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Department of Biomedical Engineering

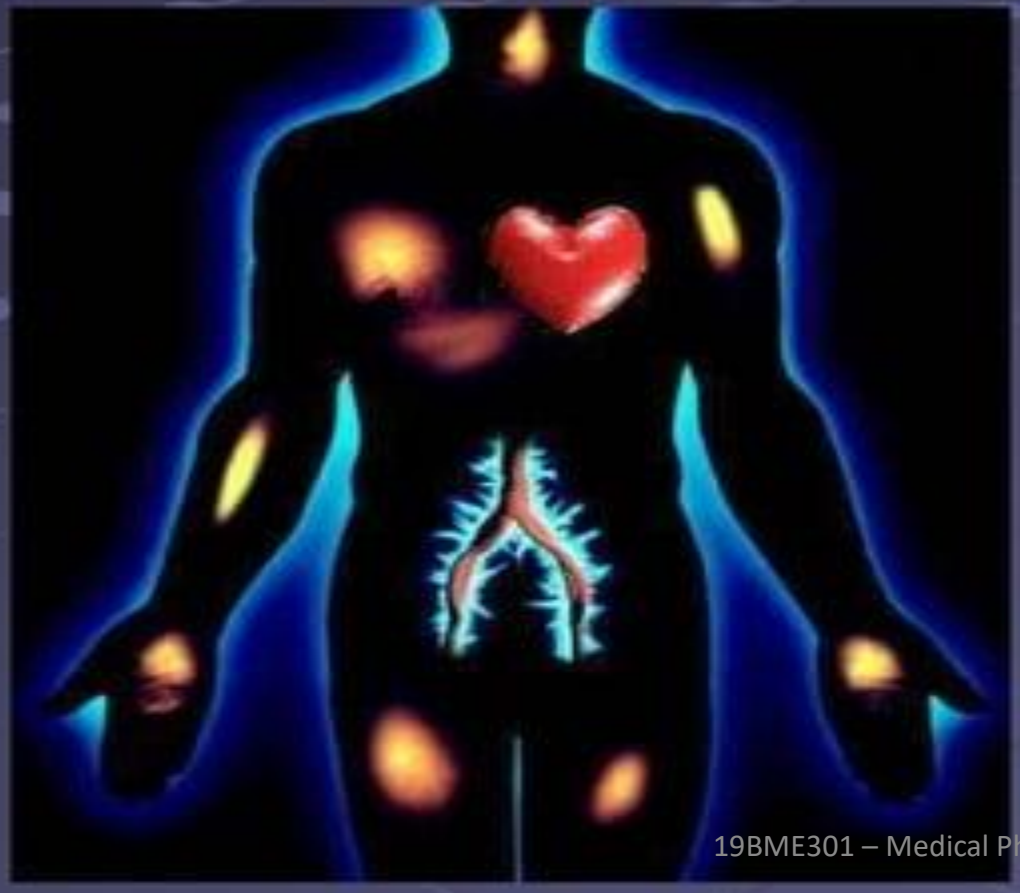
Vision Tit 2 Vision Title 3

Course Name: 19BME301 – Medical Physics

III Year : V Semester

Unit V – Radionuclide in Diagnosis

Radionuclide Imaging



Radionuclide diagnosis - a method of diagnosing a patient based on the introduction of radiopharmaceutical (RPh) in organizm. Using the radionuclide diagnostic can investigate virtually any organ or tissue in the body, as some of them in several ways. With clearly defined goals and a continuously feedback between a radiologist and doctors clinical departments, the possibilities of radionuclide diagnostics are almost limitless, especially in case of formulation particularly difficult diagnoses

RPh consists :

1. molecule, isotropic (native) to the target organ or tissue
2. presence radiolabeling, allowing to determine the dynamics and the amount of accumulated RPh via an external encoder (^{99m}Tc, ^{18}F, ^{123}I)

RPH Safety Regulations

1. RPh must be physiologically determined, i.e. it must selectively be absorbed by specific organ, inserted into it's metabolism and show the function of organ or organism.

2. RPh must be low-radiotoxic, i.e. to give minimal radiation to organism and critical organ.

The radiotoxicity of RPh is determined by T 1/2 /Tphys/. Time of the half amount of radionuclide decay.

3. must emit detectable rays or photons. Most frequently use γ-radiated RPh.

4. RPh must be radiochemically pure. The purity is determined by concentration of main radionuclide.

5. RPh must be apyrogenic. Apyrogenity is determined by the use of reagents, solutions.

The widely used radionuclides are following:

99мTC - T1/2- 6 hours, for brain tumors, thyriod gland, skeletal system, respiratory system diagnostics.

