INSTRUMENTATION

Our Department currently consists of:

- Philips Gemini-GXL 6 slice PET/CT scanner.
- GE Discovery 710 - 128slice Time of Flight (TOF) PET/CT scanner
- 3 SPECT cameras:
    - 2-GE Discovery(SPECT/CT)
    - Philips Skylight.
- GE Lunar Prodigy Bone Mineral Densitometer.
- GE Centricity PACS/RIS.

To learn about our imaging instrumentation, browse through the following Internet web sites:

- www.philips.com/healthcare
- www.gehealthcare.com

WHAT IS A SPECT CAMERA?

A SPECT camera is an imaging device which detects the gamma radiation being emitted from patients after administration of a radiopharmaceutical. It is based on the Anger camera, named after Hal Anger who developed the first gamma camera in the 1950's.

A SPECT camera consists of one or more heads mounted onto a gantry, with an imaging bed or table. The head is comprised of flat crystal detectors coupled to photomultiplier tubes. When a gamma ray is detected by the crystal it makes the crystal glow, and the photomultiplier tubes convert this light glow into an electrical signal. These electrical signals are recorded by a computer which then displays a 2D image on the monitor which reflects the distribution and relative concentration of the radiopharmaceutical within the patient's body.

Depending on the scan type and the diagnosis in question, the patient may have images performed as soon as the radiopharmaceutical is administered (dynamic imaging) or images may be acquired after a specific time delay. The SPECT camera can be used for stationary (static) imaging or may move in one motion along the body's contour (whole body sweep). SPECT cameras can also rotate around the patient to create a 3D image known as Single Photon Emission Computer Tomography and this is where their name originates from. Multiple 2D images are imaged around the body over 360° then reconstructed into slices, similar to a CT scan.

Image courtesy of Philips – Philips Skylight SPECT camera.

WHAT IS A SPECT/CT CAMERA

SPECT/CT combines the functional imaging capabilities of SPECT with the precise anatomical overlay of CT images acquired sequentially as a part of a single study. SPECT/CT systems use a low-dose-single slice or multi slice CT where both the SPECT and CT detector mounted on the same rotating platform. SPECT/CT characterised by high spatial resolution and faster scanning time.

Image courtesy of GE - Discovery 670 SPECT/CT camera.

WHAT IS A PET/CT CAMERA?

A PET/CT camera is an imaging machine which produces 3D images of the body using 2 imaging techniques, PET (Positron Emission Tomography) and CT (Computed Tomography). The PET component produces images of the function of cells and organs within the body following an injection of a positron-emitting radiopharmaceutical. The CT component provides anatomic information, assists with disease localisation and is used for attenuation correction of the PET images.

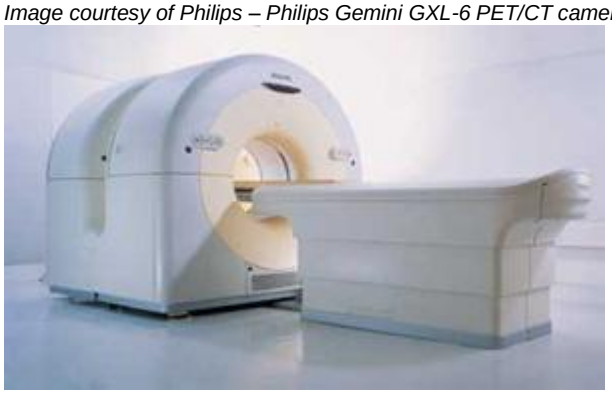
Our PET/CT scanner has 2 distinct parts to the gantry and there is a gap of approximately 50cm between the 2 components, making the scanning experience more tolerable for claustrophobic patients.

After injection with a positron-emitting radiopharmaceutical the patient waits a specific period of time for the injection to settle within the body. The patient is taken into the scanning room and positioned on the scanning table. The patient undergoes a ‘scout’ image using the CT scanner, from which the CT and PET acquisitions are planned. The CT scan is then acquired, where an X-ray tube and detectors within the CT component are rotated quickly around the patient’s body, and the images acquired are reconstructed into 3D slices. The total acquisition time is approximately 20-40 seconds.

The table translates from the CT component into the PET component and the patient then undergoes a PET scan. The scanning table is stepped slowly through the PET component for approximately 20-30 minutes. The radiopharmaceutical within the patient undergoes positron emission decay (which is also known as positive-Beta decay as a positron is a positively-charged electron). The positron travels a few millimetres in tissue before encountering an electron, which then causes an annihilation event. The result of the annihilation produces a pair of simultaneous (co-incident) 511keV gamma photons moving in opposite directions from each other: these are the gamma rays which are detected by the PET scanner and location of their source occurs along a straight line of co-incidence or line of response. When these gamma rays are detected by the crystal it makes the crystal glow, and the photomultiplier tubes convert this light glow into an electrical signal. These electrical signals are recorded by a very fast computer as a list of coincidence events representing near-simultaneous detection of annihilation photons by a pair of detectors. The PET scanner has direction-error and timing tolerances built in to the computer algorithms which reconstruct the detected events. The end

result is a 3D image that reflects the distribution and relative concentration of the radiopharmaceutical within the patient's body.

Image courtesy of Philips – Philips Gemini GXL-6 PET/CT camera.



WHAT IS BONE MINERAL DENSITOMETRY?

Bone Mineral Densitometry (BMD) is the method used to quantify the mass of bone in the body. Patients who have been referred by their doctors for a BMD scan are usually being assessed for osteoporosis. Osteoporosis is a common bone disease which makes bone fragile and easy to fracture. Future risk of fracture can be predicted for through a BMD measurement and steps can then be taken to prevent them from occurring.

The devices used to measure bone density are generally known as 'bone densitometers'. The bone densitometers used in the Nuclear Medicine Department at Liverpool Hospital is the GE Prodigy which uses the Dual Energy X-Ray Absorptiometry (DEXA) technique.

Image courtesy of GE – GE Prodigy DEXA scanner.

WHAT IS PACS/RIS?

PACS/RIS is the combination of a Picture Archive & Communication System and a Radiology Information System.

The PACS system allows for the acquisition, transmission, storage, retrieval and display of digital imaging data such as Nuclear Medicine scans. The digital imaging data is able to be

communicated within a controlled network. For example, when a Doctor in the ward orders a scan to be performed, they can access the written result on the PACS system at the same time as they view the scan.

The RIS component allows for the storage, manipulation and distribution of patient data, and encompasses patient tracking, scheduling, billing, result reporting and image tracking.

The PACS/RIS system is paper-less and streamlines the daily workflow of the Department while also ensuring that scans are reported and distributed in a timely fashion.