AL- Mustaqpal University

Science College

Dep. Biochemistry

First Stage

Biophysics

Lec 9

Radiation Doses Interpretation and Analysis of The Amount of Radiation Exposure

Asst. lec. Ali Salman Hamadi

Radiation is energy that moves from one place to another in a form that can be described as waves or particles. We are exposed to radiation in our everyday life. Some of the most familiar sources of radiation include the sun, microwave ovens in our kitchens and the radios we listen to in our cars. And in physics, radiation is the emission or transmission of energy in the form of waves or particles through space or a material medium.

BACKGROUND ON DOSE ASSESSMENT AND DOSE RECONSTRUCTION

When ionizing radiation interacts with the human body it transfers part or all of its energy to the molecules and cells of body tissues. The response of these tissues to the deposition of energy in terms of physical, chemical, and biological changes is dependent on the amount of energy deposited per unit mass of tissue, or absorbed dose . **The quantity absorbed dose** (D) is defined as **the mean energy imparted by ionizing radiation per unit mass at a point of interest.**

The unit of absorbed dose is **J/kg**, and its special name is the **gray (Gy).** Although defined as a point quantity, absorbed dose usually represents an average over some finite volume or mass, such as the mass of the thyroid or the volume of red bone marrow distributed in the entire body. When the absorbed dose has approximately the same value for all organs and tissues of the body, as is the case for direct radiation[1] from energetic gamma rays or internal irradiation from inhalation or ingestion of cesium-137, it is common to use the term whole-body absorbed dose .

Adiation dose refers to the amount of ionizing radiation energy absorbed by a substance, such as biological tissue, measured in grays (Gy). It is calculated based on the energy absorbed in 1 kg of material, with different types of radiation having varying effects and weighting factors.

Radiation Dose

What is radiation dose?

A dose of medical **radiation** is not like a dose of medicine. When it comes to radiation dose, there are different types of and units of measurement. Radiation dose is a complicated topic.

Why are there different ways to measure a dose of radiation?

When you think of a dose of medication, you think of an absolute measurement of the quantity you take. But radiation isn't measured by the quantity you take.

Radiation from medical examinations is similar to sunlight. The effect of sunlight on the skin depends on the light's intensity and how long a person stays in it.

Sunlight Effect Factors :

- Intensity
- Length of exposure
- Sensitivity of the skin

People often describe their level of sun exposure based on the effect it has on their skin. Friends may say "You got a lot of sun." Or, "You're red; that must hurt." They are gauging the amount of sunlight, to which you were exposed, by what they see.

Likewise, a radiation dose will tell us about an effect the radiation has on tissue. Radiation dose can be measured a number of ways.

Radiation Doses

What these different doses can tell us:

1. **Absorbed dose** is used to assess the potential for biochemical changes in specific tissues.
2. **Equivalent dose** is used to assess how much biological damage is expected from the absorbed dose. (Different types of radiation have different damaging properties.)
3. **Effective dose** is used to assess the potential for long-term effects that might occur in the future.

What are x-rays and what do they do ?

X-rays are a form of energy – like light and radio waves. X-rays are also called radiation. Unlike light waves, x-rays have enough energy to pass through your body. As the radiation moves through your body, it passes through bones,

tissues, and organs differently. This allows a radiologist to create images of them. The radiologist is a specially trained doctor who can examine these images on a computer display. X-rays allow the radiologist to see the structures in your body in very fine detail.

X-ray exams provide valuable information about your health and help your doctor make an accurate diagnosis. Your doctor may use x-rays to help place tubes or other devices in your body or to treat disease.

Measuring radiation dosage

When radiation passes through the body, some of it is absorbed. The x-rays that are not absorbed are used to create the image. The amount the patient absorbs contributes to the patient's radiation dose. Radiation that passes through the

body does not contribute to this dose. The scientific unit of measurement for whole body radiation dose, called "effective dose," is the **millisievert (mSv)**. Other radiation dose measurement units include rad, rem, roentgen, sievert, and gray.

Doctors use "effective dose" when they talk about the risk of radiation to the entire body. Risk refers to possible side effects, such as the chance of developing a cancer later in life. Effective dose considers how sensitive different tissues are to radiation. If you have an x-ray exam that includes tissues or organs that are more sensitive to radiation, your effective dose will be higher. Effective dose allows your doctor to evaluate your risk and compare it to common, everyday sources of exposure, such as natural background radiation.

Naturally occurring "background" radiation

We are exposed to natural sources of radiation all the time. According to recent estimates, the average person in the U.S. receives an effective dose of about 3 **mSv** per year from natural radiation, which includes cosmic radiation from outer space. These natural "background doses" vary according to where you live.

People living at high altitudes such as Colorado or New Mexico receive about 1.5 mSv more per year than those living near sea level. The largest source of background radiation comes from radon gas in our homes (about 2 mSv per year). Like other sources of background radiation, the amount of radon exposure varies widely depending on where you live. To put it simply, the amount of radiation from one adult chest x-ray (0.1 mSv) is about the same as 10 days of natural background radiation that we are all exposed to as part of our daily living.

