An approach to demonstrating cost-effectiveness of diagnostic imaging modalities in Australia illustrated by positron emission tomography

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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
The study examined positron emission tomography with fluorodeoxyglucose (FDG-PET) in the diagnosis of a variety of cancers.

Type of intervention
Diagnosis.

Economic study type
Cost-effectiveness analysis.

Study population
The study population comprised patients with pulmonary nodules, lung cancer requiring preoperative staging, axillary staging of breast cancer, recurrent colorectal cancer, or patients requiring assessment of myocardial viability.

Setting
The setting was secondary or tertiary care centre. The economic study was carried out at the Wesley PET Centre & Southern X-ray clinics, Wesley Hospital, Brisbane, Australia.

Dates to which data relate
The effectiveness and resource use data were collected from studies published between 1994 and 1998. The price data were taken from sources published in 1998 and 1996 - 1997.

Source of effectiveness data
The effectiveness data were derived from a review of published studies.

Modelling
The author adapted decision trees from the literature to establish the cost-effectiveness of FDG-PET versus "routine care".

Outcomes assessed in the review
The author did not extract variables from the literature to apply to a new model, but instead applied local costs to the published models. Some of the variables used in the respective models were quoted. These included, for solitary pulmonary nodule, the risk of pneumothorax and use of chest tube during needle biopsy, prevalence of malignancy, and the specificity of FDG-PET.
For preoperative lung cancer staging, the variables included the prevalence of inoperable lung cancer, the sensitivity and specificity of FDG-PET, and minor and major surgery complication rates.

For axillary staging of breast cancer, the variables included the prevalence of axillary metastases, and the sensitivity and specificity of FDG-PET.

For preoperative evaluation of colorectal cancer, the variables included the minor and major complication rates for laparotomy.

For the assessment of myocardial viability, the variables included the prevalence of viable myocardium and the specificity of FDG-PET.

**Study designs and other criteria for inclusion in the review**
The author included decision tree analyses and trial-based studies. The inclusion or exclusion criteria were not reported.

**Sources searched to identify primary studies**
MEDLINE was searched, supplemented by publications from the Institute of Clinical PET.

**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**
Eleven primary studies were included in the review.

**Methods of combining primary studies**
The studies were not combined. Each one was analysed separately, applying Australian costs to the models.

**Investigation of differences between primary studies**
The author investigated differences between the primary studies through a sensitivity analysis.

**Results of the review**
In the analysis of FDG-PET for solitary pulmonary nodules, the pneumothorax rate was assumed to be 20%, with a 5% requirement for a chest tube. The prevalence of malignancy was 0.62 and the specificity of PET was 0.9.

For preoperative staging of lung cancer, the rate of inoperable disease was assumed to be 0.31. The sensitivity of FDG-PET was set to 0.9 and the specificity to 0.91. The complication rates for surgery were set at 2% (minor surgery) and 0.5% (major surgery).

For axillary staging of breast cancer, the prevalence of axillary metastases was assumed to be 0.25 and the specificity of FDG-PET 0.95.

For recurrent colorectal cancer, the complication rates for laparotomy were set at 2% (minor) and 0.5% (major).

For myocardial viability, the prevalence of viable myocardium was set at 0.71 and the specificity of PET 0.74.
Measure of benefits used in the economic analysis
No summary measure of health benefit was used. Equal effectiveness between the two strategies was assumed, therefore the study was classified as a cost-minimisation analysis.

Direct costs
The resource quantities and the costs were reported separately. The costs included were those relevant to the perspective of a hospital. The costs included were for computed tomography, chest/abdomen needle biopsy, FDG-PET, thoracotomy, mediastinoscopy, lung resection (stratified to uncomplicated, minor and major complications), simple mastectomy and axillary node dissection and partial mastectomy. The costs were taken from the Australian Medicare Benefits Schedule (1998) and the Australian National Hospital Cost Data Collection AN-DRG (v3.1, 1996/7). The total costs of each strategy were estimated using modelling techniques.

Discounting was not relevant since the costs were incurred in less than one year. The study reported both the average and incremental costs.

Statistical analysis of costs
No statistical analysis of the costs was performed.

Indirect Costs
Not applicable.

Currency
Australian dollars (Aus$).

Sensitivity analysis
One- and two-way threshold analyses of disease prevalence against PET specificity were performed to show the combination of the variables where PET was still cost-saving. The rationale for these analyses was that disease prevalence is population specific. As the source studies were from different countries, it was necessary to test the robustness of the results to changes in these parameters.

Estimated benefits used in the economic analysis
Not reported.

Cost results
When using FDG-PET to diagnose a solitary pulmonary nodule, two modelling studies estimated the cost of "no PET" at between Aus$5,813.54 and Aus$6,169.26. The cost of the PET strategy was between Aus$4,878.77 and Aus$5,663.76. Using the first study, the cost-saving from the use of PET was Aus$934.77, and using the second study it was Aus$505.50. The cost-saving estimated from the trial study was Aus$1,325.11.

In modelling the preoperative staging of lung cancer, the cost was Aus$7,353.26 for no PET versus Aus$7,318.61 for PET. This represented a saving of $34.65 per patient. A trial study estimated the savings at Aus$360.03.

