Présentation Power Point du Dr. Maroun Karam

"RADIATION IN DAILY LIFE AND MEDICAL RADIATION"

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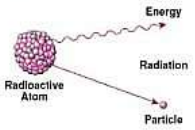
What is radiation?

- Radiation is energy that is given off by particular materials and devices.
- Low-energy radiation is called non-ionizing radiation.
  - Sound waves, visible light, microwaves
- Radiation that can cause specific changes in molecules is called ionizing radiation
  - X-rays, gamma rays and particles
  - Too much ionizing radiation may damage tissues



EXAMPLES OF RADIATION

- Non ionizing radiation : visible light , sound , infrared , ultrasound etc . Energy is too low to cause damage to cells
- Ionizing radiation: Ultraviolet , Xrays , Gamma Rays (Nuclear Medicine) , Particles (radiotherapy) . High energy can cause damage to cells
- Very large doses can kill (Hiroshima)
- Moderate doses can cause increased incidence of cancer 20 years later in adults and 10 years later in children (Leukemia) (except for iodine therapy of thyroid cancer = no increased incidence of second cancer)
- Small doses have not been shown in a definitive way to cause damage or cancer unless they are given in a repetitive way over many times

TIME COURSE OF CANCER DEVELOPMENT AFTER EXPOSURE TO LARGE AMOUNT OF RADIATION

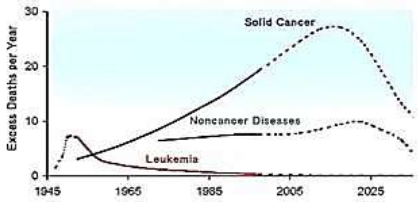


Figure 1 Actual and predicted time course of radiation-induced diseases in the Japanese life span study; 1945-2028. (Reprinted with permission from Douple et al.[18])

Measuring radiation

The international unit used to measure the amount of radiation received by a patient is the "millisievert" (mSv).

Sometimes, the traditional unit, "millirem" (mrem), is used.

1 mSv = 100 mrem

SNM

We are exposed every day to "background radiation"

Cosmic rays from space | Radioactivity in the earth | In our bodies | Radon gas in our houses

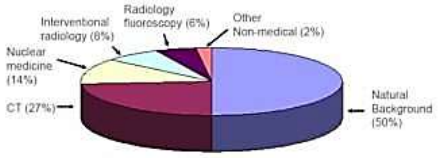
The average radiation dose in the U.S. from background radiation is 3.1 mSv, with 2.3 mSv coming from radon in our houses.

BACKGROUND RADIATION

1. Cosmic radiation comes from all the stars in the universe which emit radiation as they decay
2. Most of this radiation is blocked by the atmosphere but some of it escapes and reaches earth
3. The higher the altitude the more cosmic radiation reaches us

4. Radon is a radioactive gas produced by the breakdown of uranium in soil rock and water. Air pressure in the house is lower than in the soil acting like a vacuum and drawing radon through foundation cracks
6. There is very little radon in running water but if you draw water through an artesian well you may get more radon

How much ionizing radiation do people get?



The average annual radiation exposure in the U.S. is 6.2 mSv total, with 3.1 mSv coming from medical procedures
—NCRP Report 160

IN LEBANON FEWER RADIOLOGICAL TESTS ARE PERFORMED
PERCENTAGE FROM BACKGROUND RADIATION HIGHER
ALSO HIGHER ALTITUDE . PROBABLY AROUND 70%

Putting radiation in context

Everyday Activities	Radiation Dose
Watching television	0.01 mSv/year
Air travel (roundtrip from D.C. to L.A.	0.05 mSv
Average annual exposure from breathing radon gas	2 mSv
Average annual exposure living in the United States	3 mSv/year
Annual dose limit for radiation workers in U.S.	50 mSv/year

Medical Imaging	Radiation Dose
Chest X-ray (1 film)	0.1 mSv
Nuclear med. thyroid scan	0.14 mSv
Mammogram (4 views)	0.4 mSv
Nuclear med. lung scan	2 mSv
Nuclear med. bone scan	4.2 mSv
Tc-99m cardiac diagnostic	11 mSv
Abdominal CT scan	8 mSv
F-18 FDG PET/CT study	14 mSv
Cancer treatment	50,000 mSv

* See www.thisisnuclear.org, fact sheets, Molecular Imaging Safety for statistics sources.

