Radiology
Team 438

contrast media and safety in radiology

Lecture 2

Objectives

- Recognize, and evaluate essential information on the biologic effects of ionizing radiation and radiation safety to ensure the safe use of x-rays in diagnostic imaging.
- Know radiation quantities and units, regulatory and advisory limit for human exposure to radiation.
- Know equipment for radiation protection and measurement.
- Understand the fundamental principles of MRI safety
- Know about contrast agents reactions and safety.
- Understand how to prepare patients for radiology studies.

Color Index: -Main text -Males slides -Female slides -Dr's notes -Important -Golden note -Extra

Team Leaders :

Reem Alamri

Nouf Alsubaie

Bander Alharbi

Done by :

Mohamed Albabtain

Note taker :

Duaa Alhumoudi

REVISED BY
MISHAL ALTHUNAYN & MUNEERAH ALSADHAN

Introduction

Major sources of risk in radiology

1. Radiation hazard.
2. Radioactive materials hazard.
3. Magnetic field hazard.
4. Contrast agents hazard

Research pioneers in radioactivity

What does it measure=radioactivity

Roentgen	Becquerel	Rutherford	The Curies
Discovered X-Rays in 1895.	Discovered Radioactivity in 1896	Discovered Alpha and Beta Rays in 1897	Discovered of radium and polonium 1900-1908

What is radiation?

Radiation is an energy emitted from a substance, subdivided into:

1. Non-ionizing (non hazard)

Microwave oven, Television, Radio Waves, Ultrasound. We use them in daily life and they are safe and there is no biological effect of using it.

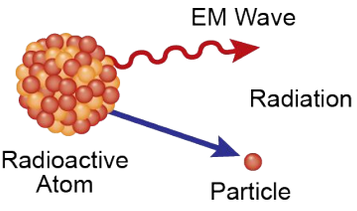
2. Ionizing (used in medical imaging)

Alpha particles (α), beta (β), gamma (γ) and X-rays (among others) that are have enough energy to knock electrons out of molecules and produce ions. Ionizing radiation such x-ray can be carcinogenic and, to the **fetus**, mutagenic or even lethal, causes DNA damage.

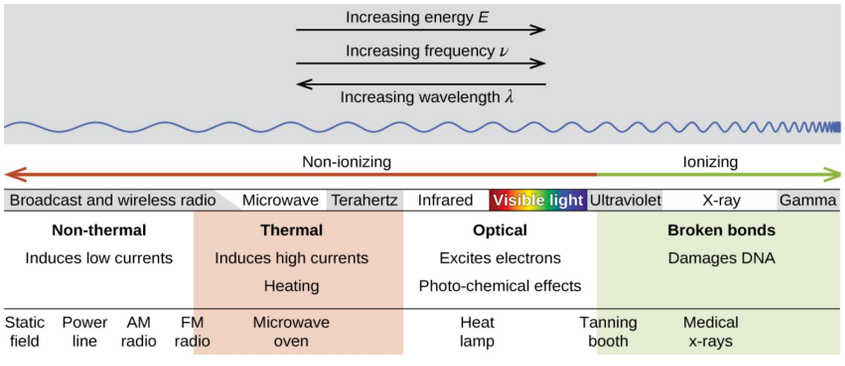
Different types of radiation have differing abilities to pass through material.

A very thin barrier, such as a sheet or two of paper, or the top layer of skin cells, usually stops alpha particles.

Explanation: a radioactive atom has an unstable nucleus; it tends to lose energy to reach a more stable state, causing radiation. Radiation will ionize atoms in living cells, damaging them.



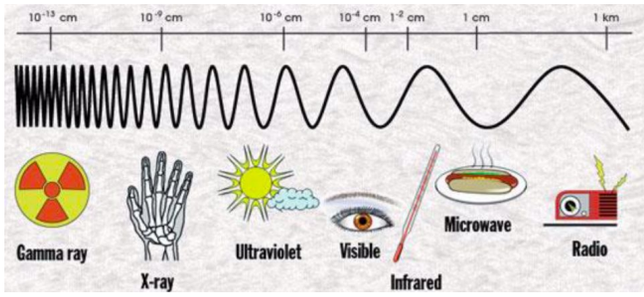
- Long wavelength, lower frequency, lower-energy electromagnetic radiation is non-ionizing.
- Short wavelength, higher frequency, higher-energy electromagnetic radiation is ionizing.



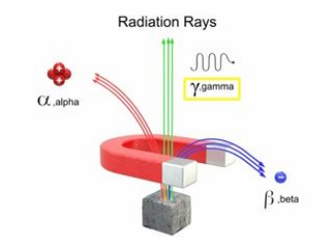
Introduction

What is X-rays?

