Positron emission tomography imaging in selected cancers

Overview of the clinical effectiveness of positron emission tomography imaging in selected cancers

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Executive summary

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Executive summary

Background

Staging the extent of disease in primary or recurrent cancer requires a range of diagnostic tests to identify the primary tumour and any metastases. Most of the imaging methods are anatomical, e.g. computed tomography (CT). Positron emission tomography using 2-[^{18}F]-fluoro-2-deoxy-D-glucose (FDG-PET) is an alternative form of diagnostic imaging based on tissue function, which can help to identify active tumours. This health technology assessment evaluates the use of FDG-PET in eight cancers. It encompasses both dedicated PET and newer PET/CT technology that integrates PET and CT into one device.

Objectives

The aim of this review was to assess the clinical effectiveness of FDG-PET in breast, colorectal, head and neck, lung, lymphoma, melanoma, oesophageal and thyroid cancers. For each cancer, use of FDG-PET to aid management decisions relating to diagnosis, staging/restaging, recurrence, treatment response and radiotherapy (RT) planning were evaluated.

Methods

Data sources

This report augments the systematic search undertaken in a previous rapid review. It uses a systematic search undertaken in August 2005 that identified systematic reviews and primary studies not included in the previous review and a survey of UK PET facilities performed in February 2006.

Study selection

Studies were limited to those using commercial dedicated PET or PET/CT devices with FDG, in one of the eight cancers. The most recent robust systematic reviews were identified, along with additional primary studies that were prospective and included at least 12 patients. Treatment response and RT planning studies were included if they had at least six patients and for PET/CT retrospective studies were included. All selections were made by two researchers independently using predefined inclusion criteria.

Data extraction

Data extraction forms were created for each study to identify key features of study design and conduct according to the Quality Assessment of Studies of Diagnostic Accuracy (QUADAS) quality checklist.

Data synthesis

Given the variety of methods used in the individual publications, the evidence has been summarised in qualitative form.

Results

From this new search, six systematic reviews and 158 primary studies were included in the systematic review.

Cost-effectiveness

An English economic model shows that in non-small cell lung cancer (NSCLC) FDG-PET was cost-effective in CT node-negative patients, but not in CT node-positive patients. There is some evidence to suggest that FDG-PET may also be cost-effective in RT planning, but this model is less robust.

A Scottish model shows that in late-stage Hodgkin's lymphoma (HL), FDG-PET was cost-effective for restaging after induction therapy.

Patient management

For staging/restaging colorectal cancer, FDG-PET changed patient management in a way that can impact on curative therapy.

For detection of solitary pulmonary nodule (SPN) there is evidence of impact on patient management, but the impact on patient outcomes is unclear.

FDG-PET had an impact on patient management across paediatric lymphoma decisions, but further study of individual management decisions is required. For other cancer management decisions, the evidence on patient management is weak.

Diagnostic accuracy

FDG-PET was accurate in detecting distant metastases across several sites, but sensitivity was

variable for detection of lymph-node metastases and poor in early-stage disease, where sentinel lymph-node biopsy would be used and for small lesions.

FDG-PET had improved diagnostic accuracy over alternatives in:

- colorectal recurrence
- detection of occult and synchronous head and neck tumours, where other tests have failed
- staging regional lymph nodes in clinically node-positive necks
- restaging/recurrence in head and neck
- staging SCLC
- staging lymphoma
- restaging NHL
- staging oesophageal
- recurrent epithelial thyroid cancer, where elevated biomarkers are not confirmed by ^{131}I scintigraphy.

Some evidence of the diagnostic accuracy of FDG-PET exists for the following cancers, but more comparative evidence is needed:

- locoregional recurrence in breast
- staging/restaging/recurrence in breast
- staging lymph nodes in colorectal cancer
- diagnosis of occult SCLC
- staging late-stage melanoma
- recurrent melanoma
- restaging thyroid
- recurrent medullary thyroid cancer, where elevated biomarkers are not confirmed by ^{131}I scintigraphy
- clinically suspected recurrent thyroid cancer with no other markers.

Treatment response/RT planning

There were 61 studies of treatment response in all cancers except for melanoma. Most studies were small and evaluated a range of treatments, at different time-points, with a variety of imaging processes and analytical techniques. They showed that FDG-PET imaging could be correlated with response, in some cases, but the impact on patient management was not documented.

There were 17 small studies on RT planning in four cancers. FDG-PET led to alteration of RT volumes and doses, but the impact on patient outcomes was not studied.

PET/CT

There were 23 studies of PET/CT in six cancers (excluding breast and melanoma). Most studies combined different groups of patients to assess primary and recurrent tumours for staging and restaging. These showed that FDG-PET/CT generally improved accuracy by 10–15% over PET, resolving some equivocal images.

Survey

The survey of PET facilities in the UK showed that PET and PET/CT are being used for a variety of cancer indications. The distribution of PET facilities is not evenly spread across the UK and uses are not consistent. FDG deliveries are often required twice a day and most units use a commercial provider. Various research studies are underway in most centres, but only a few of these are collaborative studies. There is major variation in throughput and cost per scan (£635–1300).

Conclusions

Implications for healthcare

The strongest evidence for the clinical effectiveness of PET is in staging NSCLC, restaging HL, staging/restaging colorectal cancer and detection of SPN. Some of these may still require clinical audit to augment the evidence base. Other management decisions require further research to show the impact of FDG-PET on patient management or added value in the diagnostic pathway.

It is likely that new capital investment will be in the newer PET/CT technology, for which there is less evidence. However, as this technology appears to be slightly more accurate than PET/CT, the PET clinical effectiveness results presented here can be extrapolated to cover PET/CT.

Recommendations for research

PET research could be undertaken on FDG-PET or FDG-PET/CT, using a standard cancer work-up process on typical patients who are seen within the NHS in England. For treatment response and RT planning, the need for larger studies using consistent methods across the UK is highlighted as a priority for all cancers.

For all studies, consideration should be given to collaboration across sites nationally and internationally, taking cognisance of the work of the National Cancer Research Institute.

Publication

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NIHR Health Technology Assessment Programme

The Health Technology Assessment (HTA) programme, now part of the National Institute for Health Research (NIHR), was set up in 1993. It produces high-quality research information on the costs, effectiveness and broader impact of health technologies for those who use, manage and provide care in the NHS. 'Health technologies' are broadly defined to include all interventions used to promote health, prevent and treat disease, and improve rehabilitation and long-term care, rather than settings of care.

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Reviews in *Health Technology Assessment* are termed 'systematic' when the account of the search, appraisal and synthesis methods (to minimise biases and random errors) would, in theory, permit the replication of the review by others.

The research reported in this monograph was commissioned by the HTA Programme as project number 05/01/01. The contractual start date was in August 2005. The draft report began editorial review in June 2006 and was accepted for publication in April 2007. As the funder, by devising a commissioning brief, the HTA Programme specified the research question and study design. The authors have been wholly responsible for all data collection, analysis and interpretation, and for writing up their work. The HTA editors and publisher have tried to ensure the accuracy of the authors' report and would like to thank the referees for their constructive comments on the draft document. However, they do not accept liability for damages or losses arising from material published in this report.

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