Is carotid angioplasty and stenting more cost effective than carotid endarterectomy

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
Two strategies for the treatment of carotid artery stenosis were examined. These were carotid endarterectomy (CEA), which was considered the ‘gold’ standard, and carotid angioplasty with stenting (CAS), which represented a more innovative and less invasive approach.

Type of intervention
Treatment.

Economic study type
Cost-utility analysis.

Study population
The study population comprised a hypothetical cohort of 70-year-old patients with carotid artery stenosis.

Setting
The setting was a hospital. The economic study was conducted in the USA.

Dates to which data relate
The effectiveness data were derived from studies published between 1993 and 2001. The resource use data were obtained from studies published in 2000 and 2001. The price year was 1997.

Source of effectiveness data
The effectiveness evidence was derived from a review of published studies and authors' assumptions.

Modelling
A decision model based on a Markov process was used to assess the clinical and economic outcomes associated with CEA versus CAS in a hypothetical cohort of patients with carotid artery stenosis. The four health states considered were perfect health, minor stroke, major stroke, and death. All possible 30-day outcomes pertaining to these four health states were considered. The patients were followed for their lifetime. The cycle length appears to have been 1 month.

Outcomes assessed in the review
The outcomes estimated were the following probabilities:

30-day rate of mortality,
major stroke,
minor stroke, myocardial infarction (MI), haematomas, restenosis, and cranial nerve injuries.

The utility weights associated with major and minor stroke, MI, and cranial nerve injury were also derived from the literature.

**Study designs and other criteria for inclusion in the review**
It was unclear whether a review of the literature was undertaken. The evidence about CEA came from a retrospective review of patients’ charts at the authors’ institution, (the New York Presbyterian Hospital from 1997 to 2001). Other probabilities were estimated from a series of non-randomised studies, whose sample size and dates were reported. No information on the methods used to assess the utility values, such as source of preferences, was provided.

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

**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**
Ten primary studies provided the effectiveness evidence.

**Methods of combining primary studies**
Not stated.

**Investigation of differences between primary studies**
Not stated.

**Results of the review**
The estimated probabilities for CEA and CAS, respectively, were:

- 0% (CEA) and 1.2% (CAS) for mortality,
- 0.45% (CEA) and 1.8% (CAS) for major stroke,
- 0.45% (CEA) and 3.2% (CAS) for minor stroke,
- 1.1% (CEA) and 0.8% (CAS) for MI,
2.68% (CEA) and 0.8% (CAS) for haematomas,
1% (CEA) and 3% (CAS) for restenosis, and
1.78% (CEA) and 0% (CAS) for cranial nerve injuries.

The utility weights were 0.40 for major stroke, 0.75 for minor stroke, 0.88 for MI, and 0.85 for cranial nerve injury.

Methods used to derive estimates of effectiveness
The authors made some assumptions that were used in the decision model.

Estimates of effectiveness and key assumptions
It was assumed that none of the patients with MI were symptomatic, and all cases were detected through perfunctory performance of enzyme analysis or electrocardiogram. A disutility of 2 days for CAS and 2 weeks for CEA was also assumed.

Measure of benefits used in the economic analysis
The summary benefit measure was the quality-adjusted life-years (QALYs). These were obtained from the decision model. Life expectancy was discounted using an annual rate of 3%. The utility weights were derived from the literature, whereas the source of the survival data was unclear.

Direct costs
A discount rate of 3% was applied as lifetime costs were estimated. The unit costs were presented separately from the quantities of resources used. A detailed breakdown of the cost categories was provided. The health services included in the economic evaluation were procedural costs (operating room, angio suite, endovascular equipment, diagnostic tests, and postoperative services) and morbidity costs. The cost/resource boundary of the third-party payer was presumably adopted. The resource use data were derived from the literature. Procedural costs were estimated from the accounting system at New York Presbyterian Hospital, and Medicare reimbursement rates were used, whenever appropriate. The morbidity costs came from the literature. All prices were presented in 1997 values using the medical care component of the Consumer Price Index for All Urban Consumers.