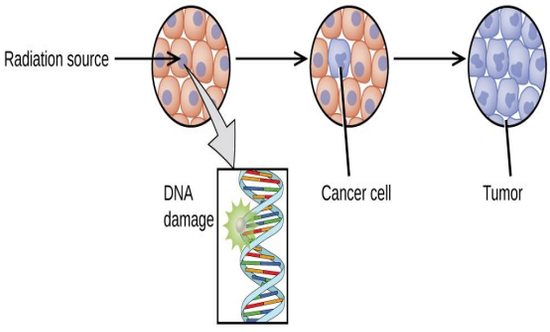
- X-rays are very short wavelength electromagnetic radiation.
- The **shorter** the wavelength and the higher the frequency, the **greater** the energy and the **greater** the ability to penetrate matter



- alpha particle sources are usually not dangerous if outside the body because it can be stopped by outer layer of skin, but are quite **hazardous if ingested or inhaled**.
- Beta particles will pass through a hand (can cause damage to dep sensitive tissue), or a thin layer of material like paper or wood, but are stopped by a thin layer of metal.
- Gamma radiation is very penetrating and can pass through a thick layer of most materials.
- Some high-energy gamma radiation is able to pass through a few feet of concrete



- The ability of various kinds of emissions to cause ionization varies greatly, and some particles have almost no tendency to produce ionization.
- Alpha particles have about twice the ionizing power of fast-moving neutrons, about **10 times that of β particles**, and about **20 times that of γ rays and X-rays**.



Radiation can harm biological systems by damaging the DNA of cells. If this damage is not properly repaired, the cells may divide in an uncontrolled manner and cause cancer.

The three types of radiation

Use this table to find information about and to compare α, β and γ radiation

	Alpha (α)	Beta (β)	Gamma (γ)
Nature	It's a nucleus of helium $^{4}_{2}He$. Two protons and two neutrons	It's an electron e^-	It's an electromagnetic wave
Charge	+2	-1	0
Mass	Relatively large	Very small	No mass
Speed	Slow	Fast	Speed of light
Ionizing effect	Strong	Weak	Very weak
Most dangerous	When source is inside the body	When source is outside the body	When source is outside the body

Radiation units

1. **RAD (Radiation Absorbed Dose)**

Original measuring unit for expressing the absorption of **all types** of ionizing radiation (alpha, beta, gamma, neutrons, etc) into any medium. (measures quantity)(is a measurement of the radiation absorbed by the material or tissue)

2. **REM (Roentgen Equivalent Man)**

Is a measurement that correlates the dose of any radiation to the biological effect of that radiation. Since not all radiation has the same biological effect, the dosage is multiplied by a "quality factor" (Q). For example, a person receiving a dosage of gamma radiation will suffer much less damage than a person receiving the same dosage from alpha particles, by a factor of three. (measures quality) (is a measurement of the biological effects of that absorbed radiation)

RAD :e.g.: patient exposed to 2 RAD radiation, it means the amount of radiation.
However, to quantify the risk we use REM. which=RADxQ.
Q is the danger of that factor, depend on type of ionizing radiation

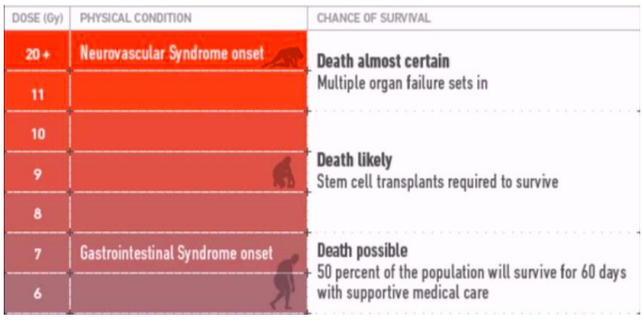
Quantity	Unit	SI unit	Relation between units
Absorbed dose	RAD	Gray (Gy)	1 Gy=100 RAD 100 mGy=10 RAD 10 mGy=1 RAD 1 mGy= 100mRAD
Equivalent dose	REM	Sievert (Sv)	1 Sv= 100 REM 100 mSv= 10 REM 10 mSv=1 REM 1 mSv=100 mREM

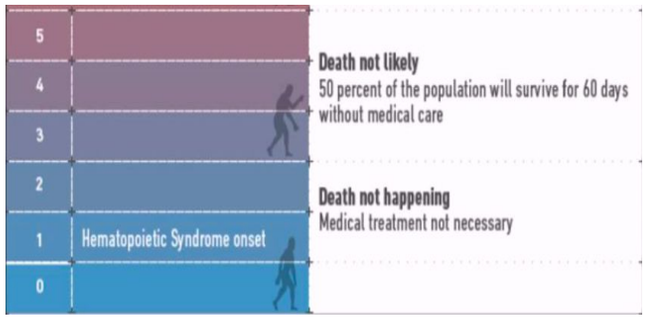
Measurement Purpose	Unit	Quantity Measured	Description
activity of source	becquerel (Bq)	radioactive decays or emissions	amount of sample that undergoes 1 decay/second
	curie (Ci)		amount of sample that undergoes 3.7 × 1010 decays/second
absorbed dose	gray (Gy)	energy absorbed per kg of tissue	1 Gy = 1 J/kg tissue
	radiation absorbed dose (rad)		1 rad = 0.01 J/kg tissue
biologically effective dose	sievert (Sv)	tissue damage	Sv = RBE × Gy
	roentgen equivalent for man (rem)		Rem = RBE × rad

- **Gray**, Rem, rad, Curie, Becquerel and Sievert are units of radiation.
- One chest x-ray 0.15 mGray.
- To reach the hazardous level of 2 Gray you need 10000 chest x ray or 100 CT abdomen or 30 mins to 1 hr fluoroscopy exposure.
- 1 CT= 100 X-rays.
- Fluoroscopy has the highest and X-ray has the lowest

Radiation Hazard

Effects of nuclear exposure





Goals of Radiation Safety:

To eliminate **deterministic** (acute) effects.

