Abdominal aortic aneurysms: cost-effectiveness of elective endovascular and open surgical repair


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 elective endovascular repair (EER) for patients with abdominal aortic aneurysm (AAA). In case of failure of EER, percutaneous procedures, late conversions to open surgery, and emergent repairs of ruptures could be performed.

Type of intervention
Treatment.

Economic study type
Cost-utility analysis.

Study population
The study population comprised patients with infrarenal AAA. The hypothetical cohort of patients comprised 70 year-old males with a 5- to 6-cm-diameter infrarenal aneurysm, which was eligible for both procedures (EER and OSR).

Setting
The setting was secondary care. The study appears to have been carried out in Boston (MA), USA.

Dates to which data relate
The effectiveness data were collected from studies published between 1988 and 2002. The cost data related to studies published between 1996 and 2001, except for costs collected from the hospital where the study was performed, for which the dates were not reported. The price year was 2000.

Source of effectiveness data
The effectiveness data were derived from a systematic review of published studies for some parameters, a non-systematic review for other parameters, and some authors' assumptions.

Modelling
A Markov model was used to evaluate the quality-adjusted life expectancy and lifetime costs for both the short- and long-term outcomes. A lifetime period was considered and the cycle length was one month. Monte Carlo simulation was also used to perform an incremental cost-effectiveness analysis of the alternatives.

Outcomes assessed in the review
It appears that a systematic review has been conducted to derive the following parameters:

the probability of mortality for endovascular repair and open surgery;
the probability of systemic-remote complications associated with endovascular repair and open surgery; and
the probability of immediate conversion after endovascular repair.

A non-systematic review was conducted to derive the remaining parameters:
the probability of mortality for emergent repair of ruptured aneurysm;
the probability of mortality after rupture, before the patient reached the operating room;
the probability of mortality with percutaneous treatment;
the probability of an excess mortality risk ratio for endovascular repair when compared with open surgery;
the systemic-remote complications associated with emergent surgical repair;
the annual rupture rate after endovascular repair;
the annual long-term failure rate (excluding ruptures) after endovascular repair, requiring treatment; and
the annual long-term failure rate after open surgery, requiring additional treatment.

**Study designs and other criteria for inclusion in the review**
Studies with large patient series and cases of both EER and OSR were included in the review. To be included, the studies had to meet the several criteria. More specifically, the results for patients undergoing EER should be compared with those of patients undergoing OSR, each treatment group should have at least 10 patients, and the patient characteristics, complications and mortality should be reported for both groups.

**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**
Two independent reviewers abstracted the data and resolved any discrepancies by consensus.

**Number of primary studies included**
Nine studies were included in a meta-analysis to derive the parameters from the systematic review. At least a further 6 studies were used to inform the remaining parameters.

**Methods of combining primary studies**
A published meta-analysis performed by the authors was included. This combined the short-term results of 9 studies using a random-effects model (see Other Publications of Related Interest). The method used to combine the long-term results was not reported, but it appears to have been a narrative method.

**Investigation of differences between primary studies**
The authors tested for heterogeneity in the meta-analysis. However, the results of these tests were not reported and there was no explanation for the differences found.
Results of the review
The mortality rates were 0.03 for endovascular repair, 0.04 for open surgery, 0.64 for emergent repair of ruptured aneurysm, 0.15 after rupture, before the patient reached the operating room, and 0.0001 for percutaneous treatment.

The excess mortality risk ratio for endovascular repair compared with open surgery was 1.81.

The systemic-remote complication rates were 0.13 for endovascular repair, 0.32 for open surgery, and 0.53 for emergent surgical repair.

The immediate conversion after endovascular repair was 0.03.

The annual rupture rate after endovascular repair was 0.01.

The annual long-term failure rate (excluding ruptures) after endovascular repair, requiring treatment, was 0.08.

The annual long-term failure rate after open surgery, requiring additional treatment, was 0.01.

Methods used to derive estimates of effectiveness
The authors made assumptions to derive some estimates of effectiveness.

Estimates of effectiveness and key assumptions
The authors made the following assumptions.

No more than two percutaneous procedures could be performed after EER. If the patient needed an additional percutaneous procedure, open surgery would be performed.

After OSR, only a secondary surgical procedure would be performed if additional therapy were needed.

Twenty-five per cent of the patients with renal complications were dependent on dialysis.

Measure of benefits used in the economic analysis
The summary measure of benefit used was the number of quality-adjusted life-years (QALYs) gained with each intervention. This measure of benefit was obtained by adjusting the life expectancy after either EER or OSR, using quality of life weights obtained in the review. No details of the methods used in the published literature to derive the utility weights were provided. A lifetime period was considered for the estimation of health benefits. A discount rate of 3% was applied.

Direct costs
The direct costs considered in the economic evaluation were those of the health service and patient. These included the procedural costs, hospitalisation costs arising from morbidity and mortality associated with procedures and complications, and the costs of follow-up (imaging and physician visits). The procedural costs covered the hospital, physician, endovascular repair, open surgery, percutaneous treatment, and emergent surgical repair of a rupture. The patient costs included time lost during hospitalisation and follow-up. The direct costs were obtained from Medicare reimbursement rates and published studies (for the base-case analysis), and from the hospital database (for further sensitivity analyses). The costs were estimated using actual data and some authors’ assumptions. Some, but not all, of the resource quantities were reported separately from the costs. Discounting was carried out, which was appropriate given that the period considered was longer than 2 years. A discount rate of 3% was applied, following the recommendations for US studies. The price year was 2000. The costs reported were the total lifetime costs per patient.

Statistical analysis of costs
No statistical analyses of the costs were performed.

