Cost-effectiveness of bypass surgery versus stenting in patients with multivessel coronary artery disease

Yock C A, Boothroyd D B, Owens D K, Garber A M, Hlatky M A

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
Coronary artery bypass graft (CABG) surgery was compared with percutaneous transluminal coronary angioplasty (PTCA), in particular PTCA with primary stenting, as a means of coronary artery revascularisation for patients with multivessel coronary artery disease (CAD).

Type of intervention
Treatment.

Economic study type
Cost-effectiveness analysis and cost-utility analysis.

Study population
The study population comprised patients with multivessel CAD who had not already undergone coronary artery revascularisation.

Setting
The setting was tertiary care. The study was conducted in the USA.

Dates to which data relate
The data for the effectiveness analysis were gathered from journal articles published between 1993 and 2002. The price year was 2000.

Source of effectiveness data
The effectiveness evidence was derived from a synthesis of published studies, which were used to provide updated estimates of procedural safety and efficiency and therapeutic effects.

Modelling
A Markov model, run at 3-month cycles, was used to project the lifetime costs and quality-adjusted life-years (QALYs) from initial treatment to death, for both groups. There were three health states in the model. These were medical management, return of symptoms and dead.

Outcomes assessed in the review
The effectiveness model parameters were as follows.
For the angioplasty model, the probabilities of the following were estimated:
multistage angiography;
stent-amenable event during angioplasty;
the proportion of patients stented;
emergency CABG;
repeat revascularisation 0 to 6 months, 6 to 12 months, or 12 to 48 months after initial angioplasty, and the probability of CABG at each of these times and each year after 48 months.

The probabilities of all of these were presented for both balloon angioplasty and primary stenting.

For the CABG model, the input parameters were:

the probability of repeat revascularisation 0 to 48 months after initial CABG;

the probability of CABG reoperation;

the probability of repeat revascularisation each year after 48 months of follow-up, and the probability of CABG reoperation for each of these times.

The probabilities of all of these were presented for SEQOL and Bypass Angioplasty Revascularization Investigation (BARI) data and also for contemporary sources.

**Study designs and other criteria for inclusion in the review**
Neither the inclusion or exclusion criteria, nor the designs of all the included studies were reported. The study drew data from the BARI and the Emory Angioplasty versus Surgery Trial (EAST), which are two of the largest randomised trials of CABG versus PTCA for multivessel disease.

**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**
Twenty-eight studies provided the effectiveness evidence.

**Methods of combining primary studies**
To populate the model, data were taken selectively from the studies.

**Investigation of differences between primary studies**
Differences between the primary studies were not described.
Results of the review
For the angioplasty model, the results were presented for balloon angioplasty and for primary stenting. For balloon angioplasty, the probabilities were 0.17 (0.14 - 0.21) for multistage angiography, 0.27 (0.22 - 0.32) for a stent-amenable event during angioplasty, 0 for the proportion of patients stented, and 0.08 (0.06 - 0.09) for emergency CABG. For primary stenting, the probabilities were 0.06 (0.03 - 0.09) for multistage angiography, 0.07 (0.03 - 0.11) for a stent-amenable event during angioplasty, 0.76 (0.50 - 0.90) for the proportion of patients stented, and 0.01 (0 - 0.08) for emergency CABG.

The probabilities of repeat revascularisation 0 to 6 months after initial angioplasty were 0.25 (0.20 - 0.30) for balloon angioplasty and 0.19 (0.14 - 0.24) for primary stenting. The probabilities of CABG at this time were 0.05 (balloon angioplasty) and 0.04 (primary stenting), respectively.

The probabilities of repeat revascularisation 6 to 12 months after initial angioplasty were 0.12 (0.09 - 0.15) for balloon angioplasty and 0.09 (0.07 - 0.12) for primary stenting. The probabilities of CABG at this time were 0.04 (balloon angioplasty) and 0.03 (primary stenting), respectively.

The probabilities of repeat revascularisation 12 to 48 months after initial angioplasty were 0.19 (0.14 - 0.23) for balloon angioplasty and 0.16 (0.12 - 0.20) for primary stenting. The probabilities of CABG at this time were 0.04 (balloon angioplasty) and 0.03 (primary stenting), respectively.

The probabilities of repeat revascularisation each year 48 months after initial angioplasty were 0.06 (0.05 - 0.07) for balloon angioplasty and 0.05 (0.04 - 0.06) for primary stenting.

For the CABG model, the input parameters were presented for SEQOL and BARI data and for contemporary CABG costs. The probability of repeat revascularisation 0 to 48 months after initial CABG was 0.09 (0.07 - 0.11) when using SEQOL and BARI data, and 0.08 (0.06 - 0.10) when using the contemporary costs. The probability of CABG reoperation was 0.003 for both sources.

The probability of repeat revascularisation each year after 48 months of follow-up was 0.05 (0.03 - 0.07) when using SEQOL and BARI data, and 0.04 (0.02 - 0.06) when using the contemporary costs. The probability of CABG reoperation was 0.005 for both sources.

Measure of benefits used in the economic analysis
Both life-years and QALYs were used as the measures of benefit. The authors adopted quality of life values taken from five published sources.

