Evaluation of PET and PET/CT for the diagnosis of breast cancer recurrence

An economic evaluation of positron emission tomography (PET) and positron emission tomography/computed tomography (PET/CT) for the diagnosis of breast cancer recurrence

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Executive summary

Health Technology Assessment 2011; Vol. 15: No. 18
DOI: 10.3310/hta15180

Health Technology Assessment
NIHR HTA programme
www.hta.ac.uk

Executive summary

Background

Breast cancer affects 1 in 13 women in their lifetime. Treatment options have developed significantly over the past decade and have had an impact on survival. The diagnosis of breast cancer recurrence is important, to allow appropriate treatment. Positron emission tomography (PET) and positron emission tomography/computed tomography (PET/CT) are technologies that have application in the detection and the management of cancer. The adoption of PET or PET/CT to conventional diagnostic procedures depends not only on their diagnostic accuracy, but on their comparative advantage over existing diagnostic approaches.

Objectives

The preliminary objective of this report was to review the published economic studies that have evaluated PET/CT in the treatment of recurrent breast cancer. The main objective was to develop a model and carry out a model-based economic evaluation to investigate the relative cost-effectiveness of PET/CT to detect breast cancer recurrence compared with conventional work-up. Given the conclusions of the review carried out by Pennant *et al.* [A systematic review of positron emission tomography (PET) and positron emission tomography/computed tomography (PET/CT) for the diagnosis of breast cancer recurrence. *Health Technol Assess* 2010;**14**(50)], the current analysis was required to consider PET/CT both as a replacement for PET and as a replacement for or supplement to conventional management.

Data sources

A systematic review of the clinical evidence on the use of PET/CT in diagnosis of breast cancer recurrence has been carried out (Pennant *et al.*, 2010). The review assessed the diagnostic accuracy of PET and PET/CT compared with conventional diagnostic strategies and prevalence. These data were used to populate the clinical parameters in the economic model. The review also identified a limited number of economic and costs studies, data from which were used to inform the economic parameters in the model. The original databases searched include MEDLINE (Ovid) (1950 to week 5 May 2009), EMBASE (Ovid) (1980 to 2009 week 22) and the NHS Economic Evaluation Database. An updated search was conducted for each database from May 2009 to week 4 April 2010.

Methods

A review of the economic studies was carried out by two independent researchers, initially, on the basis of title and abstract. Relevant studies were reviewed in full.

A decision tree was developed in TREEAGE software (TreeAge Software Inc., Williamstown, MA, USA). The relevant data on accuracy, sensitivity and specificity of each diagnostic test were linked in the model to costs and outcomes. The economic evaluation was carried out based on a primary outcome of cost per quality-adjusted life-year (QALY), and the perspective adopted was

that of the NHS. Secondary outcome measures of cost per case of recurrent cancer appropriately diagnosed and treated and cost per diagnostic error avoided were also analysed. The model begins with patients receiving a diagnostic procedure(s) depending on the symptoms presented during follow-up, then further receiving treatment and confirmation biopsy if necessary. The model estimated the mean cost associated with each diagnostic procedure and assumed that patients entering the model were aged 50–75 years. The results of the cost-effectiveness analysis are presented in terms of the incremental cost-effectiveness ratios (ICERs).

A deterministic analysis was carried out for the base-case results for the primary and secondary outcome measures. In addition, threshold-focused sensitivity analyses were carried out, deterministically, to establish the critical values for the cost and accuracy of PET/CT that could change deterministic results in terms of the ICERs, in such a way that might affect the decisions of policy-makers. Probabilistic sensitivity analysis was undertaken to determine the uncertainty of the model input parameter (prevalence, sensitivity and specificity).

Results

From the review, only two economic studies of PET/CT in breast cancer were identified and they were not relevant to recurrent breast cancer, so were reviewed qualitatively.

For the model-based economic evaluation, the ICER for the strategy of PET compared with conventional work-up was estimated at £29,300 per QALY; the ICER for PET/CT compared with PET was £31,000 per QALY; and the ICER for PET/CT combined with conventional work-up versus PET/CT was £42,100. Clearly, for each additional diagnostic test that is added to PET, the more expensive the package becomes, but also the more effective it becomes in terms of QALY's gained. Based on the current model and limited data, the probabilistic sensitivity analysis suggested that at a willingness-to-pay threshold of £20,000 per QALY, which is the threshold below which technologies are accepted and considered cost-effective by the National Institute for Health and Clinical Excellence (NICE), conventional work-up is likely to be considered the preferred option.

