Cost-effectiveness of drug-eluting coronary stents in Quebec, Canada

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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
The use of drug-eluting stents (DES) and bare metal coronary stents (BMS) for percutaneous coronary intervention (PCI).

Type of intervention
Secondary prevention.

Economic study type
Cost-effectiveness analysis.

Study population
The study population comprised a hypothetical cohort of patients undergoing PCI.

Setting
The setting was a hospital. The economic study was carried in Quebec, Canada.

Dates to which data relate
The effectiveness and resource use data were derived from a study published in 2004 and a database covering the period 1995 - 2000. The price year was 2003.

Source of effectiveness data
The effectiveness evidence was derived from a synthesis of completed studies and experts' opinions.

Modelling
A decision tree model was constructed to represent the treatment pattern for patients undergoing PCI. The model assumed that any repeat intervention within 9 months of the original dilatation was due to restenosis, and allowed a maximum of three repeat interventions per patient. In the case of either of the two procedures under investigation failing, a Markov chain considering three possible health states was developed. The three health states considered were repeat PCI, coronary artery bypass grafting (CABG) and success. Mortality, sub-acute thrombosis and myocardial infarction were not included in the model because a published meta-analysis had shown no differences between DES and BMS for these outcomes. The structure of the tree was reported graphically.

Outcomes assessed in the review
The outcomes estimated from the literature were:

the annual number of angioplasties in Quebec,
the rate of repeat revascularisation with BMS and with DES, and
the percentages of patients going to PCI versus CABG.

**Study designs and other criteria for inclusion in the review**
It would appear that the primary studies were identified selectively. One of the studies was a meta-analysis of all
published clinical trials comparing DES with BMS. Other data were derived from the Quebec provincial administrative
database (1995 - 2000). This database included 16,746 incident PCI cases and patient characteristics were reported (age
71.4 years and 61% men).

**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**
Some effectiveness data were derived from a meta-analysis of clinical trials comparing DES and BMS, which assures
the internal validity of the study.

**Number of primary studies included**
Two primary sources were used.

**Methods of combining primary studies**
The primary estimates were not combined since each source of data was used for specific model inputs. However,
effectiveness data were previously combined using a meta-analysis.

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

**Results of the review**
The annual number of angioplasties in Quebec was 14,000 (range: 14,000 - 15,000).

The rate of repeat revascularisation with BMS was 12.8% (range: 9.7 - 20) following the first intervention, 13.9%
(range: 12 - 16) after the second intervention, and 15% (range: 10 - 20) after the third intervention.

The repeat revascularisation risk reduction with DES following the first intervention was 0.74 (range: 0.48 - 0.89).

The percentage of patients going to PCI versus CABG was 83% (range: 78 - 88) after the first PCI, 74% (range: 69 -
79) after the second PCI, and 69% (range: 65 - 74) after the third PCI.

**Methods used to derive estimates of effectiveness**
Some experts’ opinions were used to derive key clinical estimates.

**Estimates of effectiveness and key assumptions**
The repeat revascularisation risk reduction with DES after a second or third PCI was 0.5 (range: 0.2 - 0.8).

The average number of stents per procedure (all interventions) was 1.7 (range: 1.2 - 2.2).

**Measure of benefits used in the economic analysis**
The summary benefit measure used was the number of revascularisation procedures avoided. This was estimated using a modelling approach. No discounting was applied given the short time horizon.

**Direct costs**
Discounting was not relevant since the costs were incurred during a 9-month period. The costs were presented as macro-categories and a detailed breakdown of the cost items was not given. The unit costs for stents and the average number of stents per procedure were reported. The economic evaluation considered the costs of angioplasty, BMS, DES and CABG. The cost/resource boundary of the third-party payer was adopted in the analysis. The estimation of resource use data and costs was based on probability rates obtained from the literature, from expert opinion, and from the authors’ institution. The price year was 2003.

**Statistical analysis of costs**
The costs were treated deterministically.

**Indirect Costs**
The indirect costs were not considered in the cost analysis.

**Currency**
Canadian dollars (Can$).

**Sensitivity analysis**
Univariate sensitivity analyses were carried out on model inputs to identify the most relevant parameters affecting both the costs and cost-effectiveness ratios. A multivariate sensitivity analysis was performed using a probabilistic Monte Carlo simulation with 1,000 simulations. The ranges of values used appear to have been obtained from the literature. Specific additional analyses were conducted to examine the impact of potentially higher baseline restenosis rates, differing scenarios of DES penetration, the various degrees of success in selecting high-risk patients, and higher revascularisation costs.