Benefit versus risk

The risk associated with medical imaging procedures refers to possible long-term or short-term side effects. Most imaging procedures have a relatively low risk. Hospitals and imaging centers apply the principles of ALARA (As Low As Reasonably Achievable). This means they make every effort to decrease radiation risk. It is important to remember that a person is at risk if the doctor cannot accurately diagnose an illness or injury. Therefore, it could be said that the benefit from medical imaging, which is an accurate diagnosis, is greater than the small risk that comes with using it.

Discussion

1. **What is radiation?**

   A) A type of chemical reaction

   B) The movement of energy as waves or particles

   C) A form of static electricity

   D) A substance found in X-ray machines

   E) A special type of light

   Correct Answer: B

2. **Which of the following is NOT a common source of radiation?**

   A) The sun

   B) Microwave ovens

   C) Radios

   D) Running water

   E) X-rays

   Correct Answer: D

3. **What is absorbed dose measured in?**

   A) Sieverts (Sv)

   B) Grays (Gy)

   C) Rads

   D) Millisieverts (mSv)

   E) Roentgens

   Correct Answer: B

4. **What does an absorbed dose refer to?**

   A) The total amount of radiation in the environment

   B) The total number of X-ray scans a person receives

   C) The energy absorbed per unit mass of tissue

   D) The total radiation exposure in a year

   E) The strength of an X-ray machine

   Correct Answer: C

5. **Which factor does NOT influence the effect of sunlight on the skin?**

   A) Intensity

   B) Length of exposure

   C) Sensitivity of the skin

   D) The time of day

   E) The person's age

   Correct Answer: E

6. **Which dose measures the potential for long-term effects of radiation?**

   A) Absorbed dose

   B) Equivalent dose

   C) Effective dose

   D) Total dose

   E) Internal dose

   Correct Answer: C

7. **What is the main purpose of equivalent dose measurement?**

   A) To measure the amount of radiation emitted by the sun

   B) To assess how much biological damage is expected from radiation

   C) To determine the weight of radioactive substances

   D) To measure the number of X-rays taken in a hospital

   E) To compare the effects of UV radiation on the skin

   Correct Answer: B

8. **What are X-rays primarily used for in medicine?**

   A) Heating the body

   B) Treating infections

   C) Diagnosing diseases by imaging body structures

   D) Increasing bone density

   E) Measuring body temperature

   Correct Answer: C

9. **Which of the following correctly describes X-rays?**

   A) A form of visible light

   B) A type of mechanical wave

   C) A form of energy that can pass through the body

   D) A type of sound wave

   E) A form of chemical radiation

   Correct Answer: C

10. **How is effective dose measured?**

    A) In Grays (Gy)

    B) In Roentgens

    C) In Becquerels (Bq)

    D) In Millisieverts (mSv)

    E) In Curie units

    Correct Answer: D

11. **What happens to radiation that is NOT absorbed by the body during an X-ray?**

    A) It disappears

    B) It contributes to the patient's radiation dose

    C) It helps create the image

    D) It is stored in body tissues

    E) It turns into heat

    Correct Answer: C

12. **Which of the following is NOT a unit of radiation measurement?**

    A) Rad

    B) Rem

    C) Roentgen

    D) Candela

    E) Sievert

    Correct Answer: D

13. **Which term describes the total radiation dose received by the entire body?**

    A) Localized dose

    B) Whole-body absorbed dose

    C) Medical dose

    D) Internal radiation dose

    E) Concentrated dose

    Correct Answer: B

14. **What is the largest source of background radiation in most homes?**

    A) Microwave ovens

    B) Cosmic radiation

    C) Radon gas

    D) Television screens

    E) Ultraviolet light

    Correct Answer: C

15. **How much natural background radiation does the average person receive annually in the U.S.?**

A) 1 mSv

B) 2 mSv

C) 3 mSv

D) 4 mSv

E) 5 mSv

Correct Answer: C

16. **How does altitude affect background radiation exposure?**

A) Lower altitudes have higher exposure

B) Higher altitudes have lower exposure

C) Altitude does not affect exposure

D) Higher altitudes have higher exposure

E) Background radiation only occurs at sea level

Correct Answer: D

17. **How does medical imaging balance benefit versus risk?**

A) It minimizes radiation exposure while ensuring accurate diagnoses

B) It eliminates all risks associated with radiation

C) It prioritizes patient safety by avoiding X-rays

D) It only uses X-rays for cosmetic procedures

E) It replaces radiation with safer alternatives

Correct Answer: A

18. **What principle is applied to minimize radiation exposure in hospitals?**

A) ALARA (As Low As Reasonably Achievable)

B) MRI (Magnetic Resonance Imaging)

C) CT (Computed Tomography)

D) RAD (Radiation Absorption Directive)

E) Maximum Exposure Limit

Correct Answer: A

19. **What is the effective dose of a single chest X-ray compared to natural background radiation?**

