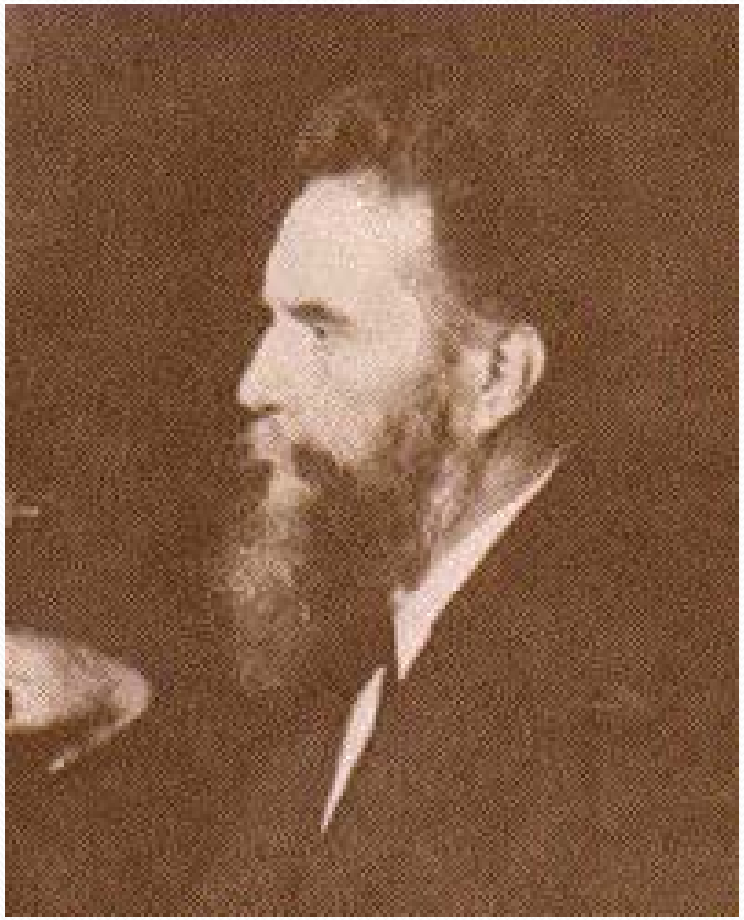
Introduction to Radiology

Department of Radiology

Wilhelm Conrad Roentgen, *discoverer of the x-ray*



discovery (and naming) of x-rays in 1895

This early radiograph was a 30 minute exposure of the hand of Roentgen's wife

- Early work resulted in harm and death
- Early x-ray tubes lacked protection and there were no standards for exposure
- From 1896 to 1903, 14 British operators died from over exposure
- Protection and standards for exposure were gradually introduced

X ray unit

Principles of interpretation

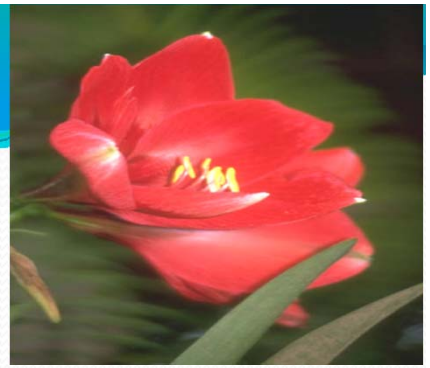
- 5 basic Radiographic densities:
  - Air
  - Fat
  - Soft tissue
  - Bone
  - Metal or x ray contrast agents (suspension of Iodine or barium compounds)

Principles of Image analysis

- What is a Normal, What is a Pathological Finding?
- Where is the Pathology?
- What kind of pathology?
  - Are There Any Volume Changes?
  - What Happens to the Surrounding Anatomy?
  - What Is the Internal Structure Like?
  - What Pathology Commonly Occurs in a Particular Anatomical Region?

Radiation Hazards

- Radiology
  - ✓ use x radiation as the energy to get the image
  - ✓ x radiation is an ionizing radiation so that it is hazardous especially to rapidly growing cells such as those in the fetus
- Two types of injury
  a) Deterministic
  b) Stochastic

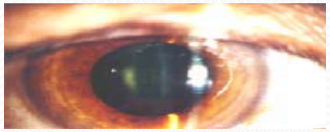


What can radiation do?

