Cost-effectiveness of PET imaging in clinical oncology
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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
Positron emission tomography (PET) in clinical oncology.

Type of intervention
Diagnosis; secondary prevention.

Economic study type
Cost-effectiveness analysis.

Study population
Patients with lung cancer, suspicion of recurrent colorectal cancer, malignant melanoma, head and neck cancer, and Hodgkin's disease.

Setting
The study was set in one PET Centre and the economic study was carried out in California in the United States.

Dates to which data relate
The years during which the data were collected were not stated. The price year was not stated.

Source of effectiveness data
Effectiveness data were derived from a single study.

Link between effectiveness and cost data
The costing was undertaken retrospectively on the same patient sample as that used in the effectiveness study for the head and neck cancer and Hodgkin's disease groups. The costing was undertaken retrospectively on different patient samples to that used in the diagnostic accuracy studies for the lung cancer, colorectal cancer and metastatic melanoma groups.

Study sample
Power calculations did not determine the sample sizes used.

The study sizes for each of the groups were:

99 patients for the solitary pulmonary nodules and non-small cell lung cancer study (NSCLC) (72 patients in the management impact analysis),

57 patients for the recurrent colorectal cancer study (68 patients in the management impact analysis),
35 patients with suspected metastatic or recurrent melanoma for the metastatic melanoma study (45 patients in the management impact analysis),

29 patients who were undergoing preoperative evaluation for the recurrent head and neck cancer study,

and 30 patients (24 with primary disease and 6 with recurrent disease) in the Hodgkin's disease study.

Study design
Case-series from a single centre. To establish the diagnostic accuracy of PET, prospective case-series were used for all the diseases studied. To determine the effect on patient management, a retrospective case series were used. The duration of follow-up was not reported. The reference tests for staging of lung cancer were biopsy and imaging follow-up (for the distant metastatic staging) and surgery (for the 76 patients undergoing staging of the mediastinum).

Analysis of effectiveness
The principle on which the analysis of the clinical study was based was not relevant. Diagnostic staging accuracy and management impact were the 'outcomes' used in the effectiveness analysis.

Effectiveness results
Solitary pulmonary nodules and non-small cell lung cancer (NSCLC): for the distant metastatic tests, PET demonstrated unsuspected metastases in 11 patients and confirmed the presence of distant metastases in 7 patients with CT abnormalities. Sixteen of 17 CT abnormalities which were negative by PET turned out to be benign. All nine PET abnormalities that were negative by CT proved to be metastatic. For the seventy-six patients undergoing staging of the mediastinum, PET had a sensitivity of 83% and specificity of 94% versus 63% and 73% respectively for CT.

For the 72 patients retrospectively reviewed, the PET findings contraindicated planned thoracotomy for resection of non-small cell lung cancer in six patients. Planned thoracotomy for diagnostic lung resection was cancelled in 5 of 18 patients who had negative PET scans, indicating that the nodules were benign. While ten other patients with benign nodules would have undergone fine needle biopsy and some lung resection if the PET result had not been available, three patients, having shown a negative finding on PET, did undergo resection which confirmed the finding.

In 11 patients with NSCLC the finding of mediastinal lymph node enlargement by CT imaging would have led to pre-thoracotomy mediastinoscopy, which was avoided by PET results.

For recurrent colorectal cancer, PET was positive at 60/63 sites of confirmed tumour (95%) in 49/49 patients (100%) who proved to have recurrent disease. The corresponding figures for CT in forty-four patients with recurrence were 36/57 (63%) and 30/44 (68%). PET was false-positive at 2 sites and CT was false-positive at 12 sites.

Change in surgical management relative to CT directed by PET occurred in 24/68 patients (35%). PET findings contraindicated surgery for 17 cases of surgery intended following CT findings, while initiating or redirecting surgery in 7 further patients.

Metastatic melanoma: PET diagnosed 43/45 tumour sites (96%) in 26/27 patients (96%) with one false-positive result. CT diagnosed 21/38 tumour sites (55%) in 12/21 patients (57%), with 13 false-positive results. Approximately 40% of PET-positive tumours were negative by CT. The PET findings directed change in surgical management in 16/45 patients (36%). In 7 patients, PET showed that lesions demonstrated by CT were benign. PET findings initiated surgery in three patients.

Recurrent head and neck cancer: PET demonstrated evidence of unsuspected distant metastases in 11/29 patients and these findings were confirmed by biopsy or by other imaging modalities in 9 patients (31%). In one case, biopsy indicated that the PET finding was false-negative, and in the other case, a final diagnosis had not been established. PET findings showed that palliative treatment rather than attempted curative surgery was indicated in 9/25 patients (31%).

Hodgkin's disease: compared to CT PET changed the stage in 5/25 untreated patients and 6/6 patients with recurrence.
Change in stage resulted in treatment change in 3/25 untreated patients and 3/6 patients with recurrent disease. In each case, PET demonstrated stage III or stage IV disease in patients thought to have stage I or stage II on the basis of conventional imaging.

