Clinical and economic outcomes of multivessel coronary stenting compared with bypass surgery: a single-center US experience


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
A percutaneous coronary intervention (PCI) with multivessel coronary stenting was compared with coronary artery bypass graft (CABG) surgery in patients with multivessel coronary artery disease. These alternatives represented new advances in both percutaneous and surgical coronary revascularisation.

Type of intervention
Treatment.

Economic study type
Cost-effectiveness analysis.

Study population
The study population comprised individuals with multivessel coronary disease. Patients were excluded if they had prior or concurrent valvular surgery, or if surgery was performed in an emergency situation.

Setting
The setting was a hospital. The economic study was carried out in the USA at Beth Israel Deaconess Medical Center (Boston).

Dates to which data relate
The effectiveness data were obtained between January 1994 and June 2000, including a follow-up of 2 years minimum. The resources used for procedural costs were estimated from the same effectiveness data source. The resources used for other hospital costs were derived from a linear regression model of hospital cost data collected between 1996 and 1999. Prices from 2000 were used.

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

Link between effectiveness and cost data
The costing was undertaken, in part, on the same patient groups as that used in the effectiveness study. The remainder of the costing was derived from an alternative sample of patients (2,692 patients who underwent PCI or CABG at 89 US hospitals between 1996 and 1999).

Study sample
The study sample consisted of two groups of patients with coronary disease. The stenting group consisted of 71 male
and 29 female patients without a history of CABG. To determine the sample size a ratio of 2:1 was used. The authors identified 2 patients with CABG for each patient in the stenting group. The patients were matched for five clinical and demographic variables known to influence the outcomes and costs of coronary revascularisation procedures. Initially, 122 patients with multivessel stenting were included in the study. Twenty-two patients were then excluded because they were treated for in-stent restenosis or had an acute myocardial infarction (MI) within 24 hours before the index procedure. Therefore, 100 patients constituted the multivessel stent group and 200 patients the bypass surgery group.

**Study design**
The study was a matched cohort study that was conducted in a single centre. The follow-up period was at least 2 years (median: 2.8 years). For patients with less than 2 years of complete follow-up, vital status was confirmed through the use of a Social Security death index.

**Analysis of effectiveness**
The basis for the analysis of the clinical study (intention to treat or treatment completers only) was not specifically stated, but it appears to have been intention to treat. The primary clinical end point was the composite of death or nonfatal MI at any point during the follow-up. The secondary clinical end point included in-hospital complications and the need for repeat revascularisation during follow-up. There were no significant differences between the two groups in baseline demographic and clinical characteristics. Long-term survival was determined by the Kaplan-Meier method.

**Effectiveness results**
There were no significant differences in the incidence of death or the composite of death and Q-wave MI between the two groups at the initial hospitalisation and over a median follow-up duration of 2.8 years.

During the follow-up, the incidence of repeat revascularisation was significantly higher for patients undergoing initial stenting compared with bypass surgery. The incidences were 32% (stenting) versus 4.5% (CABG) at 2 years, and 41.4% (stenting) versus 8.1% (CABG) at 3.5 years, \(p<0.001\).

**Clinical conclusions**
Multivessel stenting and bypass surgery resulted in similar rates of death or major MI over a median follow-up duration of 2.8 years. Repeat revascularisation was more frequent among patients undergoing multivessel stenting.

**Measure of benefits used in the economic analysis**
The authors did not develop a summary benefit measure.

**Direct costs**
The costs and the quantities were not reported separately for all the categories of costs. The resource quantities were reported for postprocedural and intensive care unit length of stay, hospital admissions, number of PCIs and number of bypass operations. Detailed quantities for the cost of follow-up were not reported. The methodology used to assess the medical costs at initial hospitalisation and the first 2 years of follow-up (a combination of "bottom-up" and "top-down") was described elsewhere (Cohen et al., see Other Publications of Related Interest). The direct costs included procedural costs, other hospital costs (those not associated with revascularisation procedures), physician costs (fees for inpatient services, major cardiac procedures and surgical procedures) and outpatient costs (rehabilitation hospitalisation and diagnostic coronary angiography only). The procedural costs included, for example, operating and recovery room, balloon catheters, stents, guides, medications and additional disposable equipment.

Procedural costs referred to the TSI cost accounting system at Beth Israel Deaconess Medical Center. Other hospital costs were derived from a linear regression model of hospital costs for 2,692 patients undergoing coronary revascularisation at 89 US hospitals between 1996 and 1999. Physician fees were estimated on the basis of the 2000 Medicare Fee Schedule for Massachusetts. Outpatient costs were calculated on the basis of length of stay, using the unit...
costs from the Massachusetts Medicaid Reimbursement Schedule. Other outpatient resources, such as physician visits, diagnostic tests and medication, were not included in the analysis. Discounting was not applied, although the costs were incurred over more than two years. The price year was reported to be 2000.

