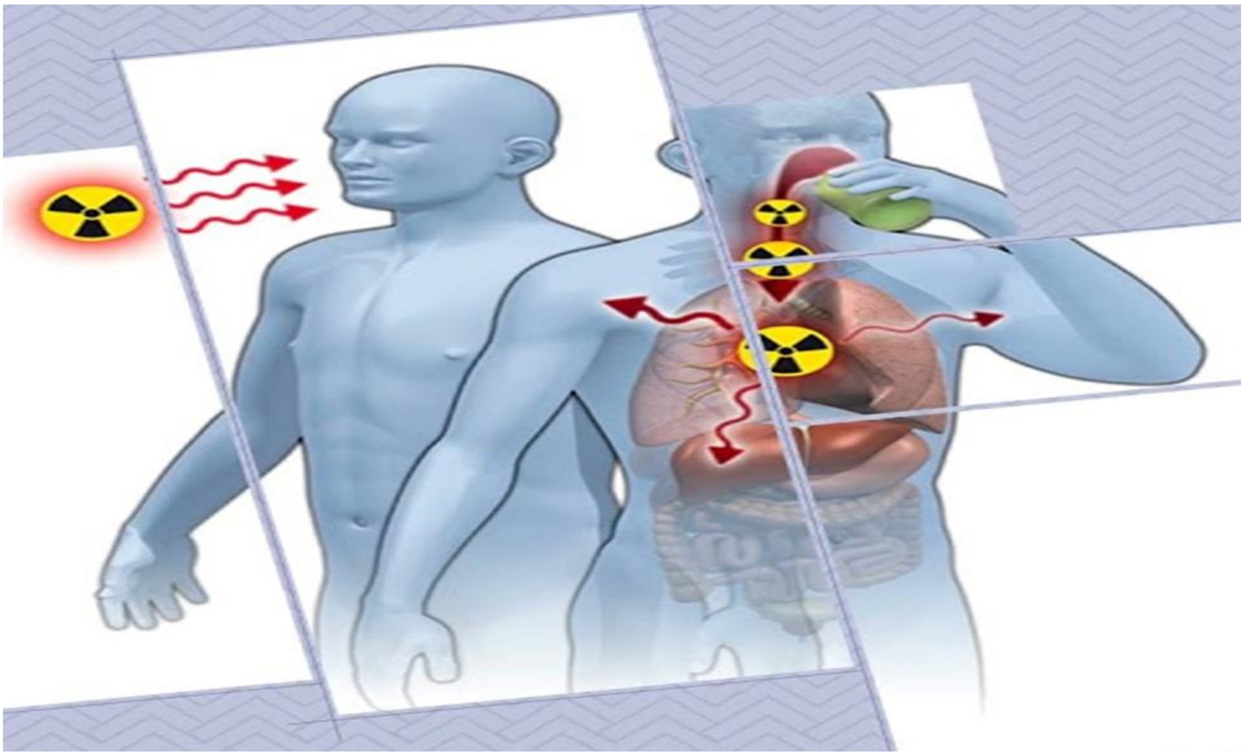
Title: Biological Radiation Hazards and Risk Estimation

9th Lecture



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Teaching of Biological Radiation hazards

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I. Introduction

- Ionizing radiation interacts with biological tissues, causing molecular and cellular damage.
- Understanding **risk estimation** helps evaluate the probability of radiation-induced health effects (primarily stochastic effects such as cancer).
- Three main epidemiological metrics are used:
  Relative Risk (RR), Excess Relative Risk (ERR), and Absolute Risk (AR).

II. Biological Basis of Radiation Risk

- Radiation can induce DNA damage: mutations, chromosomal aberrations.
- Stochastic effects → **probability increases with dose**, severity does not.
- Risk estimation models are essential for:
  - Radiation protection standards (ICRP, UNSCEAR)
  - Medical exposure evaluation
  - Occupational safety

III. Risk Estimates in Radiation Epidemiology

1. Relative Risk (RR)

Definition

Ratio comparing the frequency of an adverse effect (e.g., cancer) in an **exposed group** to that in an **unexposed group**.

Formula

RR=Incidence in ExposedIncidence in UnexposedRR = \frac{Incidence\ in\ Exposed}{Incidence\ in\ Unexposed}RR=Incidence in UnexposedIncidence in Exposed

Interpretation

- RR = 1 → No increased risk
- RR > 1 → Radiation exposure increases risk
- RR < 1 → Radiation exposure is protective (rare in radiation studies)

Example

If lung cancer incidence is 30/10,000 among exposed and 15/10,000 in controls:
RR = 2 → **Radiation doubled the risk.**

2. Excess Relative Risk (ERR)

Definition

The **increase in relative risk attributable to radiation**, beyond the baseline risk.

Formula

ERR=RR−1ERR = RR - 1ERR=RR−1

Use

- Commonly used in radiation studies such as **atomic-bomb survivor data (LSS)**.
- Useful for modeling dose-response relationships.

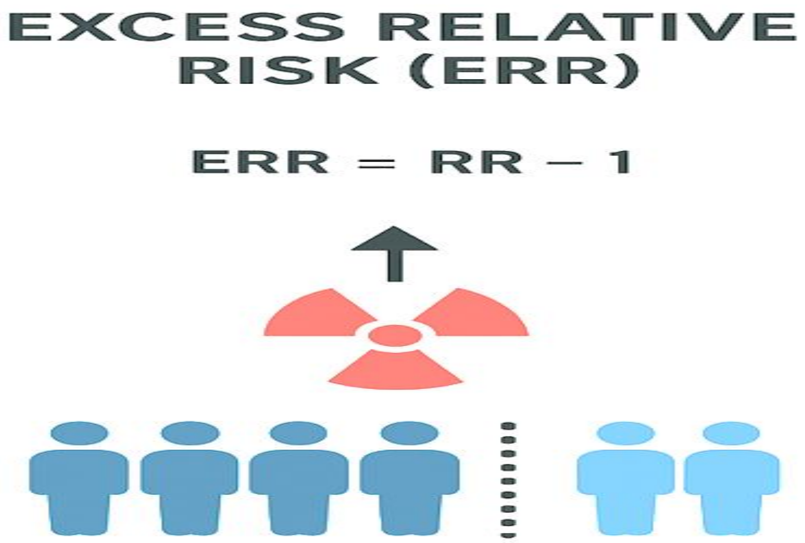
Interpretation

- ERR = 0 → No radiation-related excess
- ERR = 1 → Risk increased by 100%
- ERR = 0.5 → Risk increased by 50%

Dose Model Example

ERR=βDERR = \beta DERR=βD

Where D = dose, β = risk coefficient.



3. Absolute Risk (AR)

Definition

The **difference in incidence** between exposed and unexposed groups.

Formula

AR=Incidence (Exposed)−Incidence (Unexposed)AR = Incidence\ (Exposed) - Incidence\ (Unexposed)AR=Incidence (Exposed)−Incidence (Unexposed)

Interpretation

- Measures **additional cases** caused by radiation per population.
- Useful for estimating **public health impact**.

Example

If exposed group: 25 cases/10,000
Unexposed group: 10 cases/10,000
AR = 15 extra cases per 10,000 people.

IV. Comparison of Risk Measures

Risk Type	What It Measures	Best For
Relative Risk (RR)	Ratio of rates	Comparing populations
Excess Relative Risk (ERR)	Additional proportion of risk	Dose-response modeling
Absolute Risk (AR)	Additional cases	Public health & regulatory impact