RADIOLOGY SHEET 4.

- Date: 30.June.2015
- Written by: Deema AlQudah & Siwar AlAshhab.

Last lecture we talked about **the interactions** that occur inside the patient's head who is getting a radiation and there are three types:

1. **Coherent scattering**
2. **Photoelectric attenuation**

   In this type of interaction the energy of the photon will be absorbed by the atoms of the patient so it is also known as "photoelectric absorption".
3. **Compton scattering**

These interactions are responsible for image production, as well as the harmful effects of radiation, so we have to know **WHAT** are these effects, **WHEN** to worry about them and **WHAT TO DO** if we are worried about them.

Radiation Safety & Protection

- An interesting incidence happened in a pediatric hospital in California that was using a real HIGH dose that is 10 times higher than the normal one that is needed and they realized that after seeing that the skin of the children is burning after they finished the CT scan.
- 62 million CT scan per year in USA, 4 million are on children!
- From 1.5-2% of all cancers in the united states may be attributable to the radiation from CT studies , 2% is a big number and this problem is a big international one , but we really need Radiographs for Diagnosis , treatment options & follow up , so we have to balance between the risks versus the benefits and put policies for that and think about it "**As Low As Reasonably Achievable** = ALARA" or " **As Low As Diagnostically Achievable** = ALADA" not as low as possible because as we said before we really need the X-rays. This means that we only took X-ray for the patient who really need it in

appropriate dose and frequency by following the manufacturer instructions and use the image to the maximum.

- **ALARA: This is the guiding principle of radiation protection every where including dental offices.**

Units of Radiation:

This concept has been developed. It was very simple one, then they add more information to it until reaching the units that are used nowadays.

1. **Exposure : Roentgen (R)**

- We use roentgen as a unit because the man who discovered the X-rays is called Roentgen.
- 1R = Amount of radiation that produces 2.08 *10 ^9 **ion pairs** in 1 cc of air.
- **The harmful effects of radiation are coming from ionization.** But our bodies are not made of air, so it does give a small indication.
- SI unit : C\Kg 1 C\Kg =388 Roentgen

2. **Absorbed dose**

- The energy imparted by a radiation to a **matter** per unit mass. " matter not air "
- SI unit : Gray 1 Gray = 100 Rad

3. **equivalent dose**

- They take into consideration the radiation type.
- Alpha radiation has a mass, so its much more ionizing compared to Gamma, so the energy from them is not the same!

4. **Effective dose**

- More accurate.
- In addition to everything mentioned above, they also take into consideration the type of tissue.

- In absorbed dose: The energy imparted by a radiation to a matter per unit mass, but we don't know its mass of what, mass of muscle, mass of bone or a mass of nerves, nobody knows…

- So, the effective dose is a mean of expressing the radiation induced risk to the whole body , even though the whole body was not exposed. Its the sum of products of the equivalent dose of each tissue and organ, and **the tissue weighing factor**.

- **How did they calculate this factor?**

Hiroshima & Nagasaki was an unfortunate event, but it was a good opportunity for huge cohort studies. Those affected people had received a high dose of radiation, so what we do is that we follow up them till they die, and we follow up their children, and generation by generation until they die.

They follow up their life expectancy in general, and other specific topics, such as: does the prevalence rate of thyroid cancer –for example- increase in them? Leukemia? & other diseases.

5. Radio-sensitivity

- Tissues are either sensitive or insensitive.

- Radio-sensitivity differs between 1 cell & another, and between 1 tissue & another, they found that it will increase with the increase in:

A. Rate of proliferation

B. number of future divisions

WHY? Because more DNA will be available, thus more DNA will be affected!

(DNA is the major place that is affected by the X-rays, so more DNA content, more chance of hitting one of these molecules so more chance of getting cancer.)

But there is 2 exceptions: Oocyte and lymphocyte; they don't really proliferate and don't have future divisions but they are sensitive because the nucleus\cytoplasm ratio is high.

The bad effects of radiation are divided into two main categories:

1. **Non-Stochastic**

   = DETERMINISTIC; meaning it either happens or it doesn't.

   - Below a certain number (threshold) the bad effect does **NOT** happen. *(e.g. cataract)*
   - When skin burns occur in children after taking a radiograph that means that the dose was **ABOVE** the threshold.
   - The general rule in this type:

     As the radiation dose increases → the severity of the bad effects increases.

