INTRODUCTION TO NUCLEAR MEDICINE
(RADIO-NUCLIDE STUDIES)
(Scintigrams)

Figure 8-3 “He’s supposed to have a bone scan.” “No, he’s supposed to have a barium study first.” “Sorry, he’s scheduled for surgery right now.”
Within the range of radiation frequencies, called the electromagnetic spectrum, cell phones fall between TVs and microwave ovens. At that level, many scientists believe the radiation from cell phones couldn’t conceivably impair human health.
RADIATION EXPOSURE PATHWAYS

Airborne Radioactive Materials
- Deposition
- Crop Uptake
- Inhalation
- Skin Absorption
- Cosmic Radiation

Exposure Crop Ingestion
- Irrigation
- Food, Milk Ingestion

Indoor Air Structural Radiation
- Rocks and Soil
- Radiation

Water and Aquatic Food Ingestion

Dissolved Radioactive Pollutants

Radiation exposure comes from many common sources

We live with radiation exposure every day — just think where we would be without the sun. About 80 percent of the radiation we receive comes from the sun, metals in the ground and the food we eat. The rest comes from man-made sources.

Scientists measure the effective dose of radiation on our bodies in Sievert units. Most of us get about 1-milliSievert — one-thousandth of a Sievert — of radiation per year from natural sources, such as the sun. Here are some examples:

- **Medical/dental imaging**
  - Chest x-ray: 0.04 milliSieverts
  - Chest CT scan: 8.3 milliSieverts

- **Air travel**
  - A cross-country flight from Boston to Los Angeles (round trip): 0.05 milliSieverts

- **Smoking**
  - Three to four packs a week equals about the same dose as 25 chest x-rays.

- **Nuclear power generation**
  - About 1 percent of our exposure comes from making nuclear power and storing its wastes.

- **Around the home**
  - Some sources include building materials, phosphate fertilizers, smoke detectors.

- **Consumer electronics**
  - Television screens, computer monitors and cell phones give off some radiation.

- **Radon gas**
  - About 55 percent of our exposure comes from this natural source which gets trapped in our homes.

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**WHAT IS RADIATION?**
Radiation is energy that is transmitted in the form of waves or particles. Radiation associated with the use of nuclear energy are categorized as “ionizing” radiation.

Ionizing radiation like **gamma rays** or X-rays has such a high energy that it alters an atom or a molecule permanently.

**“non-ionizing” radiation**
Non-ionizing radiation like ultraviolet, visible light, infrared, microwaves and radio waves can alter atoms or molecules only for a very short time.

**WHAT IS RADIOACTIVITY?**
Radioactive rays is radiation of very high energy and is therefore an ionizing radiation. Radioactivity is the property/capacity of radioactive materials to emit radiation.

There exist three kinds of radioactive rays:

- **Alpha rays** are emitted from naturally occurring heavy elements such as uranium and radium, they have little penetrating power and can be stopped by the first layer of skin or a sheet of paper. If alpha sources are taken into the body, by breathing or swallowing radioactive dust, alpha particles can affect the body's cells. Inside the body, because they give up their energy over a relatively short distance, alpha particles can inflict more severe biological damage than other radiations.

- **Beta rays** are much smaller than alpha particles and can penetrate one to two centimetres of water or human flesh. Beta particles are emitted from many radioactive elements. They can be stopped by a sheet of aluminium a few millimetres thick.

- **Gamma rays** is electromagnetic radiation like light. Unlike light, gamma rays have great penetrating power and can pass through the human body. Thick barriers of concrete, lead or water are used as protection from them.
**MEDICAL APPLICATIONS:** The widespread use of radiation in the medical community. It can be used for diagnosis as well as therapy for a number of diseases.

**Diagnostic treatments:**
→ **X-rays** can provide anatomical images for identifying abnormal changes in body organs and tissues. With advanced imaging and computing technologies, a three-dimensional picture or animation can be generated.

→ **Radioactive isotopes** can be injected or ingested by patients. The most widely used diagnostic radioisotope is technetium-99m which has a half-life of six hours and releases gamma rays during radioactive decay. While giving the patient a very low radiation dose, technetium-99m allows sufficient time for the diagnosis process.

**In therapy treatments:**
→ A radioisotope of iodine, iodine-131, is used to treat hyperthyroidism and thyroid cancer.

→ For some other cancers, gamma rays from cobalt-60 sources, are used to destroy cancer cells.

