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Editorial

The role of ^{18}F-FDG PET in oncology: clinical and resource implications

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Introduction

Positron emission tomography (PET) imaging has come a long way since its inception in the early 1970's. It has matured rapidly and has already established a firm foothold in the discipline of oncology. The most commonly used radiopharmaceutical; ^{18}F-fluorodeoxyglucose (^{18}F-FDG) can provide images of metabolic activity that is vital in adding functional data to anatomic details obtained by cross-sectional imaging such as computed tomography (CT) and magnetic resonance imaging (MRI).

The mounting evidence of the benefit of PET imaging is now sufficiently robust to support the establishment of facilities [1–3]. In the immediate future 85–90% of PET utilisation will be accounted for by the oncology services, with much smaller numbers of scans being required for inflammatory, neurological and cardiac conditions. Currently, the evidence base is expanding rapidly, and this has invariably led to a growing number of validated clinical indications for PET. However, it may be difficult to keep up with the resources and infrastructure necessary for the number of dedicated PET establishments required to meet the demand. A good example is in the UK where, as recently as in 2004, each PET scanner served 8.6 million of the population, as compared to 1.02 million of the population in Germany [4]. Although more scanners are being acquired in Europe and elsewhere, the current availability is clearly not sufficient for the clinical requirements of the population.

Therefore, it is of utmost importance that this limited resource is allocated and targeted towards the appropriate patients, who will receive the most benefit in terms of clinical outcome, as well as cost benefit. It is also vital to maintain good clinical practice and integrity, as well as practising evidence-based medicine, as PET imaging will not be suitable for all pathologies.

There is a strong evidence base of the benefit of PET in lung cancer, lymphoma, melanoma and colorectal cancer. There is a rapidly expanding evidence base for oesophageal cancer, head and neck cancer, and a wide range of less common cancers. Further specific indications may be specified within each cancer group for the use of PET. These may include initial diagnosis and staging, assessment of recurrent disease, assessment of response to therapy, and radiotherapy planning. The recent development of hybrid PET-CT scanners has combined the two modalities for optimum localisation of active tumours and significantly improved the overall management of cancer [5].

This editorial is limited to the utility of ^{18}F-FDG PET in oncology. The application of other PET radiopharmaceuticals will not be discussed, but brief mention will be made when felt necessary. The use of ^{18}F-FDG PET in cardiology and neuro-psychiatry is likewise outside the scope of this article.

We present an outline of the generic indications for ^{18}F-FDG, which is applicable to all malignancies, followed by a review of its role in specific tumours. The latter is further subdivided into tumours or associated clinical conditions where ^{18}F-FDG is:

— definitely indicated;
— not indicated but may prove helpful;
— completely contraindicated.

These classifications are based on data obtained from one or more of the following sources:

— randomised controlled clinical trials, meta-analyses and systematic reviews;
— robust experimental or observational studies;
— other evidence where the advice relies on expert opinion and has the endorsement of respected authorities.

Since the references to the various clinical applications of PET are numerous, we selected a list of useful readings that include trials and reviews of the utility of PET in different types of tumours. The list is shown under different headings in the references section.

Generic indications for ^{18}F-FDG PET in oncology

— distinguishing benign from malignant disease e.g. lung nodules, brain lesions etc;
— establishing the grade of malignancy e.g. brain tumours, soft tissue masses;

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— establishing the stage of disease e.g. lung cancer, lymphoma etc;
— establishing whether there is recurrent or residual disease e.g. lymphoma, teratoma, seminoma, etc;
— establishing the site of disease in the face of rising tumour markers e.g. colorectal, germ cell tumours etc;
— establishing the response to therapy — pre, during and post therapy imaging;
— identifying the primary site of a tumour for biopsy (either when site is unknown but clinical indications are strongly pointing to a tumour e.g. paraneoplastic syndrome) or therapeutic purposes;
— radiotherapy planning in certain types of tumours (e.g. PET-CT in lung cancer).