**Indirect Costs**
No productivity loss was calculated.

**Currency**
US dollars ($).

**Sensitivity analysis**
One- and multiple-way sensitivity analyses were performed to assess the uncertainty surrounding the study findings. These investigated all model effectiveness and cost parameters, and model assumptions. Moreover, threshold analyses were carried to identify the value of the parameters at which the optimal strategy changed. A cut-off value for the incremental cost-effectiveness ratio (ICER), of less than or equal to $75,000 per QALY gained, was used. The ranges considered for the effectiveness parameters and the authors’ assumptions were based on published literature. Medicare costs were replaced by those obtained from the hospital database. Discount ratios of 1% and 5% were applied. The areas of uncertainty considered at analysis were variability in the data and analytical methods.

**Estimated benefits used in the economic analysis**
The total numbers of QALYs gained per patient were 6.52 with OSR versus 6.74 with EER. These are the discounted results. Complications were considered in the estimation of health benefits.

**Cost results**
The total lifetime costs per patient (discounted at 3%) were $37,606 with OSR versus $39,785 with EER. The costs of complications and further required interventions were considered when estimating these costs.

**Synthesis of costs and benefits**
The estimated benefits and costs were combined by calculating an ICER. The ICER was $9,905 per QALY gained with EER when compared with OSR. The most sensitive parameters in the model were the systemic-remote complication rate, the long-term failure rate, the rupture rate, and the procedural costs of EER. From the threshold analyses, OSR would become the preferred strategy, at a cut-off ICER of 75,000 per QALY gained, when:

- the systemic-remote complication rates were higher than 19% for EER, or smaller than 27% for OSR;
- the long-term failure rates were higher than 13% for EER, or smaller than 0.5% for OSR;
- the annual rupture rate was higher than 1.5% for EER;
- the excess mortality risk ratio for EER versus OSR was smaller than 1.4; and
- the cost ratio of EER, compared with that of OSR, was higher than 1.4.

The results of the multiple-way sensitivity analyses were also reported.

**Authors’ conclusions**
Elective endovascular repair (EER) is a clinically effective and cost-effective alternative to open surgical repair (OSR) for the elective repair of an abdominal aortic aneurysm (AAA). However, the results of the study were highly sensitive to variations of model parameters, such as the systemic-remote complication rate, the long-term failure rate, and the rupture rate.
CRD COMMENTARY - Selection of comparators
OSR was chosen as the comparator because it was the traditional treatment for AAA in the authors' setting. You must decide whether this is a widely used health technology in your own setting, and whether the patients you are considering are eligible for both EER and OSR procedures.

Validity of estimate of measure of effectiveness
The authors did not state that a systematic review of the literature was performed, although it seems that one has been conducted to derive a sub-set of effectiveness parameters. They did not report the databases searched to identify studies for inclusion in the systematic review, or whether they searched for unpublished studies. The criteria used to ensure the validity of the studies were also not reported. Apart from these facts, the methods used to extract data and to combine some studies, and to investigate the differences between the primary studies, seem to have been adequate. As the authors reported, few published long-term follow-up studies are available (only series). Therefore, randomised controlled trials, which are less prone to bias, could not be included. A narrative method appears to have been used to combine the results of the studies. Some effectiveness estimates were derived from authors' assumptions, and these were justified with reference to the medical literature. Sensitivity analyses were carried out to assess the uncertainty surrounding all the effectiveness estimates.

Validity of estimate of measure of benefit
The summary measure of health benefit used in the economic analysis (QALYs) was appropriate for the study question. It was derived using a Markov model. This measure allows the study results to be compared with those obtained by different interventions. The QALYs gained were discounted at a rate of 3%. The guidelines for discounting benefits vary by country.

Validity of estimate of costs
The perspective adopted was societal and, as such, all the relevant costs appropriate to this perspective appear to have been included in the economic analysis. No productivity losses were considered within the indirect costs, which appear to have been appropriate since the type of patient considered was a 70 year-old male who would be out of the labour market by that age. The authors assumed that further costs not considered at analysis would be similar for both interventions. Therefore, these were excluded from the economic analysis. Some, but not all, of the resource quantities were reported separately from the unit costs, which may hinder reflation exercises to other settings. The price year was reported. Discounting was performed using an appropriate discount rate for US studies. Sensitivity analyses of the costs were carried out to assess uncertainty surrounding the cost estimation and further authors' assumptions.

Other issues
The authors made some comparisons of the results with those from another study that also concluded that EER was more cost-effective than OSR, and that the results were highly sensitive to the systemic-remote complication rate. The issue of the generalisability of the results to other settings was not addressed, although it is likely that the results would be generalisable to the type of patient considered at analysis (70-year-old male). Moreover, as the authors reported, not all patients with AAA are eligible for both procedures (EER and OSR). This should be considered before extrapolating the results to other settings.

Implications of the study
The authors reported that randomised controlled trials comparing EER and OSR are required to evaluate more accurately the benefits of these interventions.

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Other publications of related interest

Health service costs and quality of life for early elective surgery or ultrasonographic surveillance for small abdominal aortic aneurysms on the basis of data from the United Kingdom Small Aneurysm Trial participants. Lancet 1998;352:1656-60.

Indexing Status
Subject indexing assigned by NLM

MeSH
Aged; Angioplasty, Balloon /economics; Aortic Aneurysm, Abdominal /economics /mortality /surgery; Aortic Rupture /economics /mortality /surgery; Blood Vessel Prosthesis Implantation /economics; Case-Control Studies; Cost-Benefit Analysis; Evidence-Based Medicine; Follow-Up Studies; Humans; Male; Markov Chains; Postoperative Complications /economics /mortality /surgery; Quality-Adjusted Life Years; Reoperation /economics /mortality; Survival Analysis; United States

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