I131 – T1/2 – 8,04 days, for iodine metabolism, liver, kidneys function.

51Cr /27.7 days/ - in hematology.

198Au /2.697 days/ and **In111 –** for liver, brain diagnostics.

Target (critical) Organ

So, what is target organ?

Target organ – is organ in which the RPh is maximally accumulated and which is exposed by excessive radiation. Mostly, it is the organ we want to examine.

By safety regulations there are 3 groups of target organs due to decreasing or radiosencitivity:

1. group – whole body, genitals, bone marrow, small intestine mucosa.

2. group – muscles, thyroid, fat, liver, kidneys, spleen GI tract, lungs, lens.

3. group – skin,bones.

Radionuclide Laboratory

All the activity with RPH must undergo in specific offices. All equipment must be shielded and RPH should not waste the environment. The laboratory must include following rooms:

- Storage facility – 8-10м2 ventilation 5-10 times per hour.
- Preparation room - 8-20м2.
- Washing room – 10м2.
- Procedural room - 16-20м2 .
- Radiometry facility – 20-25м2.
- Radiography facility – 15-18м2.
- Gamma – topography facility – 12-18м2.
- Room for detection of activity of biological substances – 12м2
- Observation room (for outpatients).
- Sanitary rooms.

Methods of radionuclide diagnostics

1. *in vivo i/venously or per os*.

2. *In vitro* (blood, urina, other biological fluids). Radioimmunoassay in comparison with biological and biochemical research methods has several advantages: high sensitivity, which allows to determine small amounts of the substance, specificity, due to the principle of immunological reactions, high accuracy and reproducibility of the method. The disadvantages include a relatively high cost of a standard set of reagents for each blood component.

Methods of radionuclide diagnostics (in vivo)

1. Radiometry – is method, which determines radioactivity of the body, organ. This method allows to detect amount of radionuclide in organ or organism.

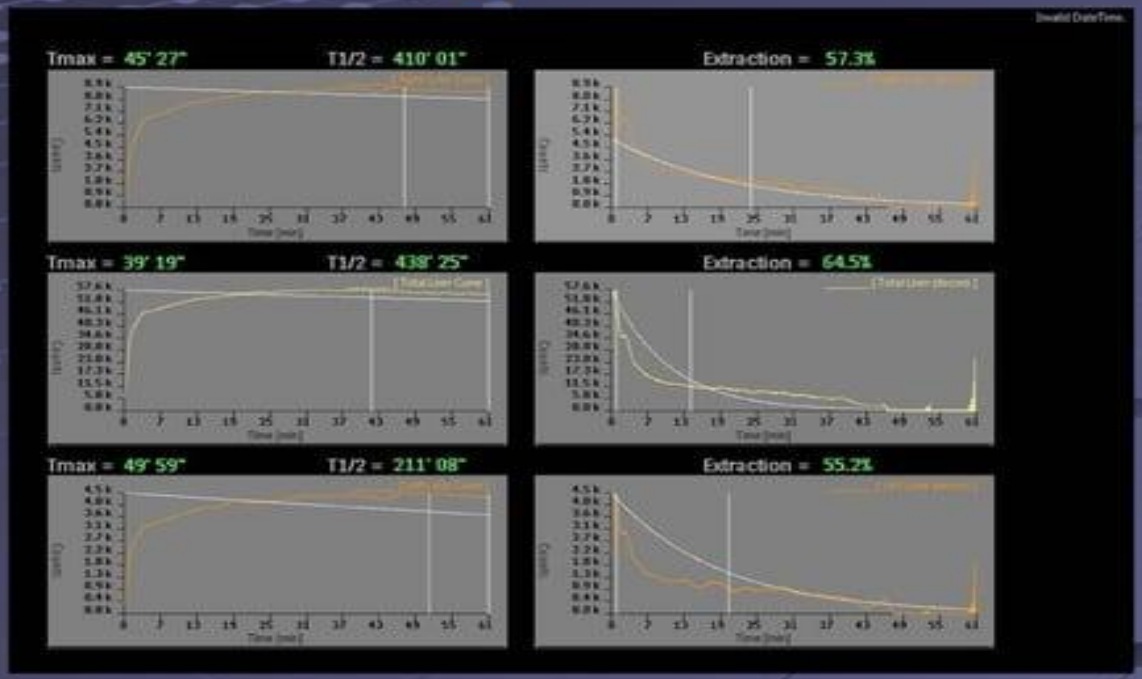
2. Radiography.