To reduce incidence of **stochastic (Chronic)** effects.
Called Background radiation (Esp. near nuclear plant areas)

Deterministic and Stochastic Effects:

	Acute/deterministic effects	Chronic/Stochastic effects. (Random events)
Definition	Acute radiation symptoms are caused by high levels of radiation usually over a short period of time.	- Also referred to as (Probabilistic), probability of occurrence depends on absorbed dose. - Chronic radiation symptoms are caused by low-level radiation over a long period of time.
Characteristics	- They cannot be predicted with certainty. - Severity of damage increases with increasing dose above that threshold.	- The effect may (potentially) occur following any amount of exposure, there is no threshold. (By accumulation) - Even the smallest quantity of Ionizing Radiation exposure can be said to have a finite probability of causing an effect. - Severity of the effect is not dose related.
Examples	1. Cataract formation 2. Bone marrow failure 3. Lung Fibrosis 4. Infertility 5. hair loss 6. lowering the WBC count 7. Skin reddening (erythema).	1. Carcinogenic effect 2. Genetic effect

Acute Deterministic Effects

Chronic Stochastic Effects

Threshold for deterministic effects

Major organs annual dose limits for preventing deterministic effects are as follows :

doctor said numbers aren't important just know the effects and compare between them

Organ	Effects	One single absorption (Gy)	Prolonged absorption (Gy-year)
Testes	Permanent infertility	3.5 - 6	2 this is the hazardous level
Ovaries	Permanent infertility	2.5 - 6	>0.2
Eye lens	Milky of lens cataract	0.5 - 2 5	>0.1 >0.15
Bone marrow	Blood forming deficiency	0.5	>0.4

Organ sensitivity to radiation

High Sensitivity

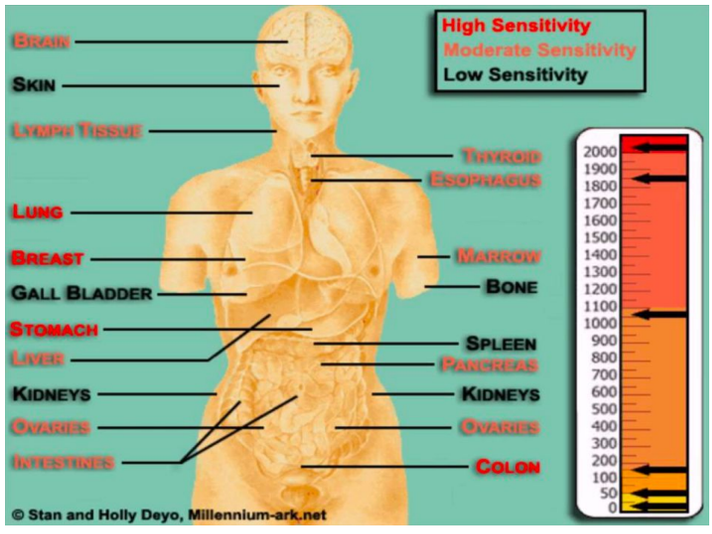
- Lungs
- Breasts
- Stomach
- Colon

Moderate sensitivity

- Brain
- Lymph tissue
- Thyroid
- Esophagus
- Marrow
- Liver
- Pancreas
- Ovaries
- Intestine

Low sensitivity

- Skin
- Bone
- Gall bladder
- Spleen
- Kidneys



Radiation Hazard

Radiation Exposure Levels and Effects

0.62 REM/year	Average annual radiation exposure.
2 REM/year	International radiation exposure limit.
25 REM/year	Measureable blood changes.
100 REM	Onset of radiation sickness.
200 REM	Radiation sickness with worse symptoms in less time
400 REM	Approximately the lethal dose for 50% of the population in 30 days.
1,000 REM	Death probable within about 2 weeks, effects on the GI tract.
5,000 REM	Death probable within 1-2 days, effects on the central nervous system like exposing to a nuclear bomb

Typical Radiation Detectors

1. Film packet

E.g X-ray film

2. Thermoluminescent Dosimeter (TLD)

Radiology staff carry it to measure radiation exposure.

3. Ionization chamber

Detect radiation leakage

4. Geiger-Müller (GM) detector

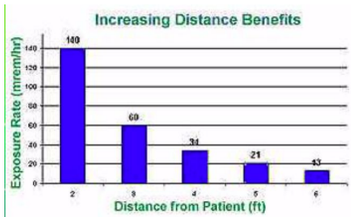
5. Scintillation Detector

For radioactive materials.

General methods of protection

What are Three basic methods for reducing exposure of workers to X-rays?