**Clinical conclusions**

Pathologic validation of PET results in non-small cell lung cancer, recurrent colorectal cancer, metastatic melanoma and recurrent head and neck cancer showed that PET was more sensitive and specific than CT in evaluating these tumours. Greater accuracy in imaging resulted in more accurate presurgical tumour staging, thereby avoiding attempted resection of nonresectable tumour in some cases and, in other cases, permitting earlier resection of tumours which were not detected by anatomic imaging.

**Measure of benefits used in the economic analysis**

The measure of benefits was the impact on patient management expressed as additional cases adequately managed.

**Direct costs**

While quantities of resource use were analysed separately, the costs included were those associated with the diagnostic and surgical procedures. Average reimbursement for oncologic PET studies at the study centre in 1992-94 was $1,800. The cost of a surgical procedure was obtained from the DRG-determined reimbursement for in-hospital treatment and from the reimbursement rates for surgical and anaesthetic services and for pathologic evaluation of surgical specimens. Only unnecessary costs actually incurred in the clinical study were considered. Changes in nonsurgical management, such as avoidance of unnecessary radiation therapy, were not considered. Also not considered were the costs of investigating false-positive CT findings, by procedures such as fine-needle biopsy and MR imaging. The price year was not clearly reported.

**Currency**

US dollars ($).

**Sensitivity analysis**

No sensitivity analysis was performed.

**Estimated benefits used in the economic analysis**

Solitary pulmonary nodules and non-small cell lung cancer:

the PET findings contraindicated planned thoracotomy for resection of non-small cell lung cancer in six patients. Planned thoracotomy for diagnostic lung resection was cancelled in 5 of 18 patients who had negative PET scans. Ten other patients with benign nodules would have undergone fine needle biopsy and some would have undergone lung resection if the PET result had not been available. In 11 patients with NSCLC the finding of mediastinal lymph node enlargement by CT imaging would have led to pre-thoracotomy mediastinoscopy, which was avoided by PET results.

Recurrent colorectal cancer:

change in surgical management was directed by the PET findings in 24/68 patients (35%).

Metastatic melanoma:

PET findings directed change in surgical management in 16/45 patients (36%).

Recurrent head and neck cancer:

PET findings showed that palliative treatment rather than attempted curative surgery was indicated in 9/29 patients.
Hodgkin's disease:
change in stage by PET resulted in treatment change in 3/25 untreated patients and 3/6 patients with recurrent disease.

**Cost results**

**Solitary pulmonary nodules and non-small cell lung cancer:**
In 72 patients the cost of procedures avoided by PET was $280,000. The net cost of PET if replacing CT was $86,000, which results in a net savings/cost ratio of 3.3.

**Recurrent colorectal cancer:**
In 68 patients the cost of procedures avoided was $300,000. The net cost of PET if replacing CT was $68,000, which results in a net savings/cost ratio of 4.4.

**Metastatic melanoma:**
In 45 patients the cost of procedures avoided was $179,000. The net cost of PET replacing CT was $45,000, thus resulting in a net savings/cost ratio of 4.0.

**Recurrent head and neck cancer:**
For 22 patients the cost of procedures avoided was $84,000. This results in a savings/cost ratio of 2.1.

**Synthesis of costs and benefits**
Synthesis was not undertaken by the authors for any of the disease groups because it was not relevant, since net costs were negative and net benefits were assumed to be positive. PET was the dominant strategy.

**Authors' conclusions**
PET imaging improved management and reduced costs when used for the following specific indications:

1. diagnosis of indeterminate lung nodules
2. staging non small cell lung cancer
3. staging prior to resection of recurrent colorectal cancer
4. staging prior to resection of metastatic melanoma, and
5. staging prior to surgery for recurrent head and neck cancer.

For these indications, PET was decisively more cost-effective than CT, combining improved patient care with reduced treatment cost. Prospective studies of cost-effectiveness are needed to assess the reproducibility of the preliminary retrospective evaluations and to determine the cost-effectiveness of PET for other indications.

**CRD COMMENTARY - Selection of comparators**
The reason for the choice of comparators is clear.

**Validity of estimate of measure of benefit**
The estimate of the measure of benefit used in the economic analyses was based on retrospective reviews of case series of relatively small numbers of patients in a single centre. Such estimates are open to bias.

**Validity of estimate of costs**

Resource quantities were reported separately from prices. Inadequate details of the quantity and cost estimation were given, and important cost items were omitted (as noted by the authors).

**Other issues**

The authors’ conclusions were not fully justified given the uncertainties in the study design. The generalisability of the study results (particularly with regard to the colorectal cancer and melanoma studies) are limited. As the authors noted prospective studies are required.

**Source of funding**

Supported by a grant from the Sutter Institute for Medical Research, Sacramento, CA.

**Bibliographic details**


**PubMedID**

8940715

**Indexing Status**

Subject indexing assigned by NLM

**MeSH**

Cost-Benefit Analysis; Humans; Medical Oncology /economics /methods; Neoplasms /economics /radionuclide imaging; Tomography, Emission-Computed /economics /methods

**AccessionNumber**

21997006532

**Date bibliographic record published**

31/10/1998

**Date abstract record published**

31/10/1998