A study on the cost-effectiveness of coronary revascularization: introducing the simultaneous MIMIC health status model

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 revascularization using coronary artery bypass grafting versus percutaneous transluminal coronary angioplasty.

Type of intervention
Treatment.

Economic study type
Cost-effectiveness analysis.

Study population
Patients with multi-vessel coronary artery disease.

Setting
Hospital. The study was carried out in Georgia, USA.

Dates to which data relate
The effectiveness and resource use data were obtained from a study published in 1994. The price year was not stated.

Source of effectiveness data
Effectiveness data were derived from a single study.

Link between effectiveness and cost data
The costing was undertaken on the same patient sample as that used in the effectiveness analysis.

Study sample
From 5,118 patients with multi-vessel coronary artery disease, a total of 392 patients was included in the analysis and randomly allocated to either PTCA (n=198), or CABG (n=194). To be eligible patients were required not to have had prior revascularization and many were screened out for various other reasons.

Study design
The study was a randomized controlled trial carried out in a single centre. The duration of follow-up was 3 years and the overall loss to follow-up for repeated revascularisations was 35% (36% for PTCA and 35% for CABG).
Analysis of effectiveness
Although power calculations were not clearly reported, the primary outcome measure met the criteria of being an objective and frequent enough end point, according to the authors. The principle used in the analysis was intention to treat. The primary health outcome used in the analysis was a composite of death, Q-wave myocardial infarction within three years, and a large ischemia burden detected by thallium scanning at three years. In addition, the changes in patient satisfaction and clinical status (percentage change in angina) at three-year follow-up with respect to baseline and need for repeated revascularization were measured. Death rate included mortality from all causes. The groups were shown to be comparable in terms of age, height times weight, angina class before the procedure, history of diabetes, family history of CAD, history of CHF, pulse, gender, and work status at the time of the procedure.

Effectiveness results
The percentage change in angina was 57.74% for the PTCA group and 62.68% for the CABG group. The extent of physical recovery was, in turn, 4.353 and 4.586, respectively. The economic status change was 1.837 and 1.942, whilst optimism had figures of 4.136 and 4.134 and general health 3.665 and 3.73, respectively (the latter two categories assumed similar values at baseline due to lack of data, and, therefore, the differences in levels represent differences in relative change against baseline values). The death rate at three years follow-up was 7.1% (PTCA) and 6.2% (CABG), (p=0.73), whilst repeated revascularization rates were 43% (PTCA) and 8% (CABG).

Modelling
A simultaneous equation econometric model, the multiple indicator multiple cause (MIMIC) model, was used in order to evaluate the cost-effectiveness of the coronary revascularization strategies in question. The model incorporated a latent variable approach in order to solve the problem of causality whereby health improvement (an unobservable variable) both affects, and is affected by, each of 5 health indicators (four based on patient satisfaction categories of response and one - percentage change in angina after the operation relative to baseline - based on a clinical parameter). Health costs are also an endogenous variable both affecting health improvement and being affected by it. The model included an equation for health improvement and one for hospital cost. The model tested for statistical significance in the coefficients of dummy variables in hospital cost and the intercept, in the former equation, so that the null hypothesis mentioned above was tested. Data from the Emory Angioplasty Surgery Trial (EAST), a study with a three year follow-up period, were used and the results were tested by comparison with non-randomised control data (referred to in the paper as WEST data).

Measure of benefits used in the economic analysis
The measure of benefits was improvement in health status. The differences in terms of effects upon health improvement for each strategy at any level of costs was analysed by using an econometric model.

Direct costs
No discounting was reported. The quantities of resource use were not reported separately from the costs. Hospital costs were included in the analysis. The figures were obtained by applying department-specific cost to charge ratios (based on microcosting and vertical costing methodologies) to data from the UB-82 billing statement for the study hospital. The authors reported that capital (depreciation) and hospital ‘indirect’ costs were also included. The price year was not clearly reported.

Currency
US dollars ($).

Sensitivity analysis
No sensitivity analysis was performed.
Estimated benefits used in the economic analysis
Not applicable.

Cost results
The mean hospital cost in the PTCA group was $17,317.31 and in the CABG group was $15,428.86.

Synthesis of costs and benefits
The t ratios associated with the dummy variables incorporated in the health improvement equation were insignificantly different from zero at p=0.05, both for the dummy variable (1= CABG, 0 otherwise) applied to the slope of hospital cost and to the intercept. The t tests for the estimates of the intercept and slope dummy were, respectively, t=0.65, and t=-0.51. In addition, the authors reported that the slope coefficient for mean hospital cost was not significantly different from zero (t=1.21), consistent with the hypothesis of no influence of costs upon health improvement outcomes.

Authors' conclusions
The results from the 3-year follow-up EAST data indicate that CABG does not require any extra hospital cost over PTCA to achieve a given health improvement. By contrast, the empirical results from the 3-year follow-up WEST data suggest that PTCA is more cost-effective than CABG. Two different explanations for this are possible. One is that the empirical results from the WEST data are misleading owing to any remaining selection biases even after the use of the inverse Mill ratio to adjust for that problem. The other explanation is that the EAST hospital cost data are misleading due to chance.

CRD COMMENTARY - Selection of comparators
The comparators used in the study were percutaneous transluminal coronary angioplasty (PTCA) and coronary artery bypass graft (CABG) surgery. These are widely used health technologies for revascularization in the USA, although coronary stenting techniques might have become relevant technologies in an economic evaluation of revascularization techniques.

Validity of estimate of measure of benefit
The results are likely to be valid although the sample size might be inadequate in order to detect clinically important differences in quality of life benefits. The authors therefore argue that chance may have led to misleading findings. Worthy of note is the fact that the final analysis was based upon an econometric model, which embodied important assumptions about linearity (in both the cost and the health improvement functions). In this respect, the study did not present any misspecification tests.

Validity of estimate of costs
Although it was made clear that the cost analysis was limited to hospital costs, it was not clearly reported which items were included in the so-called 'indirect' hospital costs. Costs related to the patient were not considered in the analysis. The price year was not clearly reported. The authors mentioned the "surprising" finding that in the EAST data costs for PTCA were higher than CABG (though not significantly different). They suggest that EAST data patients had more intensive monitoring than usual which may have generated extra costs. If EAST hospital cost data are misleading, PTCA may be more cost-effective and the conclusions of this study would be invalid (findings for this are derived from the source paper/trial).

Other issues
The conclusions reached by the authors were justified given the uncertainties in the data, with the exception of the adequacy of important assumptions made about the model used, which should be further investigated. The results found using the data from the main study were compared with data from another nonrandomised study subject to correct for selection bias. As the authors noted, inconsistent results were obtained from this comparison. The issue of
generalisability was not addressed. The results were presented in an unselective way.

**Implications of the study**

Further studies are needed in order to identify the most cost-effective strategy for coronary revascularisations. A step in this direction would consider coronary stenting as a comparator and further investigate the uncertainties in the data by testing for correct specification of the econometric model used to account for endogeneity, unobservability and causality in the statistical analysis of the cost-health outcomes relation in this area of health care.

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