1. Minimize exposure time.



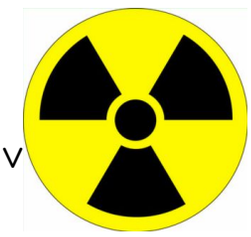
2. Maximize distance from X-Ray source.
- Exposure varies inversely with the square of the distance from the X-Ray tube

3. Use shielding (stand behind lead protection).
- Operators view the target through a leaded glass screen.
- Wear lead aprons. almost any material can act as a shield from gamma or X-Rays if used in sufficient amounts.
- Standard 0.5mm lead apron protects you from 95% from radiation exposure.

ALARA Rule:

As Low As Reasonably Achievable:

- Reduce number of exams.
- Reduce time of exams.
- Radiation Hazard symbol displayed at places where radioactiv materials are used and stored.
- Use alternative (Ultrasounds or MRI).



What does radioactivity means?

- Radioactive decay is the process in which an unstable atomic nucleus loses energy by emitting radiation in the form of particles or electromagnetic waves.
- <u>An unstable nucleus releases energy to become more stable.</u>

These are other hazard found in the department in the department other than x-ray radiation

Sources of radioactivity

- **Naturally Occuring Sources:**

1. Radon from the decay of uranium and thorium. موجود بالتربة بشكل طبيعي
2. Potassium -40, found in minerals and in plants.
3. Carbon 14, found in plants and animal tissue. It's used to know the age of fossils.

- **Manmade Sources:**

1. Medical use of Radioactive Isotopes. E.g. Radioactive iodine is typically used in thyroid tests. Also radioactive technetium used in renal/kidney scans
2. Certain consumer products e.g. Smoke detectors.
3. Fallout from nuclear testing.
4. Emissions from nuclear power plants.

Radioisotopes

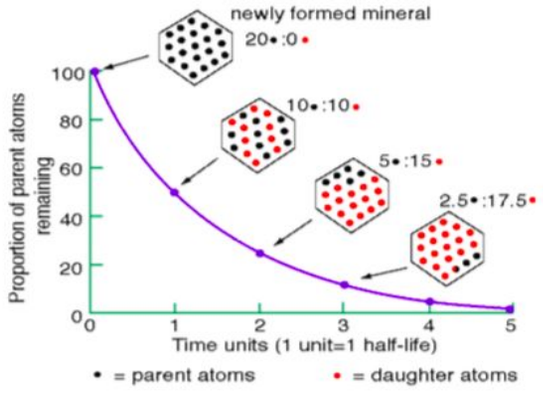
Any two or more forms of a chemical element, having the same number of protons in the nucleus, or the same atomic number, but having different numbers of neutrons in the nucleus, or different atomic weights are called isotopes.

Isotopes of an atom that are radioactive are called radioisotopes. Examples of natural radioisotopes are 238 U (uranium), 40 K (potassium), 232 Th (thorium) and their child nuclei (obtained by radioactive decay of the previous ones) 226 Ra (radio), 222 Rn (radon) and 218 Po (polonium).

This is called radioactive decay.

Radioactive decay

- In the process of radioactive decay. An atom actually changes from one element to another by changing its number of protons.
- The half-life of radioactive substances is the amount of time they require to lose one half of their radioactivity and transform into another element.



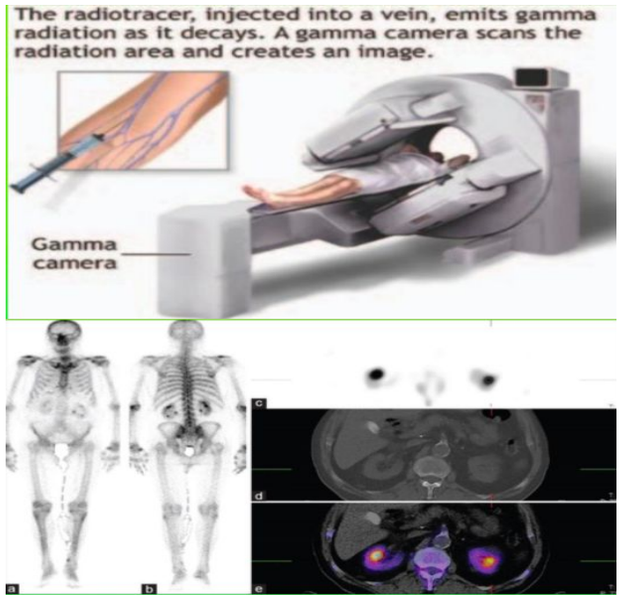
Medical use of Radioactive Isotopes. Important

- Radioactive isotopes are introduced into the body and can be distinguishable by their radiation from the atoms already present.
- This permits the relatively simple acquisition of information about the dynamics of processes of uptake, incorporation, exchange, secretion, etc.

e.g in the thyroid scan we know that iodine accumulated in thyroid so we inject the patient with ionized iodine which will accumulate there to and then scan the patient to see how much accumulated.