In modelling the axillary staging of breast cancer, the cost per patient of no PET was Aus$4,399.00 versus Aus$3,849.00 for PET. This represented a saving of Aus$550.08. A trial-based study showed a cost increase of Aus$55.08 per patient with the use of PET.

In modelling the preoperative evaluation of recurrent colorectal cancer, the no PET strategy cost an average of Aus$5,045.00 per patient compared with Aus$2,744.00 per patient for the PET strategy. This represented a saving of
$2,301.27. Trial-based studies estimated the cost-saving at between Aus$249.06 and Aus$1,723.19 per patient.

In modelling the assessment of myocardial viability, the cost of no PET was Aus$8,129 and the cost of PET was Aus$7,828. This represented a saving of Aus$300.24 per patient. Trial-based results estimated a cost-saving of up to Aus$2,069.65 per patient.

**Synthesis of costs and benefits**

Since the benefits were assumed to be equal, this study takes a cost-minimisation approach and all the costs are reported per patient.

**Authors’ conclusions**

Positron emission tomography (PET) was cost-saving in Australia for the five conditions considered. This was based on a cost of PET of Aus$950. As this increases, especially toward the equivalent American cost of Aus$1,500, PET no longer becomes cost-saving. If the technology were to be widely adopted, the cost of PET in Australia would need to be kept to a minimum.

**CRD COMMENTARY - Selection of comparators**

The decision tree for comparing the use of PET in the case of a solitary pulmonary node is the only one shown by the author. It is unclear from the analysis exactly what the comparator strategies were for the other four analyses (see source articles in ‘Other Publications of Related Interest’ section). It would appear that the comparators were chosen to represent current practice in the relevant settings.

**Validity of estimate of measure of effectiveness**

The author did not state that a systematic review of the literature had been undertaken. However, it was stated that MEDLINE was searched, supplemented by handsearches. It is unclear how the studies were selected from the literature, as no details of the inclusion or exclusion criteria were reported.

The author used the results of the review to analyse the cost-effectiveness of FDG-PET to diagnose five separate conditions. Where there was more than one estimate of the cost-effectiveness for one condition (either from a modelled or experimental study), the author compared the results, identifying reasons for the difference and cost drivers.

**Validity of estimate of measure of benefit**

The analysis of benefits was based upon the assumed therapeutic equivalence of the two strategies. Therefore, the economic analysis included only the costs. The author justifies the assumption of therapeutic equivalence on the grounds that this can “often be considered reasonable on clinical grounds”. Further, the author pointed out that the case for superior effectiveness of PET would be strengthened with data directly linking the diagnostic method to the treatment outcome. However this, he states, is difficult to measure due to the large number of potential confounding variables during a patient’s treatment pathway. Therefore, the assumption of therapeutic equivalence potentially biases against PET. As PET, nonetheless, appears cost-saving, the argument in its favour is strengthened.

**Validity of estimate of costs**

From the perspective of a hospital, most of the relevant categories of costs appear to have been included. Costs such as "hotel" costs appear to have been excluded, although this may be taken into account in costing treatments by DRG. It is unclear how this would affect the conclusions. The costs and the quantities were reported separately.

The quantities of resources were obtained from the models, while the prices were obtained from a combination of recognised published sources and the author’s own centre. A sensitivity analysis of the quantities or costs was not conducted. This may limit the interpretation of the study findings. The dates to which the prices relate were not stated, although the published sources were dated 1996 - 1997 and 1998. In order to increase confidence in the results, it would
have been preferable to have stated a price year and converted all the prices to that year.

**Other issues**
As this analysis is primarily a review, the author implicitly compared the results from a number of studies, and the issue of generalisability to other settings was addressed. The author appears to have presented some results selectively, although this may be due to space limitations. For example, the transparency and use of this study to other people would have been enhanced with the inclusion of all decision trees and complete tables of input variables. The author's conclusions reflect the scope of the analysis, but a number of potential limitations were reported. First, there is a need for theoretical models to reflect reality. The author suggests diversion between theory and practice as a reason for some of the differences in costs between model- and trial-based studies. Second, the estimate of the specificity of FDG-PET may be affected by the prevalence of a second disease, which varies from population to population. This means international comparisons have to be made with care.

**Implications of the study**
The cost-effectiveness of PET is sensitive to the price of PET. Therefore, for PET to be truly cost-saving, the cost of the procedure itself needs to be kept to a minimum.

**Source of funding**
None stated.

**Bibliographic details**
Miles K A. An approach to demonstrating cost-effectiveness of diagnostic imaging modalities in Australia illustrated by positron emission tomography. Australasian Radiology 2001; 45(1): 9-18

**PubMedID**
11259966

**Other publications of related interest**


**Indexing Status**
Subject indexing assigned by NLM

**MeSH**
Australia; Cardiovascular Diseases /radionuclide imaging; Cost Savings; Cost-Benefit Analysis; Decision Trees; Fluorodeoxyglucose F18; Humans; Neoplasms /radionuclide imaging; Radiopharmaceuticals; Sensitivity and Specificity; Tomography, Emission-Computed /economics

**AccessionNumber**