Introduction to radiology summary

Lecture 1: biological effects of radiation

- Nucleus: radiosensitive, 1Gy sufficient to kill the cell.
- Cytoplasm: radio-resistant, 10Gy is required to kill the cell.
- DNA damage: direct (e- directly interacts with the DNA, 33%) or indirect (e- interacts H2O >> radicals that interacts with DNA, 67%)
- DNA breaks: single strand break (repairable) or double strand break (less repairable, chromosome aberrations)
- Radiation results in **atrophy** of the tissues
- Tissue Radio-Sensitivity:
- 1. High: lymphoid, gonads, bone marrow
- 2. Intermediate: GI, kidney, skin
- 3. Low: brain, spine, muscles
- Whole body effects:
- 1. Early/ acute effect (deterministic):
- Significant number of injured/killed cells >> lead to tissue or organ dysfunction
- weeks to months after exposure, High dose (>25 cGy)
- Dose threshold
- Severity increase with higher doses
- 2. Late effect (stochastic)
- Years after exposure, low dose (< 25 cGy)
- No dose threshold
- The probability increases with dose
- The severity of effect is not related to the dose
- Effect on somatic cells >> cancer induction
- Effect on germinal cell >> hereditary effects (increases mutation rate)



• Radiation carcinogenesis:

- Radiation is a weak carcinogen; most damaged cells either repaired or dead
- Follow stochastic effect
- Latency is the amount of time required for the cell to grow to macroscopically sized tumor
 - Leukemia: median latency is 8 years, ,minimum latency is 2 years
 - Solid tumors: median latency 16-24 years, minimum latency is 5-10 years
- Radiation protection:
- 1. Justification:

- A radiation procedure or practice is justified only if the benefits outweigh the potential risks.
- Imaging methods with lower patient effective dose should be considered if the same diagnostic information can be obtained.
- Responsibility of the referral doctor & radiologist

2. Optimization:

- Minimize radiation exposure while achieving the intended purpose.
- Optimization is a multidisciplinary task.
- Excess cancer mortality due to radiation is **age-dependent**.
- The **younger** the age at exposure, the **greater** the lifetime risk of developing cancer.

3. Minimize External Exposure:

- Time (Reduce exposure time)
- Distance (Increase Distance): Doubling distance from source, decreases dose by factor of four. Tripling it decreases dose nine-fold
- Shielding: Shielding materials absorb or scatter radiation, Plexiglass vs. Lead

Lecture 2: Introduction to radiology

Prerequisites before contrast administration:

- Patient consent
- Check cr & eGFR
- Critical illness & allergy
 - Allergy to previous IV contrast examination is absolute contraindication for contrast re-administration.
 - Pre-medication is required for patients with history of allergy using 13 or 12 hour regimen (corticosteroids or Chlorpheniramine)
- Medications

Contrast side effects:

ns and symptoms are self-limited without evidence of progre	ssion. Mild reactions include:
Allergic-like	Physiologic
Limited urticaria / pruritis	Limited nausea / vomiting
Limited cutaneous edema	Transient flushing / warmth / chills
Limited "itchy" / "scratchy" throat	Headache / dizziness / anxiety / altered taste
Nasal congestion	Mild hypertension
Sneezing / conjunctivitis / rhinorrhea	Vasovagal reaction that resolves spontaneously
Moderate Signs and symptoms are more pronounced and commonly potential to become severe if not treated. Moderate reaction	require medical management. Some of these reactions have the ns include:
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Severe

Allergic-like

Diffuse edema, or facial edema with dyspnea Diffuse erythema with hypotension Laryngeal edema with stridor and/or hypoxia Wheezing / bronchospasm, significant hypoxia Anaphylactic shock (hypotension + tachycardia) Physiologic Vasovagal reaction resistant to treatment Arrhythmia Convulsions, seizures Hypertensive emergency

Postcontrast AKI

- Sudden deterioration of kidney function with 48 of iodinated contrast median administration:
 - 1. Absolute serum creatinine increase ≥0.3 mg/dL
 - 2. A percentage increase in serum creatinine \geq 50%
 - 3. Urine output reduced to ≤ 0.5 mL/kg/hour for at least 6 hours.