Radio-Pharmaceuticals

- The most widely used radioisotope is **Technetium** (Tc), with a half-life of six hours. .(Important to tell us when to scan)
- The activity in the organ can then be studied either as a two dimensional picture or, with a special technique called tomography, as a three dimensional picture (SPECT, PET). so the patient will be first injected with Tc then after 6 h he will come to be scanned and we will be able to trace Tc



Handling of Radio-Pharmaceuticals

- No radioactive substances should be handled with bare hands. Alpha and beta emitters can be handled using thick gloves.
- Radioactive materials must be stored in thick lead containers.
- Reactor and laboratories dealing with radioactive materials must be surrounded with thick concrete lined with lead.
- People working with radioactive isotopes must wear protective clothing, which is left in the laboratory.
- The workers must be checked regularly with dosimeters, and appropriate measures should be taken in cases of overdose.
- Radioactive waste must be sealed and buried deep in the ground.

Spill response

- On Skin —> flush completely.
- On Clothing —> remove them
- If Injury —> administer first aid.
- Radioactive Gas Release —> vacate area, shut off fans, post warning.
- Monitor all the people and define the area of contamination.

Magnetic Field Hazard

MRI hazard

- MRI is one of the imaging modality that is widely used in radiology.
- There is no dangerous radiation in MRI instead it uses very high magnetic field up to 3 Tesla (1 Tesla = 20000 times earth gravity).
- This strong magnetic field produces a powerful attractive force and torque which the magnet exerts on ferromagnetic objects, this is called missile effect.
- The missile effect can pose a significant risk to anyone in the path of the projectile, and cause significant damage to the scanner.
- The effect is clearly greater for high field systems.

Equipment made specific for MRI room are made of diamagnetic material (such as wood and stainless steel).

Precautions

- To guard against accidents from metallic projectiles, the "5 gauss line" should be clearly demarcated and the area with that line kept free of ferromagnetic objects.
- The 5, 10 and 200 Gauss lines are marked on the floor of each magnet room. These Gauss lines serve as a reminder that you are inside a magnetic field which increases sharply as you move closer to the magnet. The 5 Gauss line (the outermost line) defines the limit beyond which ferromagnetic objects are strictly prohibited.
- It is essential that patient with ferromagnetic surgical clips, implants containing ferromagnetic components and who have suffered shrapnel or steel fragments injuries (such as those who work in mines), especially to the eyes, to be excluded from the imager.
- A number of general precautions must be taken to ensure the safety of patients and personal working in the imaging suite:
    1. Access to the imaging area should be limited, and signs should be displayed to warn persons with cardiac pacemaker or neuro-stimulators not to enter the area.
    2. Credit cards and watches with mechanical parts should be left outside the imaging area to prevent magnetic tape erasure and watch malfunction.
- Some body implants are paramagnetic, or even ferromagnetic. These implants tend to move and align with the main magnetic field.
- This results in a force and torque on the implant and the implant may become dislodged, resulting in severe injury to the patient or death if displaced such as Aneurysm clips, Pacemaker and implanted cardiac defibrillator are typical examples of such devices.

there are two units for measuring a magnetic field: Tesla and Gauss, where 1 tesla = 10,000 gauss

Contrast agents

- Compounds used to improve the visibility of internal bodily structures in an image.
- Since their introduction in the 1950s, organic radiographic iodinated contrast media (ICM) have been among the most commonly prescribed drugs in the history of modern medicine.
- These contrast agents attenuate x-rays more than body soft tissues due to their high atomic weight.
- Millions of intravascular contrast media examinations are performed each year.

Types of contrast agents

- Many forms of contrast (gas,liquid,suspension) with many forms of delivery (by mouth, per rectum, intraluminal, intravenous, and intra-arterial).
- Each different delivery mode has unique applications, for example: oral contrast, a suspension of barium, is used for fluoroscopy (esophagrams, upper gastrointestinal series, and small bowel follow-throughs).
- Administration or leakage of barium outside the intestinal tract may have severe adverse outcomes.

Negative Contrast

- ✓ Organs become more radiolucent (more DARK).
- ✓ X-Rays penetrate more easily.
- ✓ Low atomic weight.
- ✓ Appears black on film.
- ✓ Examples of negative contrast:
  1. Air
  2. CO2.
- ✓ Commonly used to inflate a structure; distinguish colon from other structures.

Positive Contrast

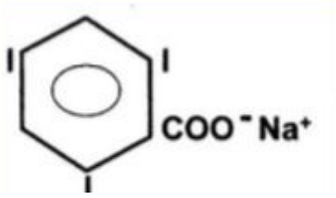
- ✓ Organ become radiopaque (LIGHT).
- ✓ Substance absorbs X-Rays hence why it becomes more light.
- ✓ High atomic weight.
- ✓ Appears white on film
- ✓ Examples of Positive contrast:
  1. Iodinated contrast agent.
  2. Barium sulfate

