Cost-effectiveness of single-level anterior cervical discectomy and fusion for cervical spondylosis

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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 compared three different treatments for single-level anterior cervical spondylosis. These were anterior cervical discectomy and fusion (ACDF) with autograft, ACDF with allograft, and ACDF with allograft and plating (ACDF+AP).

Type of intervention
Treatment.

Economic study type
Cost-utility analysis.

Study population
The study population comprised a hypothetical cohort of patients undergoing surgery for one-level cervical spondylosis.

Setting
The study setting was secondary care. The economic study was carried out in the USA.

Dates to which data relate
The effectiveness data were derived from studies published between 1981 and 2003. The price year was 2000.

Source of effectiveness data
The effectiveness data were derived from a review and synthesis of published studies, supplemented with the authors’ assumptions.

Modelling
A two-part analytic model was developed to evaluate the costs and benefits associated with each of the three treatments. The perioperative period and first year after surgery were analysed in a decision tree model. A Markov model was then used to analyse health status and re-operations between 1 and 5 years after surgery.

Outcomes assessed in the review
The outcomes assessed in the review were:

the probabilities of death, cord and root injury, re-operation, infection, dysphagia, clinical improvement, and improvement after re-operation;
the health state utilities for preoperative, improved and not improved health states;
the annual probability of adjacent segment degeneration;
the probability of re-operation for adjacent segment degeneration;
the probability of symptomatic improvement after re-operation;
the re-operation rate for graft complications for ACDF with autograft and with allograft;
the rate of plate complications,
the rate of symptomatic non-union; and
the rates of persistent symptoms requiring re-operation.

**Study designs and other criteria for inclusion in the review**
Not reported.

**Sources searched to identify primary studies**
Not reported.

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

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

**Number of primary studies included**
Approximately 20 primary studies were included in the review.

**Methods of combining primary studies**
The method used to combine the primary studies was not reported. However, in some cases, when multiple studies were found, the study with the middle value for the specific parameter was used.

**Investigation of differences between primary studies**
It was unclear whether the authors investigated any differences between the primary studies.

**Results of the review**
The probabilities used in the perioperative and first-year model were as follows:

the probability of death was 0.0022;

the probabilities of cord and root injury were 0.0016 and 0.0019, respectively;

the probability of re-operation was 0.0028;

the probability of infection was 0.017;
the probability of dysphagia was 0.0073;

the probability of clinical improvement was 0.85; and

the probability of improvement after re-operation was 0.70.

The health state utilities were 0.81 for preoperative, 1.0 for improved and 0.81 for not improved.

The annual probability of adjacent segment degeneration was 0.029.

The probability of re-operation for adjacent segment degeneration was 0.67.

The probability of symptomatic improvement after re-operation was 0.70.

The re-operation rate for graft complications for ACDF with autograft was 4.8%.

The rate of chronic donor site pain was 10%.

The rate of deep wound infection was 0.7%.

**Methods used to derive estimates of effectiveness**

Using results from the review of the literature, the authors supplemented the review with their own assumptions.

**Estimates of effectiveness and key assumptions**

The authors assumed that the rate of re-operation in the first year for ACDF with allograft was the same as that of ACDF with autograft (i.e. 4.8%).

The rate of re-operation for ACDF+AP was assumed to be 0.

The authors assumed the same rate of adjacent segment disease for all three groups.

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

The measure of benefits used was the quality-adjusted life-years (QALYs). The authors reported that the utilities were derived from a study of ACDF that reported pre- and postoperative SF-36 scores. SF-36 scores were then converted into utilities using an algorithm based on the Health Utility Index (HUI2).

**Direct costs**

The direct costs to the health care provider were included in the analysis. These covered the costs incurred by patients while at hospital, such as physician fees, procedure and length of stay, but did not include the costs after hospitalisation. The costs were derived from itemised hospital bills for 78 patients undergoing treatment for single-level degenerative cervical disease, of which 31 underwent ACDF with allograft and 47 underwent ACDF+AP. Hospital charges were appropriately converted to costs using specific cost-to-charge ratios from the Institutional Cost Reports prepared for the Health Care Financing Administration. Medicare physician fee reimbursements were used to estimate the cost of the surgeon's time for each procedure, which was then added to the hospital costs. Since the costs could be incurred over 5 years, future costs were discounted at an annual rate of 3%. The study reported the average costs. All costs were updated to 2000 prices using the medical care component of the Consumer Price Index.