EFFECTS OF LOW DOSE RADIATION

1. Defined as doses between 3 (natural) and 50 msv (radiation workers upper limit)
2. 20 yrs ago it was thought that low dose radiation did increase cancer rates
3. Recent discovery of cellular mechanisms of repair of DNA damage at low rates
4. Only when mechanisms of repair are overwhelmed effects are seen
5. However in children low doses may have an effect because they are radiosensitive

Decrease in Life Expectancy

Activity or risk	LLE (days)
Living in poverty	3,500
Being male (vs. female)	2,800
Cigarettes (male)	2,300
Working as a coal miner	1,100
30-lb overweight	900
Grade school dropout	800
15-lb overweight	450
Alcohol	230
Motor vehicle accidents	180
Speed limit: 65 vs. 55 miles per hour	40
Coffee: 2 cups/day	26
Radiation worker, age 18-65	25
Japanese Bomb Survivors who received less than 250 mGy	25
Birth control pills	5

LIFETIME RISK OF DEATH FROM EVERYDAY ACTIVITIES COMPARED TO MEDICAL RADIATION

Table 1 Lifetime Risk of Death From Everyday Activities Compared With Medical Radiation Exposures: For Example 1 of 304 Americans Will Die Because of an Accident While Riding in a Car During His or Her Lifetime

Activity	1/Risk	Examination	1/Risk
Riding in car	304		
Crossing street	652	CT abdomen (10 y old)	1600
Choking	894	CT abdomen (40 y old)	2900
Drowning	1127	^{18}FDG-PET (10 y old)	1515
Falling on stairs	2024	^{18}FDG-PET (40 y old)	2700
Riding bike	4734	^{99m}Tc-MDP (10 y old)	2560
Airplane crash	7058	^{99m}Tc-MDP (40 y old)	4760
Hit by lightning	84,388		

Reprinted with permission from Fahey et al.[3]

MEDICAL RADIATION

1. Ultrasound and MRI do NOT deliver ionizing radiation
2. Xrays (plain Xrays) or CT scan deliver small amounts of ionizing radiation
3. Gamma rays (Scintigraphy and PET scan)deliver also small amounts
4. Radiotherapy delivers large doses of radiation
5. Children and pregnant women are MORE sensitive to radiation than adults
6. There is a great variability in sensitivity of various organs
7. MEDICAL RADIATION IS ADMINISTERED
   - TO MAKE THE DIAGNOSIS OF A DANGEROUS OR POTENTIALLY FATAL DISEASE
   - OR TO TREAT A DANGEROUS OR POTENTIALLY FATAL DISEASE
   - THE RISK OF GETTING CANCER WITHOUT RADIATION IS NOT ZERO

TABLE 2
Adult Effective Doses (mSv) for Radiographic and Nuclear Medicine Procedures

Procedure	Average effective dose (mSv)
Posterior/anterior and lateral chest radiography	0.1
^{99m}Tc-radionuclide cystography	0.1
Mammography	0.4
Lumbar spine radiography	1.5
Head CT	2.0
^{99m}Tc-MAG3 renal scanning	2.7
Intravenous urography	3.0
^{99m}Tc-MDP bone scanning	4.2
^{123}I-metaiodobenzylguanidine scanning	4.8
^{99m}Tc-ethylcysteinate dimer brain scanning	5.7
Pelvic CT	6.0
^{99m}Tc-sestamibi for stress/rest cardiac scanning	6.7
Chest CT	7.0
Coronary angiography	7.0
^{18}F-FDG PET scanning	7.4
Abdominal CT	8.0
Coronary angioplasty with stent placement	15.0

Radiopharmaceutical doses are from Table 1 except ^{99m}Tc-radionuclide cystogram dose (24–27). Radiographic doses are from Mettler et al. (23).