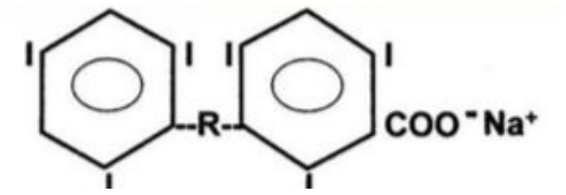
Urogenital Studies
Vascular Studies

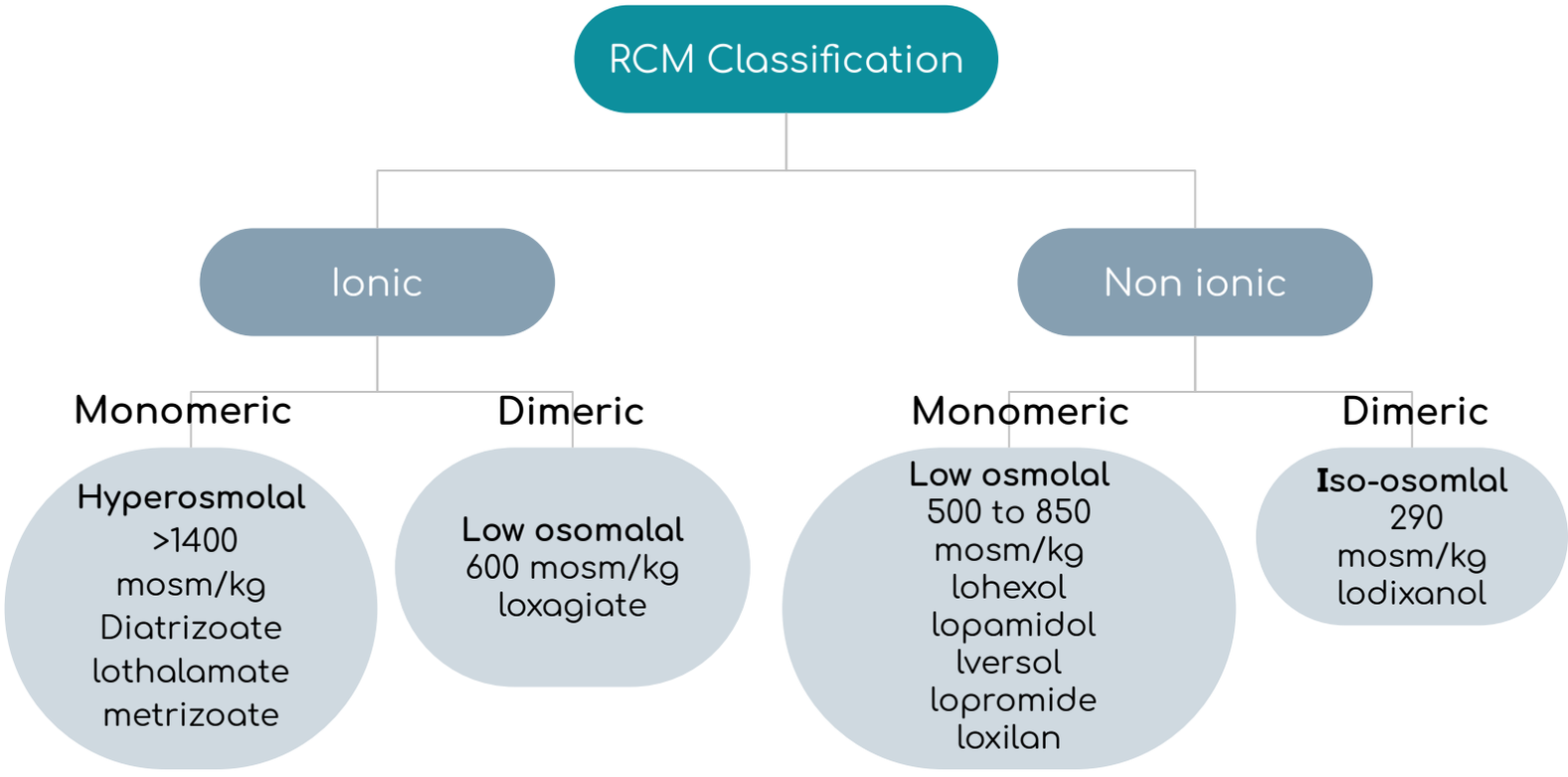
Classification of agents

Contrast agents are classified based on three properties:

1. The charge of the iodinated molecule (ionic or nonionic).
2. The molecular structure (monomeric or dimeric).
3. The osmolality of the injected preparation (hyperosmolal, low osmolal, or iso-ismolal relative to normal serum osmolality [275 to 290 mosm/kg])





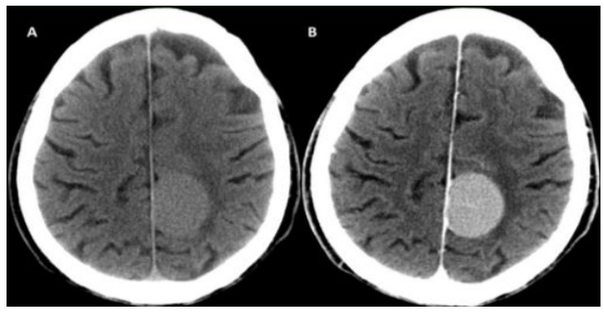


Iodinated contrast media (ICM)

- Iodinated contrast media generally have a good safety record.
- Adverse effects from the intravascular administration of ICM are generally mild and self-limited.
- Reactions that occur from the extravascular use of ICM are rare.
- Nevertheless, severe or life-threatening reactions can occur with either route of administration.

Why iodine?

- IODINE (atomic wt 127) provides excellent radio-opacity.
- Higher atomic number maximizing the photoelectric effect.



