Sleeve lobectomy or pneumonectomy: optimal management strategy using decision analysis techniques

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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 use of sleeve lobectomy compared with pneumonectomy.

Type of intervention
Treatment.

Economic study type
Cost-utility analysis.

Study population
The study population comprised patients with early-stage (Stages I and II) NSCLC.

Setting
The setting was secondary care. The economic study was carried out at the Department of Surgery, University of Chicago, Chicago, USA.

Dates to which data relate
The effectiveness data were derived from studies dating from 1990 to 2003. The price year was 2002.

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

Modelling
A decision tree model was used, with sleeve lobectomy and pneumonectomy as the options at the decision node. The model assumed that isolated local recurrences after sleeve lobectomy could be treated in a variety of ways, including re-resection (completion pneumonectomy), whereas isolated local recurrences after pneumonectomy could not be treated by further resection. It was assumed that other recurrences were treated with either chemotherapy alone, or with a combination of chemotherapy and radiation therapy. It was also assumed that survival after recurrence was related to the type of recurrence and whether re-resection could be performed for an isolated local recurrence.

Outcomes assessed in the review
The outcomes assessed were:

the weighted mean operative mortality;
the likelihood of isolated local or regional recurrence;
the isolated local or regional recurrence as a fraction of all recurrences;
the mean 5-year survival rates;
the median survival time; and
the utility associated with health states after each type of surgery.

**Study designs and other criteria for inclusion in the review**
The search was performed for reports published in English from 1990 to 2003 using the terms "sleeve resection and/or pneumonectomy" and "lung neoplasm". The criteria for inclusion in the review were:

- at least 20 patients in each surgical group;
- the surgical procedures were classified according to stage for Stage I and Stage II patients;
- operative mortality was reported or calculable by stage; and
- 5-year survival was reported by stage.

Data that concerned malignancies other than NSCLC were discarded, as was information on patients with other than Stage I or Stage II disease. Data on carinal, tracheal and arterial sleeve resection were also discarded.

**Sources searched to identify primary studies**
MEDLINE was searched for primary studies.

**Criteria used to ensure the validity of primary studies**
Not reported.

**Methods used to judge relevance and validity, and for extracting data**
Two reviewers selected articles satisfying the inclusion criteria by consensus.

**Number of primary studies included**
Twelve articles met the defined criteria and were data abstracted for the meta-analysis. Estimates of parameters such as survival after recurrent disease and quality of life (QOL) were derived from other studies. The estimates of QOL were derived from 5 studies.

**Methods of combining primary studies**
Meta-analyses of the data were performed to produce estimates for appropriate nodes of the decision model. Data were obtained for 860 sleeve lobectomy patients and 746 pneumonectomy patients. Survival within each study was calculated, assuming an equal distribution of Stage I and Stage II patients to correct for the dissimilar distributions of these stages between sleeve lobectomy and pneumonectomy series. The QOL ratings were linearly transformed to a scale that scored QOL on a continuum from 0 (very poor) to 1 (optimal health). This resulted in three estimates of global QOL during the early postoperative period and six estimates of global QOL long-term postoperatively.

**Investigation of differences between primary studies**
The authors did not report how differences between the primary studies included in the meta-analysis were investigated.
However, it would appear that the mean ages of the patients were similar between the studies. In the review of studies to derive utility values, for some studies median survival was not reached by the end of the reporting period. In these instances, median survival was estimated on the basis of the ratios between 5-year survival values.

Results of the review
The results of the meta-analysis were as follows.

The weighted mean operative mortality was 4.1% (confidence interval, CI: 2.3 - 5.9) after sleeve lobectomy and 6.0% (CI: 1 - 11) after pneumonectomy. (p=0.3).

The likelihood of isolated local or regional recurrence was substantially higher after sleeve lobectomy (20%) than it was after pneumonectomy (10%).

Isolated local or regional recurrence as a fraction of all recurrences was higher for sleeve lobectomy (51%) than it was for pneumonectomy (20%). It was also higher than for separately reported series of major lung resections for Stages I and II NSCLC (30%).

There was no difference in the mean 5-year survival for sleeve lobectomy (51.4 +/- 10.1%) versus pneumonectomy (49.1 +/- 5.5%), (p=0.6).

The mean median survival was 70.5 (+/- 16.2) months for sleeve lobectomy and 55.2 (+/- 6.6) months for pneumonectomy, (p=0.024).

The results of the review of studies to obtain utility values were as follows.

If the cancer did not recur, the utility associated with sleeve lobectomy was 0.8 (range: 0.6 - 1.0) and with pneumonectomy 0.7 (range: 0.5 - 0.9).

If the cancer did recur, the utility associated with sleeve lobectomy was 0.5 (range: 0.3 - 0.7) and with pneumonectomy 0.45 (range: 0.25 - 0.65).

Measure of benefits used in the economic analysis
The measure of benefits used in the economic analysis was the quality-adjusted life-years (QALYs). The QALYs were calculated from the product of survival duration for a given health state and the QOL (or utility) estimate. The data for utility after surgery were derived from 5 studies that used three different tools to assess utility. More specifically, the Short Form 36, the European Organization for Research and Treatment of Cancer Quality of Life Questionnaire (EORTC QLQ), and the Quality of Life Index (QLI).

Direct costs
The resource quantities and the unit costs were not reported separately. The direct costs of the hospital were included in the analysis. These were for radiotherapy, chemotherapy, surgery and operative mortality. Cost information for surgery was obtained from data collected on 100 patients undergoing thoracotomy for lung resection at the University of Chicago Medical Centre. The costs were prorated for the type of procedure based on the mean duration of hospitalisation. Other costs were derived from recent literature. All the costs were normalised to 2002 dollars using the Consumer Price Index conversion factor. Even though discounting was relevant, as the costs were incurred during 5 years, the authors did not discount the costs. The authors reported the average costs and the incremental costs.