Radiation exposure of common radiological and nuclear medicine procedures

CANCER RISK WITH AND WITHOUT RADIATION

- 10 y old child : risk of cancer is 1/10000
  - CT abdomen : (very often for cancer)risk of cancer is 1/1600
  - PET (always done because child has cancer) is 1/1515
  - Bone scintigraphy (very often done for cancer) is 1/2560
- 40 y old : Incidence of cancer 1/500
  - CT abdomen 1/2900
  - PET : 1/2700
  - Bone scintigraphy : 1/4760

BENEFIT VS RISK OF MEDICAL RADIATION EXPOSURE(1)

- 1. FDG PET for preoperative evaluation of lung cancer
  - Benefit : avoidance of futile surgeries : 2219 lives saved in the US/yr
  - risk : 122 additional cases of cancer in the US
- 2. CTA for the diagnosis of CAD
  - Benefit = 33500 lives saved / yr in the US
  - Risk = 2627 additional cancers in the US

3. Lymphoscintigraphy in operable breast cancer
  - benefit : 63% reduction in lymphedema and sensory loss
  - risk = 0

Are some populations more sensitive to ionizing radiation than others?

Children | Young women | Fetus

INCREASED INCIDENCE OF SOLID CANCER APPEARS MORE THAN 20 YRS AFTER EXPOSURE IF PT > 75 Y OLD RECEIVES RADIATION HE WILL DIE FROM OTHER CAUSES BEFORE CANCER FROM RADIATION

BENEFIT VS RISK OF MEDICAL RADIATION EXPOSURE(2)

- Myocardial perfusion imaging to predict perioperative cardiac events in non cardiac surgery
  - Benefit for 9500 pts undergoing vascular surgery; 109 lives saved
  - Risk = 3 additional cancer deaths
- Lung scan for the diagnosis of pulmonary embolism in pregnancy
  - Benefit= 323 lives saved from fatal pulmonary embolism in the US (6 million pregnancies/yr)
  - Risk = 1 additional cancer death
- Head CT after LOW RISK trauma in children
  - if normal mental status, no scalp hematoma, no loss of consciousness Or loss of consciousness< 5 sec , no palpable skull fracture → 0% brain injury on CT scan→ **No benefit from doing head CT**
  - Risk = 3 lives lost/10000 children from cancer
  - CONCLUSION : RISK from radiation is HIGHER than benefit if child is a low risk IN PARTICULAR IF CHILD IS < 2 YOLD

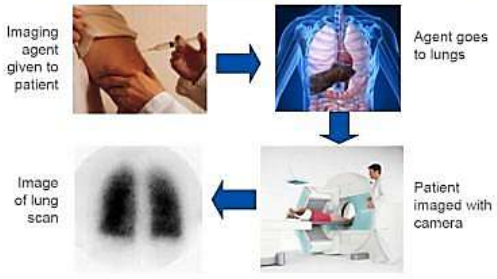
What is nuclear medicine?

Nuclear medicine imaging uses safe, painless, and cost-effective techniques to image the body and treat disease.

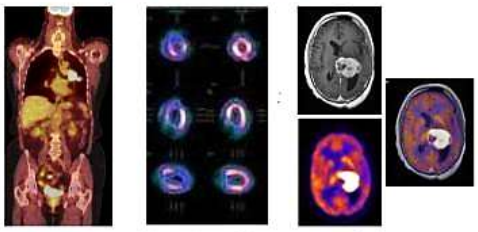
- It uses very small amounts of radioactive pharmaceuticals and traces their progress through your body.
- Nuclear medicine is unique, because it helps doctors "view" how your body is functioning.
  - This is different from x-rays or CT scans, which show how your body looks rather than how it works.

Nuclear medicine therapy uses larger amounts of radiation to treat thyroid disease and cancer.

How does it work?



Examples of scans



Whole body PET/CT scan | Myocardial perfusion heart SPECT scan | Brain tumor PET scan

What is the potential risk associated with these doses?

- For effective doses from nuclear medicine procedures, say 10 mSv, only one-twentieth of a percent (0.05%) of the patients who have a test may develop a fatal cancer sometime later in life.
- Compare that to the natural prevalence of fatal cancer—which is 22%.

MORE RECENT STUDIES SHOW THAT THERE IS NO SIGNIFICANT INCREASE IN THE RISK OF CANCER BELOW 50 mSv EXCEPT IN CHILDREN