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# Issues regarding PET Imaging for Incorporation in Radiation Treatment Planning

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In recent years, technologic advances in PET have created increasing interest in the use of this modality for more accurate radiation treatment planning. As PET provides images of specific biological active molecules in vivo, it results in a more sensitive tumor detection and discrimination, a more consistent tumor delineation and better quantification of tumor tissue characteristics, compared to conventional CT and MRI. Therefore, the use of PET, in addition to the anatomic information obtained by CT or MRI, offers a new opportunity to target cancers for radiation therapy. Furthermore, radiotherapy may benefit from the use of PET as a therapy response tool.

Incorporation of PET in radiation treatment planning, however, is not free from pitfalls.

In order to integrate PET into treatment planning for radiation oncology, logistical issues regarding patient setup, acquisition and reconstruction procedures, image fusion, target delineation and technical and functional implementation into the clinic must be addressed.

Accurate repositioning of the patient on the different modalities being used, including the treatment equipment, is of utmost importance. Inadequate repositioning may lead to a degraded planning accuracy, a reduced effective dose to the tumor, an increased dose to normal tissue and an adaptation to false tumor characteristics. The use of flat tables, (customized) supports/masks and laser guides is therefore strongly recommended.

For reliable tumor detection and discrimination with PET, the patient preparation, the image acquisition and reconstruction should be optimized and protocolized. Special attention has to be paid to image fusion. Although most PET systems are now combined with CT in a hybrid system, this does not guarantee an accurate co-registration. As there is a time difference between the imaging processes, the patient can move and organs may deform. Especially in the region of the diaphragm differences in breathing pattern between CT and PET will give rise to mismatches between both modalities. As CT is used for PET attenuation correction, even artefacts, localization errors and false-positives might be a consequence of inaccurate co-registration.

Target delineation in PET is another issue that may prove problematic. Various methods are currently used to determine the outline of FDG-positive tissue, e.g. by using a threshold based on a percentage of the maximum lesion intensity. In general, these techniques are influenced by multiple factors, such as tumor size and shape, and tumor metabolism. No consensus threshold exists for these approaches. The choice of delineation method and threshold level may have a significant impact on size measurements and delineation of lesions.

In order to integrate PET into treatment planning for radiation oncology, the abovementioned issues must be addressed. Awareness of possible imaging artefacts, pitfalls and being able to detect, correctly interpret and possibly solve them, is necessary for a maximum therapeutic yield. Furthermore, as logistics are complex, one has to accept a learning curve and to work oncologically safe when incorporating PET. Collaboration between departments of nuclear medicine and radiation oncology is crucial when performing PET for radiation treatment planning. Joint sessions for positioning and interpretation are strongly advised and results need to be validated.