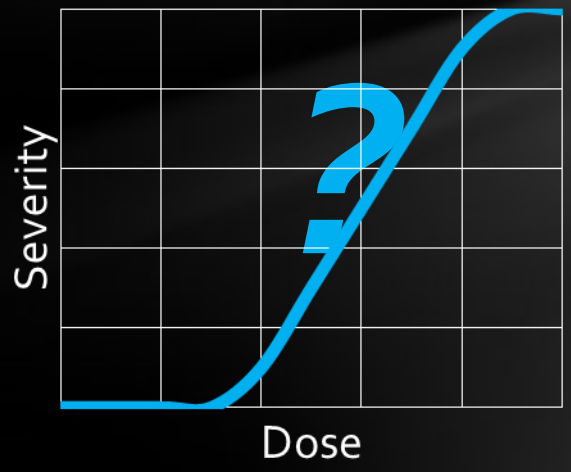


Recent evidence on tissue reactions

In particular, for late onset reactions e.g. circulatory disease

- Possibly no threshold
- Less clear relationship between dose and severity

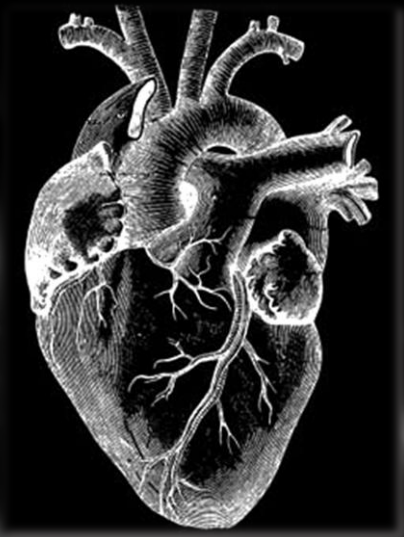




Set ***limits*** to ***prevent most*** tissue reactions

and **optimise** to reduce risk and severity

5-10 YEARS: NON-CANCER EFFECTS



Tissue reactions and stochastic effects

- Are the concepts of nominal detriment (stochastic effects) and nominal thresholds (tissue reactions) too simplistic?
  - They rely on the LNT model and the threshold model

- Does the basic aim of radiological protection need to be reexamined?
  - Aim: prevent tissue reactions and manage stochastic effects
  - BUT tissue reactions cannot be prevented if there is no threshold

10-15 YEARS: CANCER REVISITED

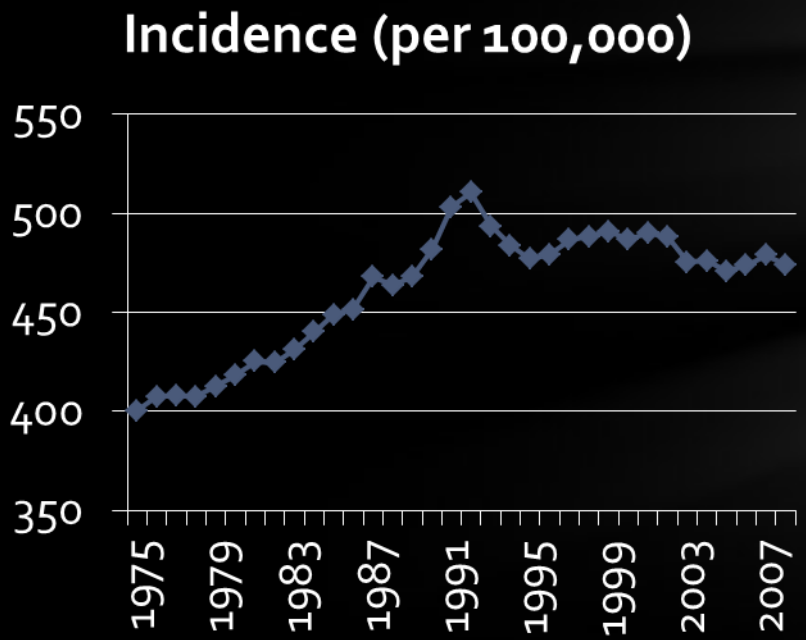
- Cancer mortality and morbidity rates are always changing

