Cost-effectiveness of FDG-PET for staging non-small cell lung cancer: a decision analysis

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Record Status
This is a critical abstract of an economic evaluation that meets the criteria for inclusion on NHS EED. Each abstract contains a brief summary of the methods, the results and conclusions followed by a detailed critical assessment on the reliability of the study and the conclusions drawn.

Health technology
Use of thoracic positron emission tomography (PET) as an adjunct to thoracic CT for staging non-small cell lung cancer (NSCLC). Strategy A consisted of CT alone. The PET-based strategies considered were as follows: Strategy B implied that patients who were CT positive underwent a confirming biopsy, and if the biopsy results were negative, they proceeded to the necessary operation. The CT-negative patients underwent thoracic PET. PET-positive results led to a confirming biopsy while patients with PET-negative results proceeded to operation; In strategy C all patients underwent thoracic PET regardless of the CT result. The PET-positive patients proceeded to biopsy, and the PET-negative patients proceeded to thoracotomy; Strategy D required all patients to undergo thoracic PET regardless of the CT result. All CT-positive patients also underwent a confirming biopsy regardless of the PET result. The CT-negative patients with PET positivity underwent a confirming biopsy while those with PET negativity proceeded directly to thoracotomy; Strategy E was similar to strategy D, except that patients who were positive on both CT and PET did not have a confirming biopsy but were treated without thoracotomy.

Type of intervention
Diagnosis.

Economic study type
Cost-effectiveness analysis.

Study population
Patients with non-small cell lung cancer.

Setting
Secondary care. The economic study was performed in the United States.

Dates to which data relate
Data for the effectiveness analysis were based on studies published during 1982-1997. Resource use data and their corresponding dates were not reported. The price year was 1997-98.

Source of effectiveness data
The estimate of final outcomes was based on a review of previously completed studies and assumptions made by the authors.

Modelling
Decision tree models were constructed with four competing strategies to estimate the costs and effects associated with each strategy. Estimated national Medicare costs and patient life expectancy were assigned to each possible outcome of each strategy.
Outcomes assessed in the review
The review assessed the sensitivity and specificity of CT and PET. Also the morbidity of operation and biopsy, mortality of PET, CT, operation, and biopsy, and life expectancy for surgical cure and unresectable disease.

Study designs and other criteria for inclusion in the review
For CT sensitivity and specificity, studies which used a patient-based analysis were included. For PET, studies which presented data on a per-patient basis with CT scan diagnosis and defined N stage as 'positive' if N2 or N3 lymph nodes contained metastases, were included.

Sources searched to identify primary studies
Not stated.

Criteria used to ensure the validity of primary studies
Not stated.

Methods used to judge relevance and validity, and for extracting data
Not stated.

Number of primary studies included
A total of 16 studies were included (including five studies for the sensitivity and specificity of CT, and five for the sensitivity and specificity of PET).

Methods of combining primary studies
Previously pooled data for the sensitivity and specificity of CT were used. No more information was given.

Investigation of differences between primary studies
This was not explicitly stated except that individual sensitivities and specificities with their corresponding sample size were reported.

Results of the review
CT sensitivity was 67% (range: 61 - 73) and specificity was 73% (range: 62 - 86). PET sensitivity with positive CT was 89% (range: 80 - 100) and specificity was 81% (range: 60 - 100) and with negative CT sensitivity was 76% (range: 67 - 90) and specificity was 97% (range: 83 - 100). The mortality rate from PET was 0% (range: 0 - 1), from CT 0.0025% (range: 0 - 1), from operation 3% (range: 0 - 20), and from biopsy 0.3% (range: 0 - 5). The morbidity from operation was 0.083% (range: 0 - 1) and from biopsy was 0.007% (range: 0 - 0.1). The life expectancy for unresectable lung cancer for patients with highly advanced disease was taken to be 0.47 years. The authors chose a baseline of 1 year (range: 0.1 - 2) for patients with mediastinal metastasis not evident from the chest radiograph. The corresponding value for the surgical cure was 7 years (range: 1 - 15).

Methods used to derive estimates of effectiveness
Assumptions about effectiveness were also made by the authors.