     (BUT! The dose **HAS** to be **ABOVE** the threshold.)

   - *Examples:*

     1. *In utero birth defects*
     2. *Burns*
     3. *Cataracts*

2. **Stochastic**

   - The effect can occur by a photon or a hundred.
   - Severity is **NOT** dependent on the dose.

     (The cancer that results from 1 photon will **NOT** be less severe than the one that occurs as a result of a hundred photon.)

   - HOWEVER, the risk is proportional to the dose; meaning as the dose increases → the risk increases.
   - Stochastic effect is ***mainly CANCER.***

     (One photon can actually cause cancer → **DANGEROUS**; but that doesn't mean to put off dentistry, because as long as we are as low as reasonably achievable that means we have a good clinical practice.)

- **REMEMBER!**

  The stochastic effect occurs with any dose = **NO THRESHOLD.**

  Thus, low-dosage radiation has certain effects too!

The effects of low dose of radiation:

1. **Heritable effect**

   If a woman (non-pregnant) or a man has been exposed to a certain radiation, would it be possible that they pass the effects of radiation to their offspring?

   There is NO significant increase in genetically related diseases in the children of bomb survivors.

2. **Carcinogenic effect**

   - Cancer has **NO** threshold.
   - From Hiroshima and Nagasaki accident I have experimental data on certain doses only and these data do NOT involve the lower doses.
   - The more conservative approach was adopted → **NO such a thing called Zero-effect.**
   - The point is: the person has to be careful as much as he can; don't stop using technology but follow the rules.

3. **Teratogenic effect**

   If a pregnant lady comes to your clinic and needs an x-ray, should you do it or not?

   - In utero birth defects would require 10-25 rad (to the fetus not the mother) = deterministic = **NEEDS A THRESHOLD.**
   - If a patient has taken a FMX=Full mouth x-ray, which represents 18 oral images, ALL these images will be less than 1 mille ram (1 ram = 1 rad), meaning; about 10-25 thousands less than the dose required to cause the in utero birth defects.
   - **So yes, you can do an x-ray to a pregnant lady.**
   - Radiograph→ Diagnosis → Treatment.

- You don't have to force patients to take radiographs, she gets a radiograph while she is pregnant after her consent.
- If you are NOT going to treat your patient because of any other medical problems, problem with the anesthesia for example, there's no need to take a radiograph.
- If the patient refuses to give you a consent to take a radiograph, you have the right to refuse doing the treatment if you think that it is essential for the treatment.

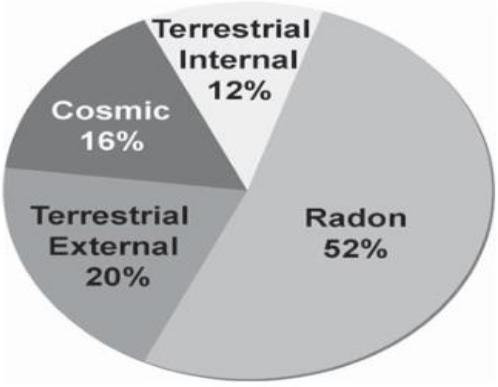

FIG. **3-1** Sources of global background radiation contribute 2.4 mSv per year. Most exposure comes from radon, but there are significant contributions from cosmic and terrestrial sources including external from the soil and building materials and from ingested radionuclides. (Data modified from UNSCEAR 2000.)

- Radiation exposure is an important thing and is a part of life.
- **The <u>biggest</u> portion of the pie is actually coming from <u>Radon</u>**; a natural source like in the sand.
- You have to be meticulous and careful but you don't really have to freak out.

Different types of x-ray modules of a machine will give us different types of **<u>equivalent dose</u>** → ***<u>related to the cancer risk</u> = how much in a million there's a risk of getting cancer.***

(Here we are talking about <u>low doses</u> which <u>do not involve any of the deterministic effects.</u>)

- There’s 1 in a million chance of dying of cardiovascular diseases in each 20 minutes of life if you’re a male with an age of 60 and above. Same with smokers, there’s 1 in a million chance of dying because of smoking 1.4 cigarettes daily.
- There’s no limits for the radiation exposure, you have to always weight the benefits and the hazards as low as reasonably achievable.

The most important principles:

1. **Awareness**
2. **Avoidance**
3. **Time**
4. **Distance**