Statistical analysis of costs
The costs were treated as point estimates (i.e. the data were deterministic).

Indirect Costs
The indirect costs were not included.

**Currency**
US dollars ($).

**Sensitivity analysis**
One-way sensitivity analyses were performed on all variables to identify those variables that influenced the outcomes in the model. Threshold values were calculated to determine the inflexion points at which the alternative choice was superior. Two-way sensitivity analyses were performed on clinically important variables that influenced the model outcomes.

**Estimated benefits used in the economic analysis**
The results of the decision model showed that 5-year survival was 52.4% for sleeve lobectomy and 48.7% for pneumonectomy. This translated into 4.37 QALYs for sleeve lobectomy and 2.84 QALYs for pneumonectomy.

**Cost results**
The cost of pneumonectomy was $17,900 and the cost of sleeve lobectomy was $19,500. Hence, the incremental costs of sleeve lobectomy over pneumonectomy were $1,600.

**Synthesis of costs and benefits**
The costs and benefits were combined using an incremental cost-utility ratio (additional cost required per QALY gained). Sleeve lobectomy was found to be associated with an incremental cost-utility of $1,300/QALY compared with pneumonectomy. One-way sensitivity analyses demonstrated that survival was influenced by:

- the risk of isolated local or regional recurrence in patients undergoing sleeve lobectomy (threshold value, 28%),
- the risk of other recurrence in both groups (threshold values, 13% for pneumonectomy and 28% for sleeve lobectomy), and
- 5-year survival in patients without recurrent cancer who were undergoing either operation (threshold values, 73% for pneumonectomy and 70% for sleeve lobectomy).

The two-way sensitivity analyses illustrated the relationship for other recurrences and for 5-year survival in patients without recurrent cancer for both options. They also indicated the preference for sleeve lobectomy over pneumonectomy.

**Authors' conclusions**
In patients with anatomically appropriate early-stage lung cancer, sleeve lobectomy offered better long-term survival and quality of life (QOL) than did pneumonectomy. Sleeve lobectomy was also more cost-effective.

**CRD COMMENTARY - Selection of comparators**
The use of pneumonectomy as the comparator was justified. It was originally considered to be the only appropriate surgical therapy for localised lung cancer, and it was not until recently that sleeve lobectomy starting gaining acceptance as a standard resection technique. You should decide if this is a widely used health technology in your own setting.

**Validity of estimate of measure of effectiveness**
The authors adopted a systematic approach to reviewing the literature and to identifying relevant research, and provided
clear descriptions of their methods. However, only one database (MEDLINE) was searched to identify studies. In addition, the authors do not appear to have searched for unpublished literature, or for studies in languages other than English.

The results from 12 studies were combined using a meta-analysis. Appropriate statistical techniques were used to test for significant differences between the two interventions. Sensitivity analyses were performed to identify those variables influencing the outcomes of the model. Estimates of QOL were derived from 5 studies. However, it is unclear how the authors combined the results of these studies to derive the utility values used in the model in the base-case scenario.

**Validity of estimate of measure of benefit**

The estimation of benefits was modelled. QOL was derived from 5 different studies using three different valuation tools (SF 36, QLI and EORTC QLQ). The results were linearly transformed to a scale from 0 to 1. However, the degree of comparability of these three different valuation tools was not discussed. Hence, it cannot be assessed whether the utilities derived using one technique can easily be compared with those derived using another valuation tool. Even though the benefits were accrued during 5 years, the authors left them undiscounted.

**Validity of estimate of costs**

Although the authors did not explicitly state the perspective used for the economic analysis, it would appear to have been that of the hospital. All the relevant categories of costs for this perspective appear to have been included in the analysis. However, it was unclear if, for each category of cost, all the relevant costs were included in the analysis. For example, it was unclear whether the hospitalisation costs (i.e. length of stay in the hospital) were captured by the cost category of surgery. The costs and the quantities were not reported separately, thus hampering the generalisability of the authors' results.

The costs were derived from published sources and study data. The authors normalised all the costs to 2002 dollars using the Consumer Price Index conversion factor. It is very likely that the total costs will be larger than those reported since health care prices rise faster than consumer prices. Ideally, the authors should have inflated all costs using a health care price index instead of the Consumer Price Index. However, the costs were varied in the sensitivity analysis, which will minimise this limitation. Even though discounting was necessary since the costs were incurred during 5 years, it was not performed. The price year was reported, making it possible to perform reflation exercises.

**Other issues**

The authors did not directly compare their findings with those from other studies. They did, however, report that several recent studies suggested that sleeve resection should be used routinely in the treatment of patients with anatomically appropriate centrally located tumours. The issue of generalisability to other settings was partly addressed through the sensitivity analysis. The authors do not appear to have presented their results selectively and their conclusions reflected the scope of the analysis.

The authors reported a number of limitations to their study. First, there were limited data on QOL after major lung resection, and that these data were not consistent with, for example, the degree of return of functional capacity or the level of perceived QOL long-term postoperatively. Second, patients in the sleeve lobectomy group, who might not have tolerated pneumonectomy, were compared with patients in the pneumonectomy group, who presumably had better cardiopulmonary function. However, this bias would be against sleeve lobectomy and, as the authors' results were strongly in favour, they concluded that this should not be an issue when interpreting the results.

**Implications of the study**

The authors reported that, due to the creation of the Society of Thoracic Surgeons General Thoracic Surgery Database, large volumes of prospectively collected data will be invaluable in refining the estimates of benefit of either intervention.
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None stated.

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Other publications of related interest


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