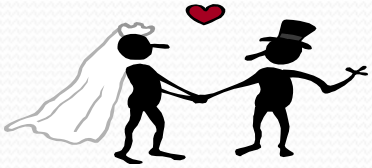
- Death

- Cancer

- Skin Burns



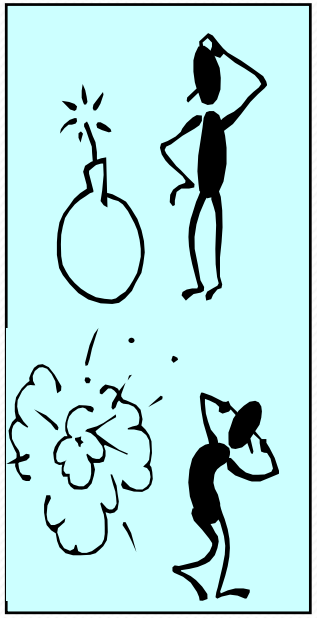
- Cataract
- Infertility

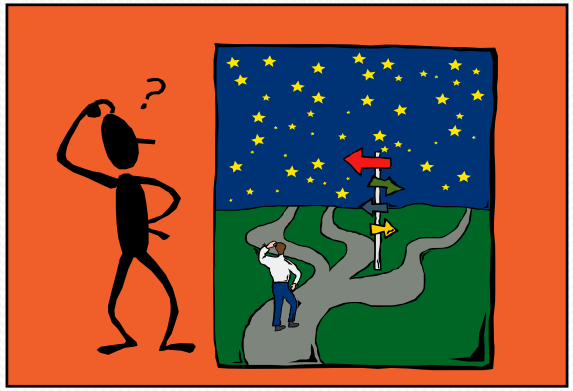


- Genetic effects

Biological effects of ionizing radiation

- **Deterministic**
  - e.g. Lens opacities, skin injuries,
  - infertility, epilation, etc
- **Stochastic**
  - Cancer, genetic effects.





Deterministic effects

Threshold/non-stochastic

- Existence of a dose threshold value (below this dose, the effect is not observable)
- Severity of the effect increases with dose
- A large number of cells are involved

Radiation injury from an industrial source

Stochastic Effects

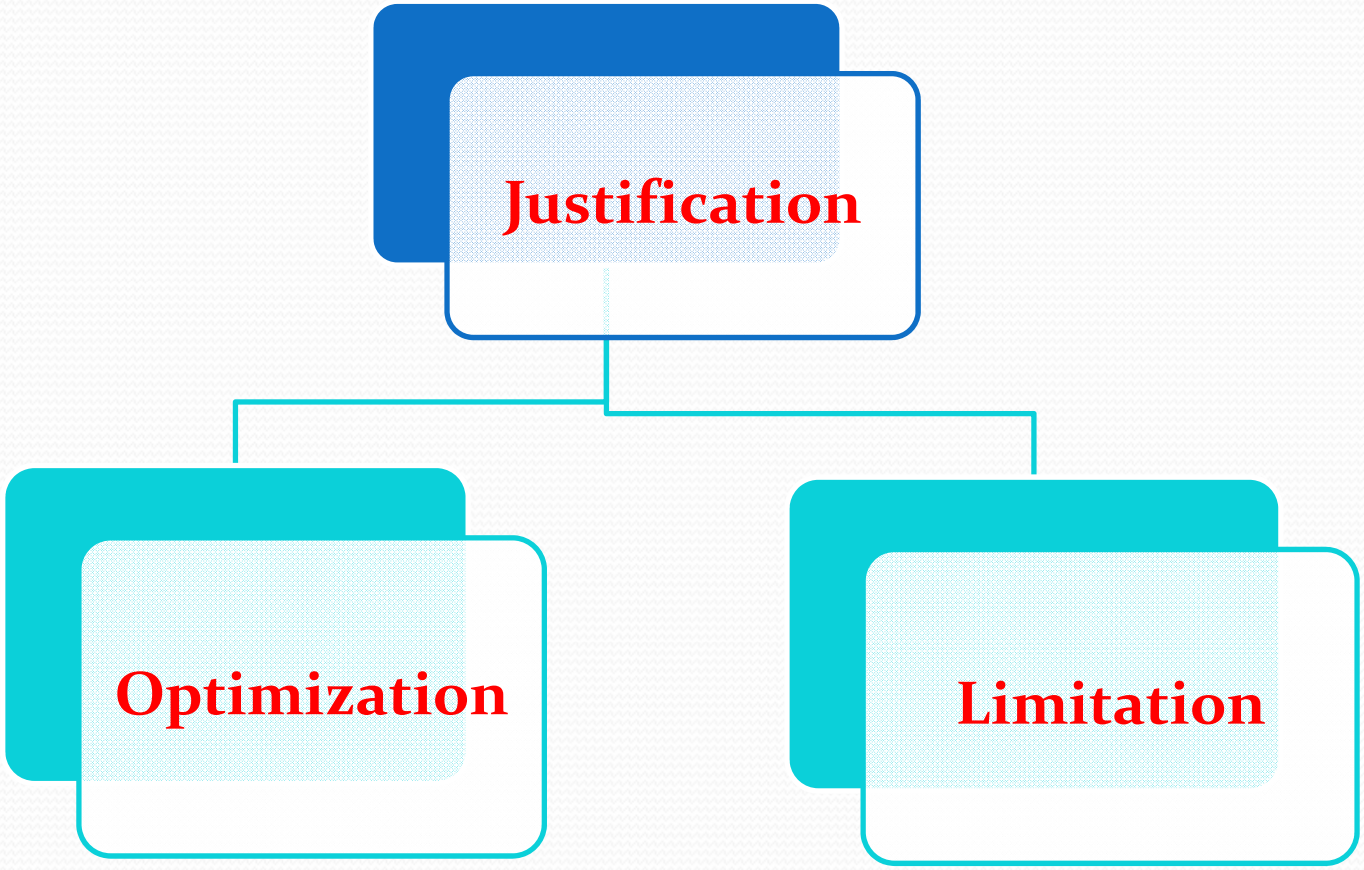
- Stochastic(Non-Threshold)
  - No threshold
  - Probability of the effect increases with dose
  - Associated with damage to DNA of cells
  - Result in cancer or genetic effects