A) 1 day of background radiation

B) 5 days of background radiation

C) 10 days of background radiation

D) 20 days of background radiation

E) 30 days of background radiation

Correct Answer: C

20. **Which of the following factors affects the biological impact of radiation exposure?**

A) The type of radiation

B) The duration of exposure

C) The sensitivity of tissues

D) The dose received

E) All of the above

Correct Answer: E

21. **Which radiation dose type is most relevant for assessing cancer risk?**

A) Absorbed dose

B) Equivalent dose

C) Effective dose

D) Primary dose

E) External dose

Correct Answer: C

22. **What is the primary purpose of dose reconstruction?**

A) To measure radiation in the air

B) To assess historical exposure levels

C) To eliminate radiation risks

D) To replace medical imaging techniques

E) To create radioactive materials

Correct Answer: B

23. **Which of the following is TRUE about gamma rays?**

A) They have low energy

B) They penetrate deep into tissues

C) They are completely harmless

D) They only exist in space

E) They are a type of sound wave

Correct Answer: B

24. **Which group is most sensitive to radiation exposure?**

A) Adults

B) Elderly individuals

C) Infants and children

D) Middle-aged adults

E) Teenagers

Correct Answer: C

25. **Which of the following contributes to internal radiation exposure?**

A) Radon gas

B) Ultraviolet rays

C) Infrared light

D) Visible light

E) Radio waves

Correct Answer: A

26. **What is radiation?**

a) A type of medicine

b) Energy that moves as waves or particles

c) Energy only from the sun

d) Heat transfer between objects

e) None of the above

Correct Answer: b) Energy that moves as waves or particles

27. **Which of the following is NOT a source of everyday radiation exposure?**

a) The sun

b) Microwave ovens

c) Car radios

d) Swimming pools

e) X-rays

Correct Answer: d) Swimming pools

28. **How is the unit of absorbed dose defined?**

a) Energy emitted by the source

b) Energy absorbed per unit mass

c) Total energy of radiation

d) Energy stored in tissues

e) Energy transferred as heat

Correct Answer: b) Energy absorbed per unit mass

29. **What is the unit for absorbed dose?**

a) Sievert (Sv)

b) Gray (Gy)

c) Millisievert (mSv)

d) Rad

e) Roentgen

Correct Answer: b) Gray (Gy)

30. **What does whole-body absorbed dose mean?**

a) Radiation absorbed equally across all organs

b) Radiation absorbed only by the bones

c) Radiation absorbed externally

d) Radiation reflected by the skin

e) Radiation absorbed over a lifetime

Correct Answer: a) Radiation absorbed equally across all organs

31. **What factor is used to calculate the effective dose of radiation?**

    a) Tissue sensitivity

    b) Exposure time

    c) Frequency of radiation

    d) Skin color

    e) Weather conditions

    Correct Answer: a) Tissue sensitivity

32. **Which unit is commonly used for effective dose?**

    a) Gray (Gy)

    b) Millisievert (mSv)

    c) Roentgen

    d) Joule

    e) Watt

    Correct Answer: b) Millisievert (mSv)

33. **What is the primary risk associated with medical radiation?**

    a) Immediate burns

    b) Cancer development

    c) Genetic mutation

    d) Loss of eyesight

    e) Organ failure

    Correct Answer: b) Cancer development

34. **What principle is followed to minimize radiation exposure in medical imaging?**

    a) ALARA

    b) OSHA

    c) ARIMA

    d) BARA

    e) LEAN

    Correct Answer: a) ALARA

35. **Who is responsible for interpreting X-ray images?**

a) General physician

b) Radiologist

c) Pathologist

d) Cardiologist

e) Oncologist

Correct Answer: b) Radiologist

36. **How much radiation does a chest X-ray typically expose a person to?**

a) 0.01 mSv

b) 0.1 mSv

c) 1 mSv

d) 10 mSv

e) 100 mSv

Correct Answer: b) 0.1 mSv

37. **What is the approximate equivalent of a chest X-ray in terms of natural background radiation?**

a) 1 day

b) 10 days

c) 1 month

d) 6 months

e) 1 year

Correct Answer: b) 10 days

38. **What is the largest source of natural background radiation?**

a) Cosmic rays

b) Radon gas

c) Soil minerals

d) Medical imaging

e) Water contamination

Correct Answer: b) Radon gas

39. **How much effective dose does the average person in the U.S. receive yearly from natural sources?**

a) 0.3 mSv

b) 3 mSv

c) 30 mSv

d) 300 mSv

e) 0.03 mSv

Correct Answer: b) 3 mSv

40. **Which location typically has higher natural radiation exposure?**

a) Sea level

b) High altitudes (e.g., Colorado)

c) Underground caves

d) Tropical rainforests

e) Polar regions

Correct Answer: b) High altitudes (e.g., Colorado)

41. **What factor does NOT contribute to natural background radiation?**

a) Radon gas in homes

b) Cosmic rays

c) X-ray imaging

d) Soil composition

e) Altitude

Correct Answer: c) X-ray imaging