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ADVANTAGES AND SHORTCOMINGS OF POSITRON EMISSION TOMOGRAPHY EXAMINATION (PET)

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With the recent trend of prophylactic medicine and treating diseases, especially ontological, at early stages, more advanced technologies are required for diagnosis of such diseases. While most technologies such as; ultrasound imaging, x-ray technologies, MRI and others are aimed at detecting structural changes for diagnostic purposes, it is not enough as the development of these structural changes takes time and becomes visible at later stages disease. To circumvent this issue cellular and metabolic changes need to be observed. Exactly this is possible with the use of PET (Positron Emission Tomography).

PET scans require special tracers to be injected to the patient before examination. These tracers are biologically active molecules coupled with radionuclides, that accumulate in different tissues. The most common of them is fluorodeoxyglucose (FDG) which is a glucose molecule with an attached Fluorine-18 molecule. The PET scanner scans the whole body or the region of suspected pathology based on other tests such as blood tests, and maps out the localizations of annihilation events which is located on a line of travel of two gamma photons that are detected by the sensors. The gamma photons are high energy particles that originate from antimatter counter part of an electron called positron which is a result of tracer decay and electrons colliding. The distribution of tracer is based on metabolic need of tissues for biologically active molecule. In case with FDG its uptake is higher in tissues with oncology and inflammation due to their higher metabolic need for glucose. Other tracers include Rubidium 82 and Thallium 201 which behaves like potassium and is used in cardiology for asses myocardial perfusion and viability.

To increase the accuracy of examination and adjust for different physiological need of glucose or other biologically active molecules by physiological processes of different tissues the PET scanner is usually paired with a CT scanner which provides anatomical structures and allows for overlaying them on top of metabolic activity data.

Another technology based on a similar principle is SPECT (Single Positron Emission Computed Tomography), it detects single photons using a collimator and different tracers the most common of which is Technetium 99m. As SPECT uses tracers which have longer half-lives and are easier to source, they are cheaper to use and are more accessible to hospitals and patients but lose out to PET in sensitivity, spatial resolution, quantification, and image noise.

The main shortcomings of the PET originate from its working principle, which are the following; a high radiation exposure, limited time for the examination as the tracers have a very short half-time as such it is necessary to produce them on site or use complex logistics to deliver in a short amount of time, and thus plays arguably into the most prevalent shortcoming, the cost of examination which makes it unavailable for some patients or countries. With the advancements such as development of new tracers, possibility for use of PET/MRI instead of PET/CT these shortcomings are having less of an impact, but the main shortcoming that cannot be overcome remains. This is the inability of the precise localization of tracer decay point due to the necessity of positrons to travel some distance before an annihilation can take place.