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The use of PET SUV in identifying abnormality

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Standardized Uptake Values (SUVs) can provide an objective index of FDG uptake that can be compared within and between patients, and indeed between sites, and so have become widely used in oncological FDG-PET studies. An SUV greater than a certain cutoff can indicate a high likelihood of malignancy in lung cancer and in some other cancers. A high SUV is correlated with a poor prognosis in lung cancer and in glioma a high SUV indicates a higher grade tumour and hence a worse outcome. A reduction in SUV between successive FDG-PET scans can indicate a good response to therapy in lymphoma, gastro-intestinal and oesophageal cancer. The percentage reduction in SUV indicating response is different for each tumour type. The utility of SUVs is nevertheless limited and visual assessment of tumour to muscle ratio and similar indices remains the mainstay of clinical reporting in the majority of cases

SUV is defined simply as the ratio of tracer uptake per ml in a defined region (i.e. tumour) to the average tracer uptake per ml in the body. This ratio can be easily determined from a region of interest (ROI) placed on the PET image, the patient weight, and the administered activity. SUV is related to the rate of tumour glucose uptake, which can also be estimated by more complex methods, and there are many modified SUV definitions which to varying degrees may be better related to the true uptake rate. These range from using the lean body mass or body surface area rather than the patient's weight, to methods requiring blood samples.

There are many sources of error in measuring SUV. These come primarily from the imaging process and the imaging protocol. All measurement assume that the scanner itself has been properly calibrated and is subject to a rigorous quality control programme, however many inaccuracies remain, the most significant being the 'partial volume effect' whereby the apparent activity for regions of uptake with comparable dimensions to the spatial resolution of the scanner (i.e. ~ 5-10 mm) can be reduced by large factors (i.e. two or threefold). Iterative reconstruction algorithms and the various corrections for scatter, attenuation etc can also introduce errors. FDG uptake increases throughout the scanning period, it is therefore essential that the scan uptake period is standardized (typically at 60 minutes), at least within the centre. Later scanning times (i.e. 90 mins or even out to several hours) offer some advantages but cause practical and logistical difficulties. A further source of uncertainty is concerned with how exactly the tumour ROI is defined on the image. SUV can be defined for the maximum value in a lesion, for an average over a small region, or a more complex definition may include the volume of the lesion. Guidelines for these procedures are emerging, in particular with a view to standardizing procedures for multi-centre trials of new anti-cancer treatments, but current guidelines are not very prescriptive.

In addition to contributing directly to the assessment of the patient, SUVs can be helpful in other ways. For example, calibrating PET image display directly in units of SUV, and maintaining a fixed relationship between grayscale level and SUV, can facilitate standardization of reporting within and between institutions. The utility of SUVS has been demonstrated in numerous situations, however they must always be used with an eye to the various uncertainties and potential sources of error that are associated with them.

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