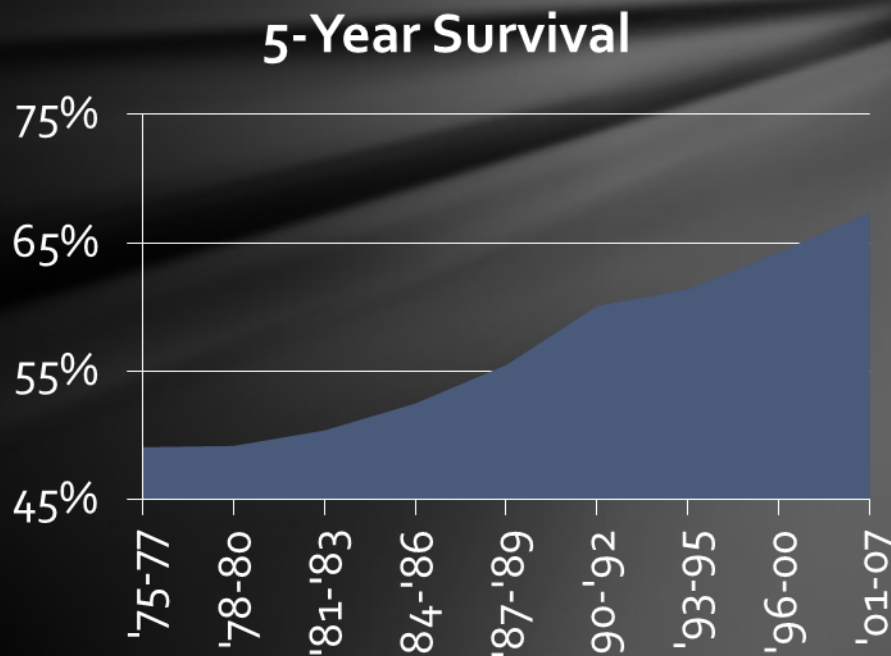
- Changes in mortality and morbidity effect
  - nominal detriment
  - tissue weighting factors

10-15 YEARS: CANCER REVISITED

Incidence and survival trends in the US

SEER Cancer Statistics Review 1975-2008, NCI, NIH





10-15 YEARS: CANCER REVISITED

- Changing morbidity and mortality influence
  - Nominal detriment
  - Tissue weighting factors

- Changes in detriment can influence effective dose limits

- Changes in tissue weighting factors effect dose conversion factors

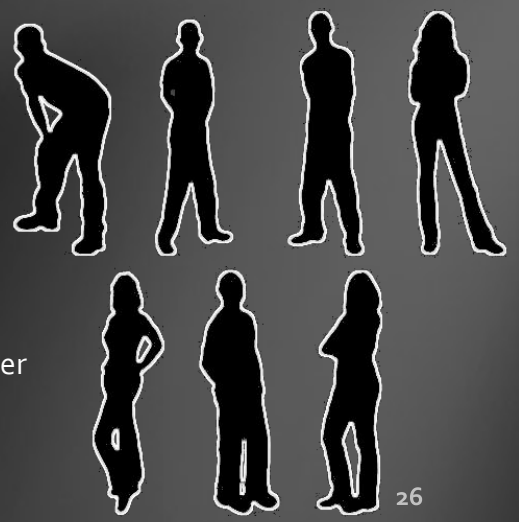
- Rebalance attention to various types of radiation exposure and to radiation vs. other hazards?

15-20 YEARS: INDIVIDUAL RADIOSENSITIVITY

Genetics and cancer incidence

- Many genes known to be associated with increased cancer incidence e.g.: BRCA1 , BRCA2, TP53, PTEN, STK11/LKB1, CDH1, CHEK2, ATM, MLH1, and MSH2

- e.g. BRCA1 / BRCA2 mutations associated with 5x breast cancer incidence and 10x ovarian cancer incidence



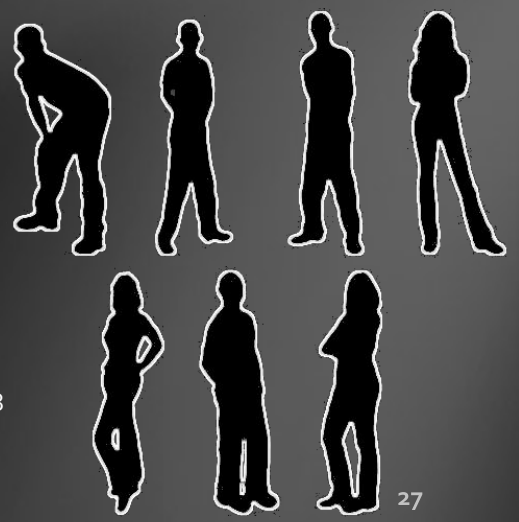
National Cancer Institute
http://www.cancer.gov/cancertopics/factsheet/Risk/BRCA

15-20 YEARS: INDIVIDUAL RADIOSENSITIVITY

Genetics and radiosensitivity

Specific genetic conditions associated with extreme radiosensitivity

- Ataxia telangiectasia
- Xeroderma pigmentosum (?)

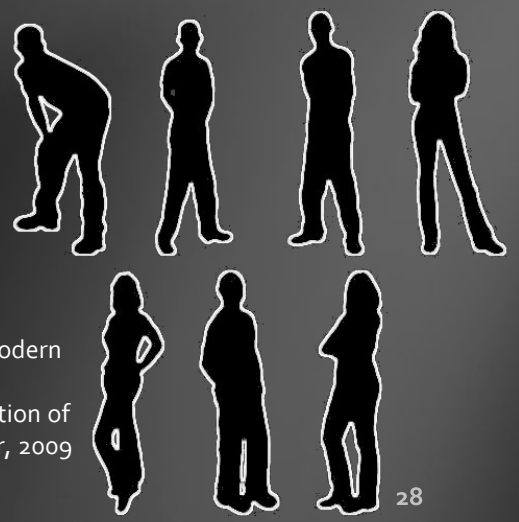


Arlett et. al. Minimal ionizing radiation sensitivity in a large cohort of xeroderma pigmentosum fibroblasts. Br J Radiol. 2008 Jan;81(961):51-8.