Statistical analysis of costs
Statistical analyses were performed on costs. The t-test was used on averages for continuous variables and the chi-squared statistic for categoric variables. A 2-tailed p-value of less than 0.5 was considered to be statistically significant. Selected cost data were reported as both the mean (+/- standard deviation, SD) and median values.

Indirect Costs
No indirect costs were reported.

Currency
US dollars ($).

Sensitivity analysis
A sensitivity analysis was not carried out.

Estimated benefits used in the economic analysis
No summary measure of benefit was derived.

Cost results
During the initial hospitalisation, both procedural and nonprocedural costs were significantly higher for the CABG group compared with the stent group.

The total costs for the index hospitalisation were substantially higher for the CABG group ($20,574) than the stent group ($11,810), (p<0.001).

When the costs of diagnostic catheterisation and preoperative length of stay for the CABG group were excluded, the net difference in favour of stenting remained greater than $6,000 per patient ($18,096 versus $11,810), (p<0.001).

The follow-up medical care costs (number of hospital admissions, total hospital days and diagnostic catheterisation procedures) were significantly higher for the stent group than the CABG group at both 1 and 2 years. At 1 year, the costs were $4,226 in the stent group versus $1,636 in the CABG group, (p=0.02). At 2 years, the costs were $5,271 (stent) and $1,967 (CABG), respectively, (p=0.005).

Over the follow-up period, multivessel stenting remained significantly less costly than bypass surgery with overall cost-savings of $7,367 (95% confidence interval, CI: 4,537 - 10,197) at 1 year and $6,654 (95% CI: 3,727 - 9,581) at 2 years.

Synthesis of costs and benefits
No synthesis of the costs and benefits was conducted.

Authors' conclusions
Multivessel stenting and bypass surgery resulted in similar rates of death or major myocardial infarction (MI) over a median follow-up duration of nearly 3 years. Repeat revascularisation was more frequent among patients undergoing multivessel stenting. Although follow-up medical care costs were higher with stenting, after 2 years, the overall medical
Care costs remained $6,500 lower with stenting than with bypass surgery.

**CRD COMMENTARY - Selection of comparators**
Although no explicit justification was given for the comparator used, it would appear to represent a new advance in the current practice within the authors’ setting. You should decide if the comparator represents current practice in your own setting.

**Validity of estimate of measure of effectiveness**
The analysis used a matched cohort study design, which was appropriate for the study question. A randomised clinical trial would provide a better assurance of baseline equivalence between the two groups, as the authors claimed. The patient groups were shown to be comparable at analysis. However, appropriate statistical analyses were undertaken to take account of potential biases and confounding factors and, consequently, the internal validity of the study is likely to be reasonable. One limitation expressed by the authors was that differences in unmeasured covariates might have influenced some of their findings. In addition, no power calculations appear to have been conducted. It is therefore difficult to be sure that the study size was large enough to detect statistically significant differences.

**Validity of estimate of measure of benefit**
No summary measure of benefit was derived.

**Validity of estimate of costs**
All the categories of cost relevant to the perspective adopted were included in the analysis. The costs and the quantities were not reported separately, particularly for the follow-up costs. The resources used were taken from a single study for procedural costs (quantities were incurred over a 5-year period between 1994 and 1998) and from published sources for other hospital costs (quantities were incurred for a 4-year period between 1996 and 1999). A statistical analysis of the quantities and costs was performed. Results from the study were extrapolated using Kaplan Meier techniques, to estimate survival for 3.5 years of following treatment. No discounting was conducted, although for some costs it would have been relevant. The price year was reported. This would enable reflation exercises to be conducted when required.

**Other issues**
The authors made appropriate comparisons of their findings with those from other studies. The issue of generalisability to other settings was addressed. The authors considered the difficulty of comparing economic data from their study with studies based on data obtained entirely from outside the USA. The study enrolled patients with coronary disease with clinical characteristics and this was reflected in the authors’ conclusions. The authors reported a number of further limitations to their study. First, the observational design and unmeasured variables, as discussed earlier. In addition, the authors referred to the difficulty of including in the study the rapid evolution of technique for both alternatives. Finally, the authors acknowledged the brief duration of the outcomes and costs follow-up (the first 2 years).

**Implications of the study**
The findings of the study suggest that, for suitable patients, multivessel coronary stenting is a clinically reasonable alternative to bypass surgery that reduces overall costs to the US health care system over 2 years of follow-up. Larger studies will be necessary to determine whether specific patient sub-groups will derive greater economic or clinical benefit from one or the other form of revascularisation. Additional follow-up will be necessary to determine whether the economic benefits of multivessel stenting extend beyond 2 years.

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Other publications of related interest


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