This method allows to detect distribution, accumulation and elimination of RPH. The result is a curve of the intensity of RPH in target organ during period of time (blood circulation, liver, kidneys function). This method allows to estimate clearance of blood.

Methods of radionuclide diagnostics

Blood clearance – the velocity of blood purification from RPH per time. The faster is clearance - the better is the organ function. A typical example is the radiographic study of the accumulation and excretion of the radiopharmaceutical from lungs, kidney, liver. Radiographic function in modern devices is combined in a gamma camera with visualization of organs

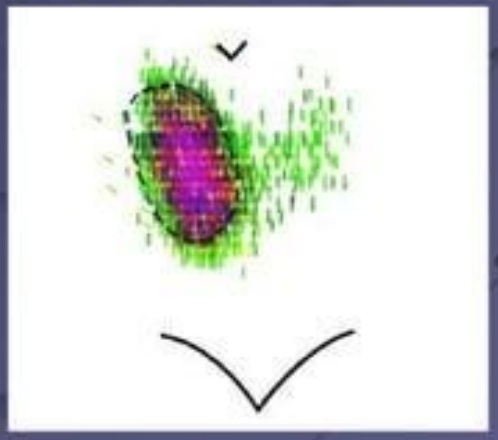
Methods of radionuclide diagnostics



3. Radionuclide imaging. The technique of painting the spatial distribution in the organs of the radiopharmaceutical injected into the body. Radionuclide imaging currently includes the following:

- a) scanning,
- b) scintigraphy with the use of gamma camera,
- c) single-photon emission tomography and two-photon positron emission tomography (PET).

Scanning - method visualization of organs and tissues by moving over the body of the scintillation detector. The device is conducting a study called the scanner. The main drawback - the long duration of the study.

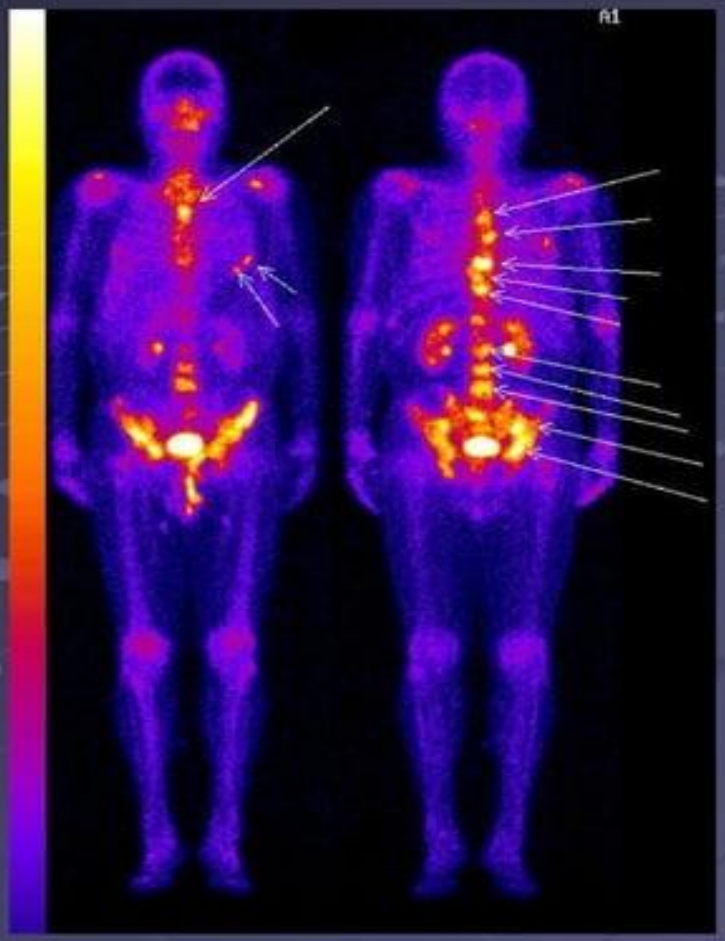


Scintigraphy. Method of imaging the spatial distribution in organ of RFh and photon detection with a scintillation detector or detectors. The method makes it possible to evaluate the morphological and functional state of the body. Scintigraphy - is currently the main method of radionuclide imaging in the clinic.

- Gamma radiation from the body of the patient is recorded by the detector gamma camera and computer after processing the obtained information is converted into a functional image of the investigated body.

There are several types of scintigraphy.
Static planar scintigraphy. The simplest type of scintigraphy. After the introduction of RPh, registration its distribution in the target organ by fixed detector. Determine the shape, size and nature of the organ contours, and most importantly, areas of abnormal accumulation indicator - high or low ("hot" or "cold" lesions). The method is applicable for the detection of tumor lesions in parenchymal organs.