Iodinated Contrast Agents

- The toxicity of contrast agents decreases as osmolality approaches that of serum.
- This has been accomplished by developing non-ionizing compounds and then combining two monomers to form a dimer.
- Currently used iodinated agents are cleared almost completely by Glomerular filtration.
- Circulatory half life is 1–2 hours, assuming normal renal function.

Effect of Ionic vs. Non-ionic Contrast Agents

Ionic	Non ionic
Dissociate into separate ion when injected	Does not dissociate
Creates hypertonic condition	Remains near isotonic
Increase in blood osmolality	No significant increase
Less money	More money
More reaction	Less reaction

Methods of Administration of Contrast Material

1. INGESTED
   - Oral: Barium sulfate suspension.
2. RETROGRADE
   - Against normal flow: Barium enema.
3. INTRATHECAL
   - Spinal canal CSF aka myelography
4. INTRAVENOUS Most Common Method!
   - Injecting into bloodstream.
   - Anything other than oral.

Note:Has highest degree of radiation among ct chest and x-ray

Reaction Classification

Immediate reactions

- Were defined as those occurring within the department (within one hour).

Delayed reactions

- As those occurring between the time the patient left the department and up to seven days later.

The American College of Radiology has divided adverse reactions severity to contrast agents into the following categories:

- Mild
- Moderate
- Severe

Mild reaction (5%)

- Signs and symptoms appear self-limited without evidence of progression.
- Nausea, vomiting, warmth, headache, dizziness, shaking, altered taste, itching, flushing, chills, sweats, rash, nasal stuffiness, swelling: eyes, face and anxiety.
- **Treatment**: Observation and reassurance. Usually no intervention or medication is required; however, these reactions may progress into a more severe category.

Moderate reaction (1%)

- Reactions which require treatment but are not immediately life-threatening.
- Tachycardia/ bradycardia, hypertension, pronounced cutaneous reaction, hypotension, dyspnea, pulmonary edema, bronchospasm, wheezing and laryngeal edema.
- **Treatment**: Prompt treatment with close observation.

Severe reaction (0.05%)

- Life-threatening with more severe signs or symptoms including: Laryngeal edema (severe), profound hypotension, convulsion, unresponsiveness and cardiopulmonary arrest.
- **Treatment**: Immediate treatment, antiemetic drugs. Usually requires hospitalization.

Delayed Contrast Reactions

- Delayed contrast reactions can occur anywhere from 3 hours to 7 days following the administration of contrast.
- It is important for anyone administering intravenous contrast media to be aware of delayed reactions.

More common reactions include:

- Cutaneous exanthema
- Pruritus without urticaria
- Nausea and vomiting
- Drowsiness
- Headache

Other symptoms:

- Flu like symptoms
- Delayed arm pain
- Rash/pruritus
- Salivary gland swelling
- Steven Johnson syndrome

- Skin effects:itching, rash, and hives.
- GI side effects: Nausea, vomiting, and diarrhea.
- General side effects: headache, dizziness, and fever.
- Infants and patients older than 60 years old are at increased risk of developing a side effect.

Some Reaction Medications

Aggressive fluids | Lasix | Dopamine | Mannitol

Contraindications For Contrast

1. **Renal failure**
   - Check BUN and Creatinine, elevated levels could cause renal shutdown
2. **Anuria** (no urine production)
3. **Asthma**
   - Possible allergies
4. **History of contrast allergy/ reactions**
5. **Diabetes**
   - Get a history of medications taken
   - Glucophage must be stopped 48 hrs before contrast injection.
6. **Multiple Myeloma**
7. **Pregnancy**
   - Risk of fetal thyroid toxicity
8. **Allergic reaction, pre-medication is available**

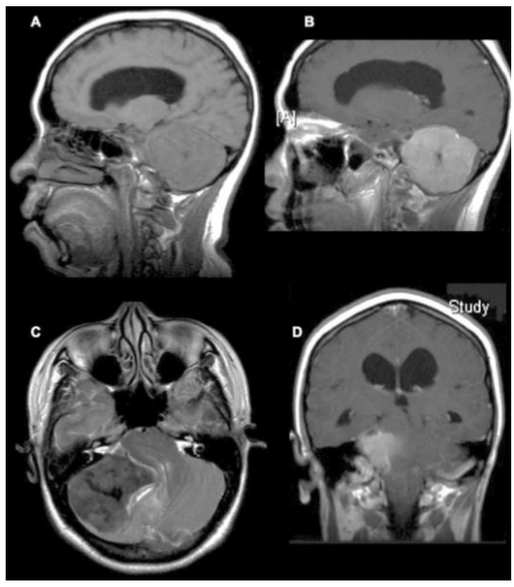
Extravasation

- Contrast material has seeped outside of vessel.
- Apply warm compress 1st 24 hours.
- Cool compress for swelling.

Extravasation of Contrast into soft tissue of arm.

MRI Contrast Agents

- The Contrast used in MRI is based on paramagnetic ions e.g. Gadolinium.
- By themselves these ions are highly toxic so bound up in large molecules eg. DTPA.
- Provides a greater contrast between normal and abnormal tissues.



