Routine angiography after surgery for ruptured intracranial aneurysms: a cost versus benefit analysis

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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
Routine cerebral angiography after surgery for ruptured intracranial aneurysms.

Type of intervention
Diagnosis and treatment.

Economic study type
Cost-utility analysis.

Study population
Patients undergoing surgery for ruptured intracranial aneurysms.

Setting
Secondary care. The economic study was conducted in the USA.

Dates to which data relate
Effectiveness data were collected from studies published between 1977 and 1995. Resource use data and their corresponding collection dates were not reported. The fiscal year was not explicitly reported.

Source of effectiveness data
Effectiveness data were derived from a review of the literature and assumptions made by the authors.

Modelling
A Markov chain was constructed for the two algorithms, routine postoperative angiography and no postoperative angiography. The Markov states for both algorithms were State 1, healthy (completely clipped aneurysm), State 2, partially clipped aneurysm, State 3, unclipped aneurysm, State 4, neurological deficit and State 5, dead. Transitions between the states occurred once each year at the 6-month point in the cycle. An initial age of 40 years was used and patients were assumed to be neurologically intact after initial surgery.

Outcomes assessed in the review
The following outcomes were assessed:

- frequency of unexpected partially clipped or unclipped aneurysms,
- combined morbidity and mortality rate associated with subsequent surgery,
frequency of persistent partially clipped or unclipped aneurysms,
morbidity rate associated with angiography, combined morbidity and mortality rate associated with early/late subsequent haemorrhage,
rate of early subsequent haemorrhage, unclipped aneurysm,
annual rate of late subsequent haemorrhage, unclipped aneurysm/partially clipped aneurysm.

Study designs and other criteria for inclusion in the review
The criteria for inclusion in the review were not stated. Prospective studies and case series were among the studies referenced.

Sources searched to identify primary studies
Not reported.

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
A total of 10 studies were directly used as the references for the transition probabilities, and 8 further studies were referenced indirectly.

Methods of combining primary studies
The narrative method was used to obtain initial input data (mostly from recent studies).

Investigation of differences between primary studies
Not performed.

Results of the review
Baseline values were as follows:

frequency of unexpected partially clipped/unclipped aneurysms, 4%,
combined morbidity and mortality rate associated with subsequent surgery, 12%,
frequency of persistent partially clipped or unclipped aneurysms, 12%,
morbidity rate associated with angiography, 0.5%,
combined morbidity and mortality rate associated with early subsequent haemorrhage, 80% and late subsequent haemorrhage, 50%,
rate of early subsequent haemorrhage, unclipped aneurysm, 40%,
annual rate of late subsequent haemorrhage, unclipped aneurysm, 3% and partially clipped aneurysm, 0.5%.

Methods used to derive estimates of effectiveness
Assumptions about effectiveness were also made by the authors.

Estimates of effectiveness and key assumptions
The sensitivity and specificity of cerebral angiography were assumed to be 100% for diagnosing unexpected partially clipped and unclipped aneurysms.

Measure of benefits used in the economic analysis
Benefits were quantified using quality factors assigned to each state. A quality factor of 1.0 was assigned to Markov states 1 through 3. State 4 was assigned a quality factor of 0.7 and state 5 a quality factor of 0.0. Quality-adjusted life years (QALYs) were calculated based on these quality factors and all future benefits were discounted at 5%. A societal perspective was adopted when measuring benefits.

Direct costs
Costs were discounted. Quantities and costs were not presented separately. Direct health service costs were considered: cost of angiography (including charges for catheterisation and interpretation based on CPT codes from the Federal Register for 1993, and technical charges based on institutional data), cost of subsequent surgery (estimate based on a fraction of the DRG costs of a surgical admission for craniotomy), and downstream costs (including the costs of subarachnoid haemorrhage and rehabilitation based on two studies published in 1991 and 1995). The fiscal year was not explicitly specified. Cost analysis did not cover costs common to both modalities such as costs of initial operations.

Indirect Costs
Not considered.

Currency
US dollars ($).

Sensitivity analysis
A series of one-way and two-way sensitivity analyses was conducted for the following input variables: frequencies of unexpected partially clipped and unexpected unclipped aneurysms, morbidity and mortality rates of subsequent surgery and of angiography, costs of angiography and subsequent surgery, rates of early and late subsequent haemorrhage, patient age at time of initial aneurysm rupture and discount rate. Threshold values were calculated for the sensitive parameters of the model.

Estimated benefits used in the economic analysis
QALYs gained due to each strategy considered were not reported.

Cost results
Costs were discounted at 5% per year. Cost of angiography, baseline value was $1,500 and cost of subsequent surgery, baseline value was $4,000. The costs of subarachnoid haemorrhage were $6,000 per year and rehabilitation, $16,000 per year. No grand total cost associated with each strategy was produced.

Synthesis of costs and benefits
Incremental cost-utility (cost per additional QALY gained) was calculated as a measure of cost-utility. Using baseline values, routine postoperative angiography resulted in an acceptable cost-utility ratio of $22,500/QALY. However, the vast majority of the added benefits resulted from intervention on unexpected unclipped aneurysms; conversely, intervention on unexpected partially clipped aneurysms was not cost-effective. The acceptable cost for this analysis was considered to be less than $50,000 per additional QALY. Sensitivity analyses showed that the cost of angiography had a moderate influence on the cost-utility analysis, while small alterations in surgical complication rates resulted in marked changes in the cost-utility ratio in the setting of partially clipped aneurysms.

Authors’ conclusions
When routine postsurgical angiography was performed primarily to diagnose and subsequently to operate on unexpected partially clipped aneurysms, the cost-benefit ratio was unacceptable. However, even low frequencies of unexpected unclipped aneurysms resulted in favourable cost-benefit ratios.

CRD COMMENTARY - Selection of comparators
The reason for the choice of the comparator is clear.

Validity of estimate of measure of benefit
The internal validity of the estimates of benefit (baseline values) can not be reasonably guaranteed given the apparent lack of a systematic literature review and quality assessment of the primary studies included in the review. There was also a lack of adequate information on the methods used to derive utility factors attributed to different health states. Some benefit components (such as mass effect from regrowth to giant sizes of aneurysm rests) as well as the effects of co-morbid disease were not included in the analysis, (as mentioned by the authors).

Validity of estimate of costs
Quantities and costs were not presented separately and insufficient details of methods of cost estimation were given. Although the authors stated that the cost analysis was carried out from a societal perspective, indirect costs, such as lost wages, were not included (the authors gave some explanations in this regard).

Other issues
The authors’ conclusion seems reasonably justifiable given the extensive sensitivity analyses performed. The authors acknowledged that their results could not be applied in the following cases:

(1) when a suboptimal result is expected after postoperative angiography;

(2) intraoperative angiography (repositioning aneurysm clips intraoperatively);

(3) in individual cases, because of expected wide variation among patients (it should be interpreted in the context of decisions regarding the application of routine postoperative angiography in general).

Appropriate comparisons were made with other studies.

Implications of the study
Refined data regarding the frequency of unexpected unclipped aneurysms would be highly valuable, since unclipped aneurysms had a marked effect on the cost-benefit ratios.

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