Fetal exposure

- The most vulnerable period for deterministic effect is 2nd and 20th week of gestation
- No deterministic effects are expected to occur at a cumulative fetal dose below 100 mGy
- Stochastic effect of radiation induced cancer risk in utero is the same as the risk of exposure during childhood (about 3 times higher than that of the whole population)

Radiation Protection

ALARA : As Low As Reasonably Achieved



Justification

- Population screening like mammography screening
- Radiation exposure of volunteers in biomedical research
- Radiation exposure of carers and comforters
- Expected from the physicians that any referral of patients to medical imaging is justified by the fact that this examination will contribute to good medical care

Optimisation

- Finding a balance between the required image quality and the associated radiation exposure
- Radiologist, nuclear medicine specialist or radiographer has an important role in keeping the radiation dose to patient as low as possible with the diagnostic purpose.
- Type of examination and imaging technique must be selected so as to minimise the dose to the patient

Limitation

- Means that the total dose to any individual in a planned exposure situation should not exceed the dose limits specified by the legal authorities
- Most countries adopt in their legislation the dose limits recommended by ICRP (International commission for radiation protection)

Effective Doses from diagnostic medical exposures

Radiographic examination	Effective dose equivalent (mSv)	Equivalent no. of CXR	Approx. equivalent period of natural background radiation
Extremities	<0.01	<0.5	<1.5days
CXR	0.02	1	3 days
Skull	0.07	3.5	11 days
Thoracic spine	0.7	35	4 months
Lumbar spine	1.3	65	7 months
Hip	0.3	15	7 weeks
Pelvis	0.7	35	4 weeks
Abdomen	1.0	50	6 months
IVU	2.5	125	14months
Ba swallow	1.5	75	8 months
Ba meal/follow through	3	150	16 months
Ba enema	7	350	3.2 years

CT

Radiographic examination	Effective dose mSv	Equivalent no. of CXR	Approx. equivalent period of natural background radiation
CT head	2.3	115	1 year
CT chest	8	400	3. Years
CT abdomen or pelvis	10	500	4.5 years

Radiation protection of staff and public

- Staff in radiation area is only justified if they are essential to the procedure or if they are being trained
- The public should be excluded from radiation area unless they are accompanying a patient, e.g., a child
- Radiation area should be designated as controlled areas