Science of Nuclear Energy and Radiation

Health Physics Orientation

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Outline...

- Modes of Exposure to Ionizing Radiation
  - ⇒Internal
  - ⇒External
- Risks and Hazards of Ionizing Radiation
- Control of Exposures
- McMaster University Radiation Protection Program

Exposure to Ionizing Radiation

- α, β, γ, η interact in any material and deposit energy through ionization
- The amount of energy deposited and its potential to cause harm are described by ***Dose***
- ***Dose*** is measured in units of mSv (millisieverts)

How much is a mSv?

- Background dose is about 3mSv per year
- Abdominal X-Ray leads to about 1.3 mSv
- Permissible occupational doses are...

Dose Type	Workers (mSv/y)	Public (mSv/y)	Pregnant Woman
Effective Dose	50	5	1 mSv abdomen + 0.05 ALI
Lens of the eye	150	15	
Any single organ	500	50	30
Hands and feet	500	50	50

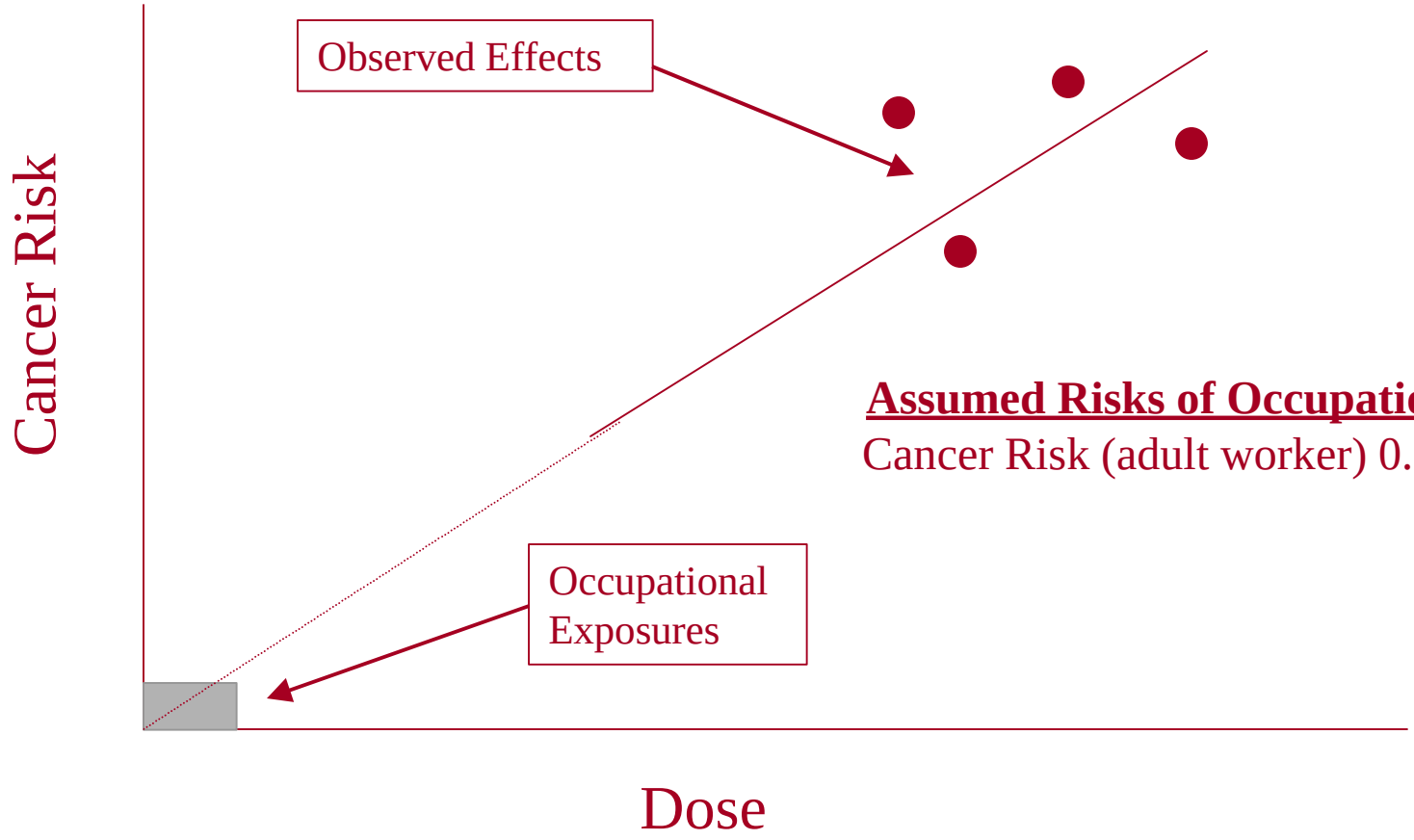
Risks and Hazards

- In living matter, damage to DNA may result from ionization
- Consequences of damage may be
  - ⇒NOTHING
  - ⇒ cancer
  - ⇒ genetic effects
  - ⇒radiation injuries

Controlling Risk

• Radiation Injuries ⇒have a threshold ⇒below threshold there is no effect	• Avoid by keeping doses to permissible levels
• Cancer and Genetic Effects ⇒**assumed** slight increase in risk proportional to dose for any exposure	• Minimize chance by maintaining doses As Low As Reasonably Achievable (ALARA)

Cancer Risk



Assumed Risks of Occupational Exposures

Cancer Risk (adult worker) 0.004% per mSv

Cancer Risk in Perspective

Assumed Additional Risk of Occupational Exposures
Cancer Risk (adult worker) 0.004% per mSv

Baseline Risk
Fraction of adults expected to die from cancer ≈ 20 %

Cancer Deaths Expected in a population of 10 000 with no Occupational Exposure
10 000 x 20% = 2 000

Cancer Deaths Expected in a population of 10 000 with 1 00 mSv Lifetime Occupational Exposure
Risk changes from 20% to 20.4%
10 000 x 20.4% = 2 040

See HP Manual pg. 17 for more risk perspective

Risk of Genetic Effects

- Radiation induced genetic effects have never been observed in humans
- Based on animal experiments they are assumed to occur at about 0.001% per mSv
- Baseline risk for genetic disorders is about 5% in live births (see HP Manual pg. 16)

Controlling Exposures

Internal Exposures	• Containment • Ventillation • Hygiene • Protective equipment
External Exposures	• Time • Distance • Shielding
General	• Monitoring • Posting/labeling • Training