→ Irradiating a tumor with ionizing radiation has proved to be effective in inhibiting the tumor's growth or even destroying it.
X-Rays show up abnormalities and fractures (breaks) in bones and abnormalities in certain body tissue (such as lung tissue).

You will be asked to lie on a table or stand against a surface so that the part of your body being x-rayed is between the x-ray machine and a drawer containing a film cassette (similar to photographic film).

You will have to keep still so the image is clear and not blurry. The x-ray is painless and you cannot see or feel it. The x-ray image is stored on computer, and doctors will view your x-ray on special computer screens.
Scans using a **Gamma Camera** assess the **function of organs**, for example the kidneys or the thyroid gland. Gamma scans can **check for disease at an early stage**, giving a greater chance of successful treatment.

Before the scan, a very small amount of a **radioactive liquid (radioisotope) is injected** **IV**. The gamma camera is then positioned over the area being scanned. The **radioisotope is taken up by overactive cells**, allowing the gamma camera to produce a highly detailed **picture of how the body is working**.

The gamma camera has two heads, which simultaneously scan the body overhead and underneath, giving the information quicker and more accurately.

A **radioactive tracer** is **injected** into a peripheral vein. As the radiotracer decays, **gamma radiation** is emitted and is **detected by a Gamma camera**. When the **tracer has collected in the target organ** the area is scanned.

**Radionuclide scans** can detect abnormalities such as fractures, bone infections, arthritis, rickets, and tumors that have spread, among other diseases.
RADIONUCLIDE STUDIES
Distribution of plain Technesium:
* thyroid
* salivary glands
* stomach epithelium
Normal distribution of Tc-99m + MDP for Bonescans

Tc-99m + MDP tracer

Whole body bone scan/scintigram
Bone scan when dissociation between the Tc-99m and the MDP took place.
SKELET EN LEWERFLIKKERGRAM VAN DIESELFDE PASIENT

LEWERFLIKKER DAG1
LEWER METS TEENW

SKELETFLIKKER DAG2
LET OP!!!
DEURSKYN AKTIWITEIT
OOR VAN VORIGE DAG
SE LEWER/MILT
“Cell function imaging”
Beelding van “Sel funksie”

KYK MET DIE “REGTE BRIL”
(ASSEBLIEF!)

PLEASE!!!! USE THE RIGHT GLASSES
THYROID FUNCTION IMAGING

Tc-99m = pertechnetate

Follicular cell function
Tin kolloied studies
Evaluate the **EFFECT** of underlying DVT on the flow of blood through the deep venous systems of the lower leg +

Exclude or confirm the presence of PE in the lungs
NORMAL LIVER/SPLEEN SCINTIGRAPHY

Artifacts or Filling defects

LIVER ANT

Size, position

LEAD MARKERS

SPLEEN POST
LIVER-cELL FUNCTION SCINTIGRAPHY

LIVER-SPLEEN SCAN

Kupffer cell function

HIDA SCAN

Hepatocyte Cell function
BONE SCANS

(child)

(adult)
SPECT/CT images

Fused images

Nuclear scan alone

CT scan alone
KIDNEY FUNCTION IMAGES

CORTICAL FUNCTION = DMSA
MAG3 or DMSA KIDNEY Fx STUDIES
First pass study: evaluate the flow of blood through the anatomical structures of the heart

Normal QP : QS ratio  =  1.2
GATED BLOODPOOL STUDY

Normal LVEF:

(N= 57±8%)
MYOCARDIAL BLOOD SUPPLY/
PERFUSION STUDY
(REST and STRESS)
THE PARATHYROID GLANDS

Hyperparathyroidism

Sestamibi Scanning
Radioactive iodine ablation treatment uses a radioactive form of the element iodine to treat and/or diagnose hyperthyroidism (overactive thyroid gland resulting in abnormally high thyroid levels) but is primarily used to treat papillary and follicular forms of thyroid cancer.

For thyroid ablation you will take RAI as a pill or liquid. You may need to change your diet and have blood, urine, and other tests done before your procedure. After thyroid ablation, you may need to take thyroid medicines for the rest of your life. More than one RAI treatment may be needed. Repeat treatments are usually at least three months apart. You may need to stay in the hospital after your procedure, or you may be able to go home. You may need to follow safety rules to keep others safe from the radiation in your body.
20 mCi RAI TERAPIE
5 DAE GELEDE GEHAD

WAG 8-12 WEKE (3 MAANDE)