Positron Emission Tomography (PET)

What is PET?

Positron Emission Tomography (PET) is a powerful, non-invasive, diagnostic tool used in medical research. It allows us to measure, in microscopic detail the functioning of distinct areas of the brain in a conscious, comfortable and alert human being. It can detect biochemical processes involved in the functioning of a healthy or diseased brain. Virtually all diseases alter the body’s biochemical processes, so by detecting these chemical abnormalities, PET has the capability to identify the early biochemical markers of disease. PET is very sensitive and can detect changes in the brain associated with vision, hearing and thought processes. The PET scanner gives us, in essence, a picture of the brain at work.

How Does PET Work?

The electron-positron decay results in two 511 keV gamma photons emitted in opposite directions from each other. Gamma rays are detected by a circular array of detectors in the PET scanner and the location of the molecule being tracked is calculated. This information is then used to generate a series of images that use different colors or degrees of brightness to show the concentration and location of the molecule and the different levels of brain activity.

Before the examination begins, the radioactive substance, fluorine-18 is produced in a machine called a cyclotron located in the basement of the Huntsman Cancer Institute. It is attached, or tagged, to the natural body compound, glucose, producing FDG.

Regan Butterfield, the Nuclear Medicine Technician, will take you into the mobile PET trailer located outside the Huntsman Cancer Institute. In the waiting room she will administer the freshly produced FDG through an intravenous injection.

It takes approximately 30 to 90 minutes for the substance to travel through the body and accumulate in the brain. During this time, you will be asked to rest quietly and avoid significant movement or talking, which may alter the localization of the administered substance. After that time, scanning begins.

The PET is a donut-shaped apparatus with an attached examination table. To ensure good image clarity, you must lie quietly and avoid any head movements. This scanning process may take 30 to 45 minutes. PET scans are completely painless.

PET images show how the body uses common substances such as glucose, ammonia, water and oxygen. These substances are tagged with a radioactive atom that is unstable and breaks down quickly. The brain function being studied during a PET scan determines the radiopharmaceutical used. To study neurological diseases such as Frontotemporal Dementia (FTD) and Alzheimer’s Disease (AD), fluorine-18 is attached to a glucose molecule, creating the radiotracer 2-fluoro-2-deoxy-D-glucose or FDG for short. Glucose is a type of sugar that serves as the main energy source for the cells of the brain. The brain cells that are more active take up more glucose. FDG accumulates in the metabolically active brain regions, providing three-dimensional information about brain function and glucose metabolism.

Positron Emission

Radioisotopes such as FDG are extremely unstable (with a half life of about 110 minutes). When it breaks down, the nuclei give off anti-electrons, known as positrons. When the positrons come in contact with electrons from other molecules in the body, a matter-antimatter annihilation occurs with the release of pure energy in the form of photons, or 511 keV gamma rays. The gamma rays leave the body in nearly opposite directions and are detected by the PET scanner.