Use of ^{18}F-FDG PET in specific tumours

Lung carcinoma

^{18}F-FDG PET is indicated in:
— differentiation of benign versus malignant lesions where anatomical imaging or biopsies are inconclusive or there is a relative contraindication to biopsy;
— preoperative staging of lung cancer particularly non small cell primary lung tumours;
— assessment of recurrent disease in previously treated areas where anatomical imaging is unhelpful.

^{18}F-FDG PET is not indicated but may help in:
— assessment of response to treatment.

Colorectal carcinoma

^{18}F-FDG PET is indicated in:
— assessment of recurrent disease, particularly when markers are raised and CT is negative;
— prior to surgical removal of liver metastases;
— prior to use of ^{90}Y-microsheres for ablation of liver metastasis.

^{18}F-FDG PET is not indicated but may help in:
— assessment of tumour response to chemotherapy or ^{90}Y-microspheres;
— assessment of a mass that is difficult to biopsy;
— assessment of neoadjuvant chemotherapy in colorectal cancer.

^{18}F-FDG PET is not indicated in:
— assessment of polyps;
— staging of a known primary.

Lymphoma

^{18}F-FDG PET is indicated in:
— staging of Hodgkin's lymphoma and non Hodgkin's lymphoma;
— assessment of residual masses following treatment of active disease;
— identification of possible disease sites when there is suspicion of relapse following clinical assessment;
— assessment of early response to chemotherapy and response following completion of chemotherapy;
— confirmation of remission.

^{18}F-FDG PET is not indicated but may help in:
— assessment of bowel lymphoma;
— assessment of bone marrow to guide biopsy.

Melanoma and other skin tumours

^{18}F-FDG PET is indicated in
— malignant melanoma with known dissemination to assess extent of disease;
— malignant melanoma in whom a sentinel node biopsy was not or can not be performed in stage II.

^{18}F-FDG PET is not indicated but may help in:
— staging of skin lymphomas.

^{18}F-FDG PET is not indicated in:
— malignant melanoma with negative sentinel node biopsy.

Oesophageal and other GI tumours

^{18}F-FDG PET is indicated in:
— staging of primary oesophageal carcinoma;
— assessment of disease recurrence in previously treated oesophageal carcinoma.

^{18}F-FDG PET is not indicated but may help in:
— assessment of gastro-oesophageal malignancy and local metastases;
— proven small bowel lymphoma to assess extent of disease.

^{18}F-FDG PET is not indicated in:
— routine assessment of neuroendocrine tumours. Receptor imaging with ^{111}In-octreoscan and ^{168}Ga-DOTATATE is more helpful.

Pancreatic exocrine cancer

^{18}F-FDG PET is indicated in:
— staging a known pancreatic primary.

^{18}F-FDG PET is not indicated but may help in:
— differentiation of chronic pancreatitis from pancreatic carcinoma;
— assessment of pancreatic masses to determine benign or malignant status.

Other head and neck tumours

^{18}F-FDG PET is indicated in:
— identification of metastatic disease in the neck from a diagnosed malignancy;
— identify extent of the primary oropharyngeal cancer;
— identify tumour recurrence in previously treated carcinoma;
— identify recurrence of laryngeal cancer in previously treated carcinoma;
— assessment of patients with differentiated thyroid carcinoma who present with possible recurrent disease and showing elevated thyroglobulin but negative iodine scan.

^{18}F-FDG PET is not indicated but may help in:
— preoperative staging of known oropharyngeal tumours;
— search for primary with nodal metastases;
— staging known laryngeal tumours;

— identification of metastatic disease in the neck from a diagnosed laryngeal cancer;
— assessment of tumour recurrence in medullary carcinoma of the thyroid.