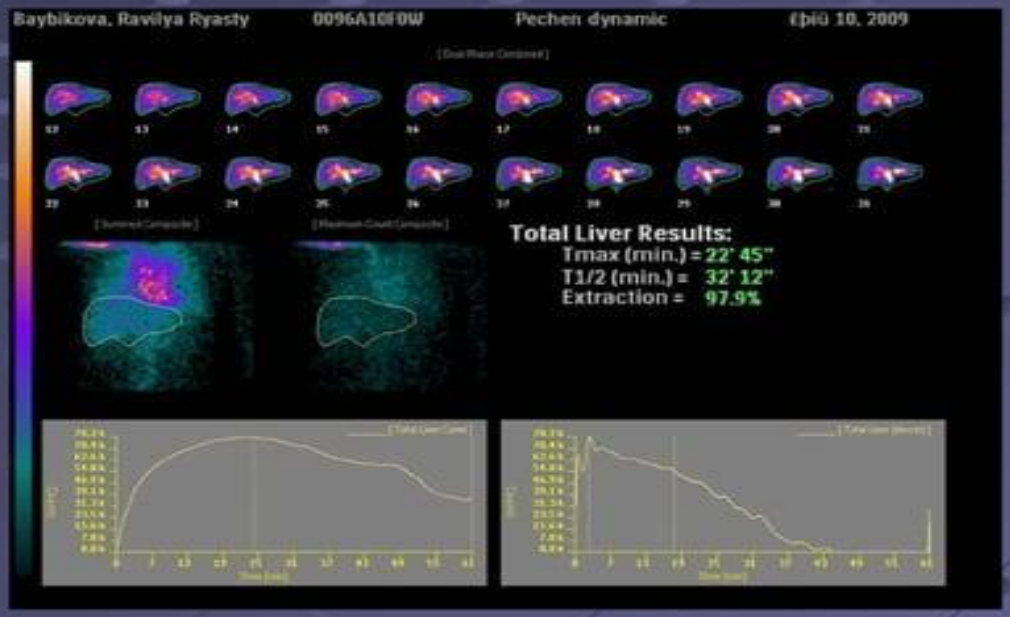
Whole-body scintigraphy. Variant static scintigraphy, however, here the table with the patient or the detector are moved in a horizontal plane, which allows to detect of photons from all Rph tracers of organism or a part of it. Widely used in the study of skeletal - bone scintigraphy to identify multiple lesions pathological process, such as searching for metastases.



- metastases in bone

- arthrosis

Dynamic scintigraphy. In contrast to the static, here, a series of scintigrams with a certain time interval. This allows, in addition to anatomical characteristics, to study organs function (eg. excretory function of the liver, the filtration and excretory function of the kidneys, etc).



Immunoscintigraphy - imaging of tumors by monoclonal antibodies with RPh are obtained by immunization of animals extracts antigens from remote malignant tumors. Sufficiently accurate method for the diagnosis of malignancy.

Single photon emission computed tomography (SPECT tomoscintigraphy) - registration of photons RPh of the examined organ by using one, two or three detectors rotate around the patient's body for some orbit (circular, elliptical, or difficult-adaptive). The number of slices obtained from 32 to 128, slice thickness of 4 to 10 mm, reconstruction is possible in different projections. This allows not only the anatomical and topographical characteristics of the organ, but also allows to study the biochemical, physiological, and transport processes. Used for the diagnosis of volumetric formations and vascular disorders of the brain, for the early detection of pulmonary embolism, coronary artery disease.

- Slice images
- accumulation
- Of RPh

Positron emission tomography (PET) - a method of nuclear medicine based on the use of ultra-short-lived radiopharmaceuticals labeled with positron emitters - 15O, 13N, 11C, 18F-FDG. T- aff. these drugs is 2, 10, 20.4 and 110 minutes. Sensitivity of the method is fantastic. PET allows us to conclude the change rate of glucose labeled with C11 in the "eye center" of the brain when you open the eyes, it is possible to detect changes at the thinking process, and even to determine the so-called "Soul". PET enables the study of functional changes and ability to live of tissue at the molecular level, such as glucose metabolism, oxygen utilization, assessment of blood flow and perfusion assessment . As well as functional changes precede morphological, cellular metabolism study provides an opportunity to diagnose a number of diseases earlier than with CT and MRI.


SONOMED TIBBI GORUNTULEME MERKEZI
STUDY: PET/BT TUM KONTRASTLI (Adult) STUDY DATE: 10.08.2012

Thank You

19BME301/Medical Physics /Dr Karthika A/AP/BME