**Statistical analysis of costs**

The total costs were treated as point estimates (i.e. the data were deterministic).
**Indirect Costs**
Although the authors reported that a societal perspective was adopted, the indirect costs were not included in the analysis.

**Currency**
US dollars ($).

**Sensitivity analysis**
The authors reported that extensive sensitivity analyses were performed to determine the effect of the base-case assumptions on the results. Ranges for the analyses were derived from the literature, where possible, if not they were determined as a percentage of the base-case values.

**Estimated benefits used in the economic analysis**
Over the 5-year period, 4.365 QALYs were gained with ACDF-autograft, 4.486 QALYs with ACDF-allograft and 4.529 QALYs with ACDF+AP.

**Cost results**
Over the 5-year period, the costs were $11,230 with ACDF-autograft, $11,290 with ACDF-allograft and $12,690 with ACDF+AP.

**Synthesis of costs and benefits**
The costs and benefits were compared using an incremental cost-utility ratio (i.e. the additional cost per QALY gained). When ACDF-allograft was compared with ACDF-autograft, the additional cost per QALY gained was $496. When ACDF+AP was compared with ACDF-allograft, the additional cost per QALY gained was $32,560.

The results of the sensitivity analysis showed that when the postoperative recovery period was assumed equal for all procedures, ACDF-allograft was cost-effective ($741 per QALY gained) in comparison with ACDF-autograft and dominant over ACDF+AP. In addition, larger effect sizes (e.g. lower symptomatic utilities or higher asymptomatic utilities) resulted in smaller incremental cost-utility ratios. The authors also found that varying the discount rate between 0 and 10% did not have a big effect on the results.

**Authors' conclusions**
Anterior cervical discectomy and fusion (ACDF) with autograft, ACDF with allograft, and ACDF with allograft and plating (ACDF+AP) had similar cost-effectiveness ratios. The results were particularly sensitive to the costs of the procedures and to the rate of postoperative recovery of patients undergoing these operations.

**CRD COMMENTARY - Selection of comparators**
The authors performed head-to-head comparisons of three different treatment strategies for single-level anterior cervical spondylosis. You should decide if these three treatments are current practice in your own setting.

**Validity of estimate of measure of effectiveness**
The authors did not state that a systematic review of the literature was undertaken to identify relevant research and minimise biases. However, they appear to have performed a comprehensive review of the literature, as a great number of studies were included in the review. The authors failed to report the methods they used to review the literature. They also did not report how data from the relevant studies was combined or if there were any differences between these studies. However, in some cases, when multiple studies were found, the study with the middle value for the specific parameter was used. The authors supplemented the results from the literature with their own assumptions. These
assumptions were then tested in a sensitivity analysis.

**Validity of estimate of measure of benefit**
The estimate of measure of benefit was derived from an appropriate model. As the benefits could be incurred over a 5-year period, all future benefits were appropriately discounted.

**Validity of estimate of costs**
The authors reported that a societal perspective was adopted in the economic analysis. However, they only included the direct costs to the hospital and did not include other health care costs or indirect costs. Consequently, the perspective adopted was that of the health care provider. Further, it was unclear which resources were included in the total cost estimates, and this will therefore limit the generalisability of the authors' results. The costs were estimated from hospital bills for patients undergoing ACDF with allograft or ACDF+AP, thus it was unclear how the costs for patients undergoing ACDF with autograft were estimated. The unit costs were derived from hospital charges and Medicare physician reimbursement fees. The costs were appropriately varied in a sensitivity analysis. All charges were appropriately converted to costs, to reflect the true price of providing the service, using appropriate cost-to-charge ratios. The costs were appropriately discounted since they could be incurred over 5 years. The price year was reported, which will aid any possible inflation exercises.

**Other issues**
The authors reported that no prior studies had estimated the cost-effectiveness of procedures for single-level cervical spondylosis. The issue of generalisability to other settings was partially addressed in 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 noted a further limitation to their study in that, because their study used data from published reports, the costs and outcomes were not measured in the same population.

**Implications of the study**
The authors recommended that further prospective, comparative studies of procedures for single-level cervical spondylosis should be undertaken to determine more accurately their relative cost-effectiveness.

**Source of funding**
Supported by funds from professional organisations.

**Bibliographic details**

**PubMedID**
16135991

**Other publications of related interest**


**Indexing Status**
Subject indexing assigned by NLM