Direct costs
The health service costs relating to PTCA and CABG were obtained from the literature. These were presented as a range. It appears that the average cost has been calculated for use in the model. The procedural costs included hospitalisation, laboratory and professional fees. The follow-up costs were for hospitalisation, outpatient tests and procedures, and provider fees. The cost estimates came from published sources. Resource use was determined using the model. The costs were incorporated into the Markov model to examine long-term events. A discount rate of 3% was applied to the costs. The price data were reported for the year 2000.

Statistical analysis of costs
The costs were treated as point estimates.

Indirect Costs
The indirect costs were not included.
Currency
US dollars ($).

Sensitivity analysis
The authors conducted sensitivity analyses on each model variable using 95% confidence intervals where appropriate. This enabled variability in the data to be explored. Three further analyses investigated provisional stenting, restenosis and post-surgical cognitive deficit, to make the results more comprehensive.

Estimated benefits used in the economic analysis
CABG with primary stenting in follow-up angioplasty resulted in the highest lifetime projected gain of 9.78 QALYs and a life expectancy of 13.90 years. This was followed by CABG with provisional stenting in follow-up angioplasty (9.77 QALYs and 13.89 years), CABG without stenting in follow-up angioplasty (9.76 QALYs and 13.87 years), initial angioplasty with primary stenting (9.46 QALYs and 13.06 years), and initial angioplasty with provisional stenting (9.42 QALYs and 13.04 years).

Cost results
CABG with provisional stenting in follow-up angioplasty had the lowest projected lifetime cost of $135,200. This was followed by initial angioplasty with provisional stenting ($135,500), CABG without stenting in follow-up angioplasty ($135,700), CABG with primary stenting in follow-up angioplasty ($139,800), and initial angioplasty with primary stenting ($143,600).

Synthesis of costs and benefits
The estimated benefits and costs were not combined. An incremental analysis was not performed. A discount rate of 3% was applied to the costs and QALYs.

The results from the sensitivity analysis were robust. The parameters that were sensitive in the short term (4 years) were the cost of the initial procedure and patient utility for one year in good cardiac health. In the long term, the annual cost of medical management became the most sensitive variable. Compared with a provisional stenting strategy, a primary stenting strategy added $189,000 per QALY gained, while primary stenting after an initial CABG procedure cost $770,000 per QALY gained. When varying the effectiveness of the stent in decreasing restenosis, the cost-difference between CABG and primary stenting groups decreased to $150 when the stent was 100% effective, with a slight QALY improvement from 9.46 to 9.50. Primary stenting was cheaper than CABG when the stent costs were less than $900 and the restenosis rates less than 12%. When exploring post-surgical cognitive dysfunction, patients would need to trade 26 months to avoid these effects in order for stenting to achieve similar quality of life outcomes as CABG.

Authors' conclusions
For patients with multivessel disease, coronary artery bypass graft (CABG) surgery results in better outcomes than angioplasty, and at a lower cost.

CRD COMMENTARY - Selection of comparators
Although no explicit justification was given for the comparator used, it would appear to represent current practice in the authors' setting. You should decide if the comparator represents 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 had been undertaken. The authors used data from the available studies selectively. They also did not consider the impact of differences between the primary studies when estimating the effectiveness.
Validity of estimate of measure of benefit
The estimation of benefits was modelled. The instrument used to derive a measure of health benefit, a Markov model, was appropriate. The authors did not combine the costs and benefits into a cost per QALY or cost per life-year gained ratio.

Validity of estimate of costs
The authors reported that the costs were estimated from a societal perspective, but the indirect costs were not included. The costs and the event probabilities were reported separately. A sensitivity analysis of input probabilities was conducted, using ranges that appear to have been appropriate. Similarly, a sensitivity analysis of the prices was conducted, using the range of costs obtained from the literature. Discounting was appropriately applied. The date to which the prices related was reported.

Other issues
The authors made appropriate comparisons of their findings with those from other studies. The issue of generalisability to other settings was not specifically discussed. The results were not presented selectively.

Implications of the study
Over recent years improvements have taken place in coronary revascularisation procedures. The elimination of target lesion restenosis improves the short-term outcomes of catheter-based interventions. However, CABG remains a less costly and more effective treatment for relieving angina in patients with multivessel disease.

Source of funding
Supported by grant 15151 from the Robert Wood Johnson Foundation, Princeton (NJ) and by grant HL-58324 from the National Heart, Lung and Blood Institute, Bethesda (MD), USA.

Bibliographic details

PubMedID
14553874

Indexing Status
Subject indexing assigned by NLM

MeSH
Angioplasty, Balloon, Coronary /economics; Coronary Artery Bypass /economics; Coronary Artery Disease /economics /therapy; Coronary Restenosis /prevention & control; Cost-Benefit Analysis; Costs and Cost Analysis; Decision Trees; Humans; Markov Chains; Quality-Adjusted Life Years; Stents /economics; Treatment Outcome

AccessionNumber
22003001376

Date bibliographic record published
31/10/2004

Date abstract record published
31/10/2004