^{18}F-FDG PET is not indicated in:
— differentiation of Sjogren's syndrome from malignancy in the salivary glands;
— primary tumour of the parotid to distinguish benign from malignant disease;
— routine assessment of patients with differentiated thyroid carcinoma with thyroglobulin positive recurrence and positive radioiodine uptake.

Brain and spinal cord

^{18}F-FDG PET is indicated in:
— suspected tumour recurrence when anatomical imaging is difficult or equivocal and management will be affected. Often a combination of ^{11}C-methionine and ^{18}F-FDG PET scans will need to be performed;
— benign versus malignant lesions, where there is uncertainty on anatomical imaging and a relative contraindication to biopsy;
— investigation of the extent of tumour within the brain or spinal cord.

^{18}F-FDG PET is not indicated, but may help in:
— assessment of secondary tumours in the brain and evaluation of tumour response to therapy.

Liver tumours

^{18}F-FDG PET is indicated in:
— equivocal diagnostic imaging in metastatic liver disease;
— assessment pre and post therapy intervention in metastatic liver disease;
— to exclude other metastatic disease prior to excision of metastases.

^{18}F-FDG PET is not indicated in:
— routine assessment of hepatocellular carcinoma.

Breast cancer

^{18}F-FDG PET is indicated in:
— assessment and localisation of brachial plexus lesions in breast cancer to differentiate radiation effects from malignant infiltration;
— assessment of the extent of disseminated breast cancer.

^{18}F-FDG PET is not indicated but may help in:
— axillary node status especially where there is a relative contraindication to axillary dissection;
— assessment of multifocal disease within the difficult breast (dense breast or equivocal radiology);
— suspected local recurrence;
— assessment of chemotherapy response.

^{18}F-FDG PET is not indicated in:
— routine assessment of primary breast cancer.

Genito-urinary cancer

^{18}F-FDG PET is indicated in:
— assessment of possible adrenal metastases;
— assessment of recurrent disease from seminomas and teratomas;
— assessment of residual masses;
— assessment of primary testicular tumour for staging;
— difficult cases of ovarian carcinoma to assess local and distant spread.

^{18}F-FDG PET is not indicated but may help in:
— paragangliomas or metastatic phaeochromocytoma to identify sites of disease. Currently, ^{68}Ga-DOTATATE is proving more sensitive in this respect;
— staging a known bladder primary or recurrence with equivocal imaging;
— in difficult cases of uterine cervical malignancy to define the extent of disease with accompanying image registration.

^{18}F-FDG PET is not indicated in:
— assessment of renal carcinoma;
— primary phaeochromocytoma — ^{123}I-MIBG and ^{68}Ga-DOTATATE scanning are more sensitive;
— assessment of prostate carcinoma.

Musculoskeletal tumours

^{18}F-FDG PET is indicated in:
— soft tissue primary mass assessment to distinguish high grade malignancy from low grade or benign disease;
— staging of primary soft tissue malignancy to assess nonskeletal metastases;
— assessment of recurrent abnormalities in operative sites;
— assessment of osteogenic sarcomas for metastatic disease;
— follow up to detect recurrence or metastases.

^{18}F-FDG PET is not indicated but may help in:
— PET-CT image registration of the primary mass to identify optimum biopsy site.

Metastases from unknown primary

^{18}F-FDG PET is indicated in:
— determining the site of an unknown primary when this influences management.

^{18}F-FDG PET is not indicated in:
— widespread metastatic disease when the determination of the site is only of academic interest.

Miscellaneous

^{18}F-FDG PET is indicated in:
— identifying sites to biopsy in patients with pyrexia;
— differentiating benign from malignant cerebral pathology.

^{18}F-FDG PET is not indicated but may help in:
— routine assessment of weight loss where malignancy is suspected;
— assessment of spinal infection or problematic cases of infection;

— in bone metastases when bone scan or other imaging is equivocal;
— identifying recurrent functional pituitary tumours when anatomical imaging has not been successful;
— identifying source of the fever of unknown origin.

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Lymphoma

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