- Risk factors:

- Preexisting severe renal insufficiency (the most important).
- Multiple contrast administration with <24 h
- Other diseases: DM, HTN, CVD, MM, dehydration, hyperuricemia, diuretics uses, advanced age.
- Prevention:
 - Avoidance of iodinated contrast medium administration.
 - Volume expansion:
 - Use Isotonic fluids (RL or NS) 6-12 hours before and continued 4 to 12 after contrast administration.
 - Oral hydration

Gadolinium based contrast media

- Safer
- Most adverse reactions are physiologic and mild (coldness, warmth, or pain at the injection site; nausea with or without vomiting; headache; paresthesias; and dizziness).
- Allergic like reactions are uncommon.
- Anaphylactic reaction is rare
- Important side effect: Nephrogenic Systemic Fibrosis (don't use if eGFR <30]

Pregnant:

• All IV iodinated and gadolinium-based contrast media cross the blood-placental barrier.

Head CT:

- Seizure, headache, acute strok, GCS <13, FND, skull fracture
- > 1 episode of vomiting especially if there is coagulopathy or anticoagulant use in adult (>3 in children)
- Increased ICP, hydrocephalus, ...

Chest CT:

 To evaluate abnormalities on CXR, evaluate pulmonary and pleural masses, diffuse pulmonary disease (diagnosis and extent), evaluation of mediastinum, bronchiectasis (suspected, extent, and severity), Suspected PE.

Abdomen/pelvic CT:

• acute appendicitis, diverticulitis, acute pancreatitis and pseudocyst "chronic

pancreatitis without contrast), cancer staging, evaluation of urinary tract (with or without contrast), abdominopelvic blunt trauma (echymosis, drop Hb/HCT.

Fluoroscopy

- Visualize in real time the organ motion, ingested or injected contrast agent (Barium, MCUG / VCUG, Hysterosalpingogram
- Therapeutic intervention: stent insertion or catheterization of the vessels
- Visualization of vessels is called angiography:
 - Diagnostic: aneurysm, thrombosis, AVM, AVF
 - Therapeutic: embolization, stenting, thrombectomy, thrombolysis

• MCUG/ VCUG

- VUR, study urethra during voiding, bladder leak after trauma, or post-surgery, uodynamic studies i.e incontinence
- <u>C/I inAcute UTI</u>
- Patient preparationm Foley's catheter insertion, Empty UB

• Hysterosalpingogram

- Infertility, recurrent abortion, assessment of fallopian tubes or CS scar
- Early phase and late phase of uterine filling demonstrating peritoneal spillage bilaterally, suggesting patent fallopian tubes.
- Patent preparation:
 - Abstain from intercourse
 - Examination done before day 21 of menstrual cycle between 4th-10th day.
- C/I:
 - Pregnancy
 - Bleeding (menses)
 - Purulent discharge or PID before 6 months
 - Recent abortion or dilatation

Ultrasound

- Advantage ps: available, speed, low cost, non-invasive, no radiation
- Doppler examination during early pregnancy is limited for long time application due to thermal induced effects on the embryo.
- Probes:
 - Linear: **low penetration, high frequency and resolution** used to examine superficial organs.
 - Curved (curvilinear): high penetration, low frequency and resolution used to examine deep organs
- Gel: For the transducer to make secure contact with the skin and eliminate air pockets that block sound waves into patients body
- Doppler ultrasound is a special application of US which measures the direction and speed of blood cells through blood vessels.

MRI

- Advantages:
 - Superior soft tissue contrast

- Multiplanar capability
- Non ionizing radiation
- Relatively safe contrast media
- Disadvantages:
 - Expensive
 - Not widely available
 - Claustrophobia
 - Certain contraindications i.e pacemaker...etc.

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