15-20 YEARS: INDIVIDUAL RADIOSENSITIVITY

Individual radiosensitivity

- ~5% of patients have severe tissue reactions after radiotherapy
- Predictive radiosensitivity tests
  - clonogenic, micronuclei, cytogenetic, DNA repair assays
- Newer, simpler tests with more predictive power now being used in clinical practice
- Tests may predict severe tissue reactions, but what about cancer induction?



International Conference on Modern Radiotherapy - Advances and Challenges in Radiation Protection of Patients - Versailles, December, 2009

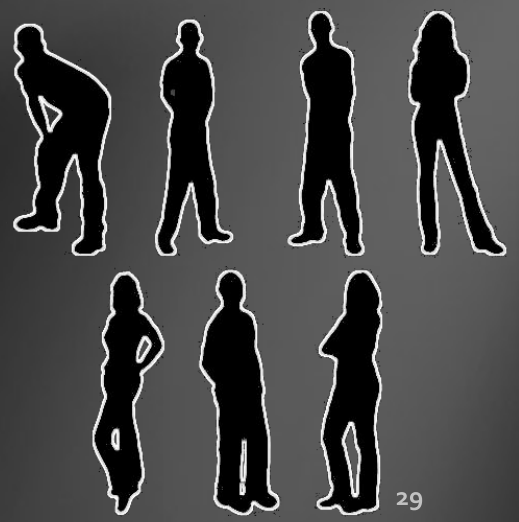
15-20 YEARS: INDIVIDUAL RADIOSENSITIVITY

Scientific challenges

- How well can an individual's radiosensitivity be understood?

- Not so simple! Individual sensitivities likely for many different endpoints (e.g. types of cancer and non-cancer effects) rather than an "overall" sensitivity

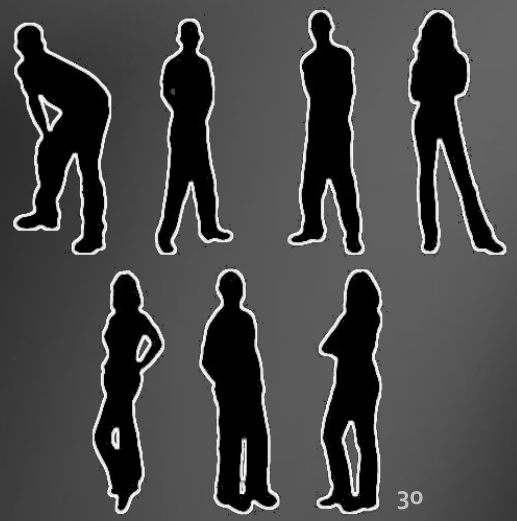
- Influenced by genetics, medical status, habits, age, environmental factors…



15-20 YEARS: INDIVIDUAL RADIOSENSITIVITY

Ethical challenges

- Privacy
- Fairness
- Deny more sensitive people radiation work?
- Deny more sensitive people medical insurance or face higher premiums?
- Individuals required to test or disclose?
- Will individuals want to know?



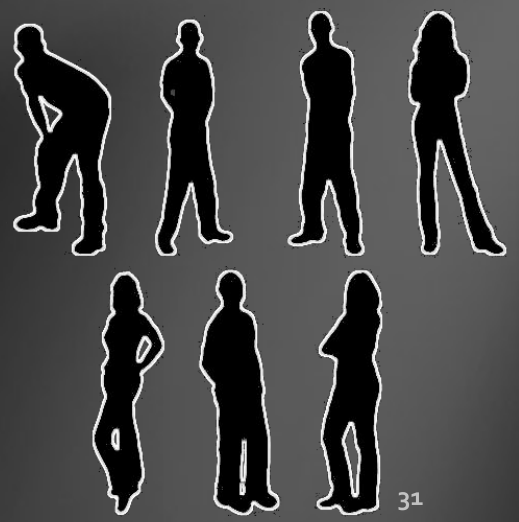
15-20 YEARS: INDIVIDUAL RADIOSENSITIVITY

Opportunities

- Better radiotherapy based on radiosensitivity of cancerous and normal tissues?

- More individual-risk based system of protection?

- Better protection of the workforce as distribution of work includes consideration of individual sensitivity?



Is our work never done?

The System of Radiological protection must continue to evolve as:

- New uses are found for ionising radiation
- More is understood about the effects of radiation
- Societal values evolve
- Experience is gained in practical implementation

BUT!

- What if for all practical purposes cancer and other negative effects of radiation exposure could be prevented or easily treated?

www.icrp.org