Based on the current model, severely limited evidence and some fundamental assumptions, neither the strategies of PET nor PET/CT appear cost-effective at the £20,000 per QALY threshold. At the upper end of the accepted threshold at the £30,000 per QALY level, there is considerable uncertainty regarding what would be considered the preferred strategy. PET/CT is currently the most cost-effective strategy only at thresholds > £40,000 per QALY, which exceeds the threshold currently considered acceptable by NICE. However, these results should be interpreted with some caution as limitations exist in the data that were available. Only data from indirect comparisons were available from the accuracy review, and the interpretation of whether the data defining the accuracy of PET/CT present its use as a replacement or as an adjunct to conventional work-up represents two clear limitations.

The deterministic threshold analysis showed that relatively small increases in the sensitivity of PET/CT and relatively small reductions in the cost of PET/CT can change the ICERs estimated in the deterministic base-case analysis to within the acceptable range of £20,000–£30,000 per QALY. Clearly, these deterministic results do not take into account the uncertainty highlighted by the base-case probabilistic sensitivity analysis at the £30,000 per QALY level for PET, PET/CT and PET/CT combined with conventional work-up compared with conventional work-up. However, the analysis suggested that relatively modest reductions in the cost of PET/CT might lead to policy decisions that consider PET/CT to be a cost-effective strategy.

Conclusions

This study has highlighted the limitations in available evidence from which to make firm conclusions about the cost-effectiveness, or not, of PET/CT. Based on the current limited evidence and necessary assumptions in the model, the use of PET/CT in the diagnosis of recurrent breast cancer in every woman suspected of breast cancer recurrence does not appear to be cost-effective given the current willingness-to-pay thresholds that are accepted in the UK by decision-making bodies such as NICE. Our modelling suggests that conventional work-up appears to be the most cost-effective diagnostic strategy. Future primary studies need to secure robust accuracy and cost data that can be verified from more than one source for the diagnostic tests involved in PET and PET/CT. Reliable and verifiable data on quality of life associated with this clinical condition are also crucial.

Recommendations for future research

- The vast majority of data used for the model-based economic evaluation had clear limitations.
- Studies investigating the possibility of using PET/CT as a replacement for, rather than an addition to, conventional work-up.
- Study to accurately assess the resource use and costs associated with PET and PET/CT, as well as the cost of conventional work-up strategies.
- Study to clarify the pathways and resource use for patients being treated for recurrent breast cancer are essential to further develop and refine the model structure.
- Study of quality of life associated with treatment pathways for recurrent breast cancer.
- If future research is undertaken to economically evaluate use of PET/CT in the current context, more resources and time are required than afforded to current analysis.

Implications for policy

The evidence on cost-effectiveness of PET/CT in recurrent breast cancer seems finely poised, so further research would thus seem to be the priority. It is important to ascertain whether the relative cost-effectiveness of the diagnostic tests associated with PET and PET/CT will improve if more reliable data on accuracy of the tests, resource use costs or the outcome in QALYs were available, or whether PET/CT is just not yet accurate enough in this application to compete with conventional work-up on cost-effectiveness grounds.

Funding

The National Institute for Health Research Health Technology Assessment programme.

Publication

Auguste P, Barton P, Hyde C, Roberts TE. An economic evaluation of positron emission tomography (PET) and positron emission tomography/computed tomography (PET/CT) for the diagnosis of breast cancer recurrence. *Health Technol Assess* 2011;**15**(18).

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The research reported in this issue of the journal was commissioned by the HTA programme as project number 08/34/02. The contractual start date was in December 2009. The draft report began editorial review in May 2010 and was accepted for publication in September 2010. 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.

The views expressed in this publication are those of the authors and not necessarily those of the HTA programme or the Department of Health.

ISSN 1366-5278 (Print)

ISSN 2046-4924 (Online)

ISSN 2046-4932 (DVD)

Published by Prepress Projects Ltd, Perth, Scotland (www.prepress-projects.co.uk), on behalf of NETSCC, HTA.

Printed on acid-free paper in the UK by the Charlesworth Group.