**Estimated benefits used in the economic analysis**
The actual number of revascularisation procedures avoided with DES over BMS was not reported.

**Cost results**
The complete substitution of DES for BMS would require an additional Can$44.9 million in the annual Quebec health care budget. The savings in repeat revascularisation would amount to Can$9.7 million. Thus, the net incremental cost of DES over BMS would be Can$35.2 million.

**Synthesis of costs and benefits**
An incremental cost-effectiveness ratio (ICER; i.e. the cost per revascularisation procedure avoided) was calculated by combining the costs and benefits of the two types of stents. Assuming 100% substitution of BMS with DES, the ICER would be Can$23,000.
A sub-group analysis showed that 20% DES use in patients with a relative risk (RR) of 2.5 for restenosis led to an ICER of Can$7,800. With 40% DES use, the ICER was Can$12,800; with 60% DES use, the ICER was Can$17,300. A break-even analysis of DES cost showed that in the scenario of 20% penetration applied to patients at medium to high risk of restenosis (RR=2.5), the break-even cost for DES was Can$1,626. For 100 per cent DES implementation, the break-even purchase cost was Can$1,161.

The sensitivity analysis showed that the five most important factors influencing the model results were the selection of high-risk patients, the cost of DES, the cost of BMS, the baseline restenosis rate, and the efficacy rate for DES. For example, with a restenosis rate of 20% (it was 12.8% in the base-case analysis), the ICER would be Can$12,400 with 100% DES implantation and Can$4,000 with 20% DES implantation applied to patients with an increased risk (RR=2.5). Further, at the significantly higher PCI and CABG costs of Can$25,000 and Can$100,000, respectively, DES would be cost-saving (and thus dominant).

Authors’ conclusions
The total replacement of bare metal stents (BMS) with the new drug-eluting stents (DES) in Quebec would lead to a substantial increase in costs that would not be fully offset by savings due to reductions in repeat revascularisations for restenosis. DES could be cost-effective among patients at an increased risk for restenosis.

CRD COMMENTARY - Selection of comparators
The selection of the comparators was appropriate because BMS represented the traditional approach, while DES were a recently available technology. You should decide whether they are valid comparators in your own setting.

Validity of estimate of measure of effectiveness
The effectiveness evidence came from studies that were selectively identified. One of the studies was a meta-analysis of clinical trials, which should ensure a high internal validity. Other data came from an administrative dataset, which is usually less robust but has the advantage of offering a large amount of clinical data. Some assumptions were also made. The authors investigated extensively the issue of the impact of clinical estimates on the results of the analysis and pointed out that the rate of restenosis represented the key model input.

Validity of estimate of measure of benefit
The benefit measure was specific to the disease considered in the study and is not comparable with the benefits of other health care interventions. The authors stated that the use of quality-adjusted life-years would have been more appropriate, but quality of life data were not available for patients undergoing PCI. Further, it was pointed out that for coronary stenting, the avoidance of repeat interventions was associated with only a very short-term disutility. Therefore, the use of revascularisation procedures avoided was appropriate.

Validity of estimate of costs
The costs included were consistent with the perspective of the study. However, limited information on the unit costs and the quantities of resources used was provided, which limits the possibility of replicating the analysis in other settings. A detailed breakdown of the cost items was not provided as the costs were presented using macro-categories. Several sources were used to derive resource consumption data, while the costs reflected local data. The costs were treated deterministically but uncertainty in the economic estimates was investigated in the sensitivity analysis. The price year was reported, which aids reflation exercises in other settings.

Other issues
The authors reported the results from other studies in order to corroborate the clinical estimates used in the decision model. It was pointed out that the results of this analysis differed from those obtained from other published studies (where DES was cost-effective not only for high-risk patients), probably because of the low restenosis rate associated with BMS use in this study. The issue of the generalisability of the study results to other settings was addressed and the
authors investigated the use of higher costs for PCI and CABG, which would be more appropriate for other countries. Sensitivity analyses were performed on key model inputs, which enhances the external validity of the study. The authors noted not only the strengths of their study (i.e. the use of a systematic measure of DES efficacy based on clinical trials) but also some limitations, such as the uncertainty surrounding the rate of restenosis. It would have been interesting to have investigated the cost-effectiveness of DES versus BMS for a longer time horizon.

**Implications of the study**
The study results supported the selective use of DES for high-risk patients. Further analyses should be performed to validate this model with long-term data.

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**Other publications of related interest**


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