Statistical analysis of costs
The costs were treated deterministically in the base-case.

Indirect Costs
The indirect costs were not considered.

Currency
US dollars ($).

Sensitivity analysis
Sensitivity analyses were conducted to assess the robustness of the estimated costs and QALYs to variations in the baseline model inputs. The ranges of values were derived from the literature, or plausible ranges were assumed. Univariate and multivariate sensitivity analyses were conducted.

Estimated benefits used in the economic analysis
The expected QALYs were 8.20 with CAS and 8.36 with CEA.

The difference in QALYs was 0.16 years, favouring CEA.

**Cost results**
The estimated lifetime costs were $35,789 with CAS and $28,772 with CEA. Thus, CAS was $7,017 more costly than CEA.

**Synthesis of costs and benefits**
As CEA cost less than CAS and was more effective, it was the dominant strategy (lower costs and more QALYs).

The univariate sensitivity analysis showed that CEA remained cost-effective under a variety of scenarios in which plausible variations of the baseline model inputs were investigated.

When multiple variables were set in order to favour CAS, then the cost per QALY with CAS approximated the threshold of $60,000. However, wide variations were needed for CAS to become the preferred strategy.

CAS became cost-effective only when its major stroke and mortality rates were made equivalent to those of CEA.

Major stroke and perioperative mortality had the greatest impact on the estimated cost per QALY.

**Authors' conclusions**
Carotid endarterectomy (CEA) was more effective and less expensive than carotid angioplasty with stenting (CAS) for the treatment of carotid artery stenosis. Mortality and major stroke rates of CAS needed to be at least equivalent to those of CEA for CAS to be a cost-effective strategy.

**CRD COMMENTARY - Selection of comparators**
The authors provided an explicit justification for the choice of the comparators. CEA represented the 'gold' standard approach for the treatment of carotid artery stenosis, while CAS represented a newer and less invasive approach. You should decide whether they are valid comparators in your own setting.

**Validity of estimate of measure of effectiveness**
The effectiveness evidence came mainly from published studies. However, it was unclear whether a review of the literature was undertaken. The designs of some of the primary studies were reported. Their internal validity appears to have been low, as most of them were non-randomised studies. The methods used to extract and then combine the primary estimates were not described. Authors' assumptions were also made, but most of them were mixed up with data extracted from the literature. The authors conducted several sensitivity analyses, owing to the uncertainty around the inputs used in the decision model.

**Validity of estimate of measure of benefit**
The choice of the summary benefit measure was appropriate as it detected the impact of the interventions on the patients' health. Details of the utility weights used to calculate the QALYs were not reported and it was unclear whether patients' preferences were used. Discounting was applied, as recommended in the USA. The source of the survival data was unclear. The use of QALYs permits comparisons to be made with the benefits of other health care interventions.

**Validity of estimate of costs**
The authors did not state explicitly which perspective was adopted in the study, but it appears to have been that of the third-party payer. The source of the data was reported, as was the price year, which makes relflation exercises in other
settings easy. The cost calculation approach was very clear since details on the unit costs and quantities of resources used were provided. Therefore, replication of the study in other centres should be easy. Although the cost estimates were treated deterministically, the economic inputs were varied extensively in the sensitivity analysis. However, the calculation of the morbidity costs was less clear, as a comprehensive estimate was derived from the literature and a detailed breakdown of the cost items was not reported. The authors stressed that true costs rather than charges were used in the economic analysis.

**Other issues**
The authors compared their findings with those from other studies that assessed only the short-term impact of the interventions on the benefits and costs. The authors also justified the choice of specific probability values that were used in the model. Any uncertainty around the estimates used in the model was investigated in the sensitivity analysis, which was also conducted to address the issue of generalisability of the study results to other settings. The authors noted that clinical outcomes associated with both approaches were improving over time.

**Implications of the study**
The study results suggested that improvements in CAS are needed before it can become the preferred strategy over CEA. The authors stressed that this conclusion held under several scenarios considered in the analysis. A further assessment of the relative cost-effectiveness of the two approaches should be conducted when long-term reliable data are available.

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**Other publications of related interest**


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