READING HOSPITAL SCHOOL OF HEALTH SCIENCES
MEDICAL IMAGING PROGRAM
RADIATION PROTECTION—2021

RADIATION QUANTITIES & UNITS

I. **Historical Events in Radiation Protection**

a. X-rays were invented:

    1.Date:_____

    2.By:_____

b. First clinical x-ray in US

    1.Date: _____

    2.By: _____

    3.Image was of:_____

c. First radiation induced death in US

    1.Year:_____

    2.Who:_____

    3.What did Edison invent?_____

d. First cancer from occupational exposure to a physician

    1.Year: _____

e. Early 1900's
    1.Radiodermatitis

    2.Aplastic enema

    3.Leukemia

f. 1921- British X-ray and Radium Protection Committee

g. 1900- 1930
    1.Inaccurate skin erythema dose
    2.International Congress of Radiology met

3. ICRU was established
4. Roentgen accepted
5. Tolerance does 0.2 Roentgen/ day established

h. 1935- 1950
1. Tolerance dose lowered to 0.1 Roentgen/ day
2. Roentgen accepted as unit of exposure measurement
3. NCRP established
4. SI unit established
5. Maximum Permissible Dose replaced tolerance dose
- Measures in rem

i. 1970- 1990
1. Dosimetry and risk analysis established
2. Effective dose equivalent
- Measured in sievert
3. SI unit adopted

II. Radiation Effects

a. Somatic effect- effect seen in the individual who received the exposure

1. Short term effect examples:

_____

_____

2. Long term effect examples:

_____

_____

b. Genetic effect- damage to the cell's _____

1. Effects seen in offspring of exposed individual.

2. Exposure is received _____

- Causes: _____

III. Basic Radiation Quantities

a. Exposure (X)
1. Radiation that may strike an object when in the vicinity of a source

2. Used to measure: _____

3.Measures tube output of imaging and monitors used to calibrate machines.

4.Applies only with _____ and _____

5.Measured in:

- SI:

- Traditional:

6.Conversion: _____

b. Air Kerma

1.SI unit that can be used to describe radiation that is transferred to a point (skin surface)

2.Can be used to describe:

- Tube input

- Tube output

- Exposure to skin

3.Kinetic energy released in matter.

4. Measured in _____

5.Entrance Skin Air Kerma (ESAK) definition:

c. Absorbed Dose (D)

1.Amount of energy (radiation) absorbed per unit mass (patient tissue)

2. Measures the absorbed patient dose

4. Higher atomic number = _____

5. Responsible for biological damage

6. Measured in:

- SI:

- Traditional:

7. Conversion: _____

Examples:

10 Gy = _____rad   545 rads= _____Gy
10 * 100 =   545/ 100=
= 1000 rad   = 5.45 Gy

d. Dose Equivalent (H) or Equivalent Dose (EqD)

1. Average dose in human tissue by different types of radiation that measures biological harm

2. Used to measure: _____

3. Uses radiation weighting factors

4. Measured in:

   • SI:

   • Traditional:

TABLE 3-2	Radiation Weighting Factors for Different Types and Energies of Ionizing Radiation
Radiation Type and Energy Range	Radiation Weighting Factor (W_h)
X-ray and gamma ray photons and electrons (every energy)	1
Neutrons, energy <10 keV	5
10 keV-100 keV	10
>100 keV-2 MeV	20
>2 MeV-20 MeV	10
>20 MeV	5
Protons	2
Alpha particles	20

Data adapted from International Commission on Radiological Protection (ICRP): *Recommendations*, ICRP Publication No. 60, New York, 1991, Pergamon Press.

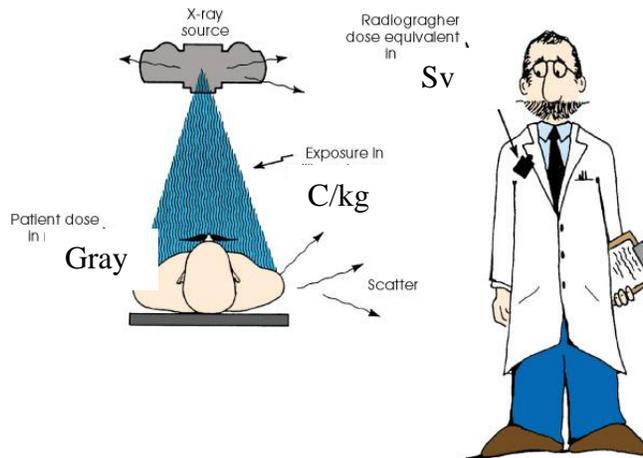5. Conversion: _____

Examples:

450 rem = _____Sv   2 Sv= _____rem
450/ 100=   2 X 100=
=4.5 mSv   =200 rem

X-ray source
Radiographer dose equivalent in Sv
Exposure in C/kg
Patient dose in Gray
Scatter

e. Radioactivity (A)

    1.Used to measure quantity of radioactivity

    2.Not used in diagnostic x-ray

    3.Measured in:

- SI:

- Traditional:

    4.Conversion: _____

TABLE 3-3	Organ or Tissue Weighting Factors	
Organ or Tissue		**Weighting Factor (W$_T$)**
Gonads		0.20
Red bone marrow		0.12
Colon		0.12
Lung		0.12
Stomach		0.12
Bladder		0.05
Breast		0.05
Liver		0.05
Esophagus		0.05
Thyroid		0.05
Skin		0.01
Bone surface		0.01
Remainder*†		0.05

Data from National Council on Radiation Protection and Measurements (NCRP): *Limitation of exposure to ionizing radiation*, Report No. 116, Bethesda, 1993, NCRP.

IV.   **Other Terminology**

a. Effective Dose (E)

    1.Define:

    _____

    _____

    2.Measured in: _____

    3.Takes into consideration type of radiation and radiosensitivity of the tissue

    4.Uses tissue weighting factor

b. DAP – Dose Area Product

    1.Define:_____

    _____

    2.ESE x area

    3.Takes into consideration the dose and the tissue exposed

    4.Gives better indication of overall harm

c. Collective Effective Dose (ColEfD)

    1.Define:

    _____

    _____

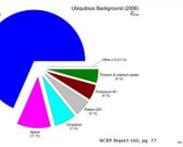   2.Measured in person sievert or man-rem

    3. Example:

      200 people receive 0.25 Sv,

      200 X 0.25= 50 person sievert or man- rem

d. Average Effective Dose (Eexp)

    1.Define:

    _____

    _____

e. Effective Dose per Individual in US (EUS)

    1.Define:

    _____

    _____