Estimates of effectiveness and key assumptions
The accuracy of biopsy was assumed to be 100%. For the purposes of the present analysis, it was assumed that the
benefit of surgical intervention has not been proved for most patients with N2 or N3 metastases from NSCLC and that these patients would not be referred for operation.

**Measure of benefits used in the economic analysis**
Life years saved was used as the outcome measure in the economic analysis.

**Direct costs**
Costs were not discounted due to the short time frame of the cost analysis. Quantities were not reported separately from the costs. Cost items were reported separately. The mean Medicare reimbursement (combined technical and professional charges) for thoracic CT, biopsy and curative thoracotomy was estimated. A mean PET national Medicare reimbursement cost was used. The cost of subsequent therapies such as chemotherapy and radiation therapy were not included in this analysis. The model, therefore, primarily accounts for the difference in treatment cost due to thoracotomy. The price year appears to have been 1997-98. The cost analysis did not directly cover the costs associated with bone scans, whole-body screening, or plain films since they were deemed common to all strategies.

**Indirect Costs**
Not included.

**Currency**
US dollars ($).

**Sensitivity analysis**
One-way sensitivity analyses of benefits and costs was performed on all the key variables in the decision-tree model. Multivariate sensitivity analysis was performed on sensitivity, specificity, and cost of PET. Threshold values were calculated for the most sensitive parameters of the model.

**Estimated benefits used in the economic analysis**
The life expectancy accruing from strategy A was 4.921 years, from strategy B 4.928 years, from strategy C 4.930 years and from strategy D 4.928 years.

**Cost results**
The costs of each strategy were: $16,743 (A), $16,920 (B), $17,381 (C) and $17,708 (D).

**Synthesis of costs and benefits**
Strategy B was the most cost-effective strategy based on a generally held criteria that society is willing to spend up to $50,000 for an additional year of life. The incremental cost-effectiveness ratio for strategy B was $25,286, for strategy C $70,889 and for strategy D $137,857. Sensitivity analysis showed that the ratio of the cost of thoracotomy to the cost of PET was the most sensitive parameter of the model. From the sensitivity analyses, strategy B remained the cost-effective alternative when PET accuracy was penalised by 10%. When PET sensitivity and specificity and cost were penalised by 10%, none of the strategies were more cost-effective than strategy A. Performing a sensitivity analysis on other variables did not have a significant impact on the baseline results. Strategy E had the lowest expected cost ($16,095) but also had the lowest life expectancy (4.76 years). Because 3.5% of strategy E patients miss undergoing a beneficial thoracotomy, this strategy was not considered further.

**Authors' conclusions**
These results show, through rigorous decision tree analysis, the potential cost-effectiveness of using thoracic PET in the...
management of non-small cell lung carcinoma.

CRD COMMENTARY - Selection of comparators
A justification was given for the choice of the comparator (the use of thoracic CT alone). It was the standard test in the context in question. You, as a database user, should consider whether this is a widely used health technology in your own setting.

Validity of estimate of measure of benefit
The estimate of benefit is likely to be internally valid given the authors' claim that they performed a comprehensive literature review (although details of search, study selection criteria and the designs of the primary studies included in the review were not reported).

Validity of estimate of costs
As the authors noted the study uses estimated national Medicare reimbursed costs, whereas an optimal approach would look at the true costs of each procedure and model those costs explicitly. The study assumed that PET was readily available and that patients did not require extra days in hospital while awaiting investigation by PET. Indirect costs were not included in the cost analysis.

Other issues
Given the uncertainties in the data, the authors' conclusions were justified. The issue of generalisability to other settings or countries was addressed by performing sensitivity analysis and appropriate comparisons were made with other studies. As acknowledged by the authors, a cost-utility framework might have been a more appropriate approach for the context in question.

Implications of the study
The results of the current investigation support the use of thoracic PET as an adjunct to thoracic CT for preoperative staging. Greater use of thoracic PET for non-small cell lung carcinoma staging is warranted, and further clinical trials should help to validate the analytic results predicted from this study. Future studies using quality-adjusted life-years may prove that these are a more useful outcome measure to model effectiveness.

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