Gadolinium Side Effects

- With impaired kidney function, gadolinium could lead to a serious and potentially fatal disorder called Nephrogenic Systemic Fibrosis (NSF)

- NSF: Nephrogenic systemic fibrosis (NSF), also known as nephrogenic fibrosing dermopathy (NFD), is a disease of fibrosis of the skin and internal organs reminiscent but distinct from scleroderma or scleromyxedema. It is caused by gadolinium exposure used in imaging in patients who have renal insufficiency. It could even lead to death.

- Check if the patient has renal failure, decreased GFR, decreased clearance before giving Gadolinium.

Summary

Radiation hazard

- Hazardous Ionizing radiation comprize (α, β, γ) particles, and X-rays.

Acute/deterministic effects	Chronic/Stochastic effects
- Caused by **high levels of radiation** usually over a **short period of time.** - Severity of damage increases with increasing dose above that threshold. - Cataract formation, Bone marrow failure, Lung Fibrosis, Infertility, hair loss, lowering the WBC count, Skin reddening (erythema).	- Caused by **low-level radiation** over a **long period of time.** - Severity of the effect is not dose related. - Carcinogenic effect and Genetic effect.

General methods of protection

Three basic methods for reducing exposure of workers to X-rays:	ALARA Rule: As low as reasonably achievable:
- Minimize exposure time. - Maximize distance - Use shielding	- Reduce number of exams. - Reduce time of exams. - Radiation Hazard symbol displayed at places where radioactive material are used and stored. - Use alternative (US or MRI).

Radioactive materials hazard

- Radioactive decay is the process in which an unstable atomic nucleus loses energy by emitting radiation in the form of particles or electromagnetic waves.
- **Examples**: Radioisotopes and Radiopharmaceuticals.
- **Spill response:**
  - On Skin → flush completely.
  - On Clothing → remove them.
  - If Injury → administer first aid.
  - Radioactive Gas Release → vacate area, shut off fans, post warning.
  - Monitor all the people and define the area of contamination.

Magnetic field hazard

MRI Safety:	MRI Contraindications:	MRI Contrast Agents:
- The "5 gauss line" should be clearly demarcated and the area free of ferromagnetic objects. - Access to the imaging area should be limited, and signs should be displayed to warn persons with cardiac pacemaker or neuro-stimulators not to enter the area.	- Patients with ferromagnetic surgical clips Pacemaker, shrapnel or steel fragment injuries...	- The Contrast used in MRI is based on paramagnetic ions e.g. Gadolinium. - With impaired kidney function, gadolinium could lead Nephrogenic Systemic Fibrosis. (NSF)

Summary

Contrast Agents

- **Adverse effects:** Adverse effects from the intravascular administration of ICM are generally mild and self-limited; Reactions that occur from the extravascular use of ICM are rare.

Classification of contrast agents

- The toxicity of contrast agents decreases as osmolality approaches that of serum. (non-ionizing ,dimeric compounds)

Ionic	Non ionic
- Creates hypertonic condition - Increase in blood osmolality - Less money - More reaction	- Remains near isotonic - No significant increase - More money - Less reaction

Reaction classifications

The most common reactions include:

- Cutaneous exanthema, pruritus without urticaria, nausea, vomiting, drowsiness, headache ,flu like symptoms delayed arm pain , salivary gland swelling, and Steven Johnson syndrome.
- **Duration:**
  1- immediate reaction
  2- delayed reaction
- **Severity:**
  1- Mild Reaction (5%)
  2- Moderate Reaction (1%)
  3- Severe Reaction (0.05%)

Reaction medications

- Aggressive fluids
- Lasix
- Dopamine
- Mannitol

Contraindication for contrast

- Diabetes
- Multiple Myeloma.
- Renal Failure
- Anuria
- Asthma
- Hx of Contrast Allergy / Reactions
- Pregnancy
- Allergic Reaction.
- Get a hx of medications taken

quiz

1- Which of the following is a characteristic of X-ray
a. Shorter wavelength and shorter frequency
b. High wavelength and high frequency
c. Shorter wavelength and high frequency
d. High wavelength and Shorter frequency

2- Which of the following is an example of stochastic effects
a. Cataracts
b. Infertility
c. Lung fibrosis
d. Carcinogenic abnormalities

3- which organ is considered highly sensitive to radiation
a. Pancreas
b. Stomach
c. Intestine
d. Kidney

4- The least toxic class of contrast agents:
a. ionizing, dimers
b. non ionic, monomer
c. non ionic, dimer
d. ionizing, monomers

5- The area around the MRI should be clear of any ferromagnetic objects due to?
a. Missile effect
b. Patient falls
c. Radiation
d. Distorted results

6- Which of the following cause NSF with impaired kidney function?
a. barium
b. gadolinium
c. Thorotrast
d. Iodinated contrast

7- Which cell structure that is the most affected by radiation?
a. Cell membranes
b. Cell wall
c. DNA
d. Cytoplasm

8- Which of the following IS NOT a side effect of iodinated contrast material?
a. Urticarial rash
b. Bronchospasm
c. Laryngeal edema
d. Hypertension

Answers
1) c
2)d
3)b
4)c
5) a
6) b
7)c
8)d