Cost-Effectiveness of Drug-Eluting Stents in a US Medicare Setting: A Cost-Utility Analysis with 3-Year Clinical Follow-Up Data

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ABSTRACT

Background: There is only limited information about cost-effectiveness of drug-eluting compared with bare metal stents (BMS) over a time horizon of more than 1 year.

Methods and Results: We developed a Markov model based on clinical outcome data from a meta-analysis including 17 randomized controlled trials comparing drug-eluting versus BMS with a minimum follow-up of 1 year (n = 8221) and a maximum follow-up of 3 years (n = 4105) in patients with chronic coronary artery disease. Costs were obtained as reimbursement rates for diagnosis related groups from the US Centers for Medicare and Medicaid Services. All costs and effects were discounted at 3% annually. All costs are reported in US dollars of the financial year 2007. The incremental effects are 0.002 (95% confidence interval 0.039 to 0.041) quality-adjusted life-years (QALYs) for the sirolimus- and paclitaxel-eluting stents (PES). The incremental costs are $2790 for the sirolimus- and $3838 for the PES. The incremental cost-effectiveness ratio is $1,000,000 per QALY for the sirolimus-eluting stent. PES are dominated by BMS (i.e., less effective and more costly). Among various sensitivity analyses performed, the model proved to be robust.

Conclusions: Our analysis from a US Medicare perspective suggests that drug-eluting stents are not cost-effective compared with BMS when implanted in unselected patients with symptomatic ischemic coronary artery disease.

Keywords: cardiology, cost-utility analysis, decision-analytic model, drug-eluting stents.

Introduction

The economic burden of cardiovascular disease is substantial. In the year 2006, health-care spending and lost productivity from cardiovascular disease exceeded $400 billion in the United States [1]. Among patients with coronary artery disease, stent implantation has become the treatment of choice in the last decade [2,3]. Currently, nearly 80% of all inserted stents in the United States are drug-eluting stents (DES) [4]. It is estimated that the world market for DES sums up to $6 billion annually [5].

In recently published meta-analyses of randomized controlled trials (RCTs) comparing bare metal with DES, DES were found to reduce restenoses and the need for revascularization procedures, but not overall mortality or the incidence of myocardial infarction (MI) [6–12].

As with many new interventions, there is a significant price premium on DES when compared with conventional bare metal stents (BMS). Limited health-care budgets increase the incentive to not only look at the clinical effectiveness of an intervention but also to take into account the cost-effectiveness of a novel therapy. Several economic evaluations of DES exist to date, some of which are directly based on clinical trials and others on model-based economic evaluations [9,13–18]. Nevertheless, there still remains a considerable controversy about the cost-effectiveness of DES when compared with BMS for all patients undergoing percutaneous coronary intervention (PCI) [19,20].

In a recent systematic review, Lightart and colleagues identified 19 cost-effectiveness studies of DES that were published between January 2000 and July 2006 [5]. In their conclusions, 10 studies were in favor, whereas 9 studies were not in favor of widespread use of DES. Five of the 19 studies were performed from a US third-party payer perspective, and favored the widespread use of DES [21–25]. All studies from the United States used a short time horizon, with maximum clinical follow-up of 1 year, and thus disregarded potential differences in other patient-relevant outcomes, as well as quality of life estimates that may arise beyond the first year after stent implantation. Other studies used a single trial as a vehicle for the economic evaluation that will often lead to a partial and limited analysis [26].

To provide a more thorough answer to the question whether the routine use of DES is cost-effective for the treatment of coronary artery disease from a US Medicare payer’s perspective, we developed a decision-analytic model based on recently published data of long-term outcomes of RCTs comparing DES with BMS. We developed a model that allows for a probabilistic sensitivity analysis to address the joint implications of parameter uncertainty (i.e., uncertainty about the input data) on the uncertainty relating to the decision whether a novel technology is cost-effective [26].

Methods

A half-cycle corrected Markov cohort simulation model with the five mutually exclusive health states stent, nonfatal MI, PCI, coronary artery bypass graft surgery (CABG), and death was developed (Fig. 1) [27]. We compared both DES versus BMS. Because baseline event rates differed in the two BMS groups, we calculated the pooled event rates weighted by the number of patients in the BMS trial arms. The transition probabilities from the index procedure to death, nonfatal MI, clinically driven PCI, and CABG were derived from an updated, previously published meta-analysis of RCTs comparing sirolimus-eluting stents (SES)
or paclitaxel-eluting stents (PES) with BMS in patients with coronary artery disease [11]. Briefly, trials were required to report mortality data after at least 1 year of follow-up. Trials exclusively including patients with acute coronary syndromes or trials focusing on interventions in nongenital coronary arteries were excluded because these trials evaluate a different patient population. We conducted a systematic literature search of MEDLINE, Embase, Web of Science, and the Cochrane Library dedicated to the dissemination of results from cardiovascular trials from January 1980 up to April 2006 and contacted the manufacturers of SES and PES. We identified 17 trials including 8221 patients that fulfilled inclusion criteria. Seven trials used SES (n = 2487), nine trials (n = 4908) PES, and one trial [15] used (n = 826) both DES. Twelve trials including 4631 patients reported outcome data after 2 years, nine trials including 4105 patients reported outcome data after 3 years. Details on the selection process for potentially eligible trials, the characteristics and quality of included trials, and on the generation of summary estimates are provided in the Appendix and have been published elsewhere [11].

The cycle length in the model is 1 month to allow for a precise estimation of the timing of events and related cost. The study’s perspective is a US Medicare payer’s perspective. Estimates for all parameters where there was no data available from our meta-analysis were derived from a systematic search of the medical literature. All costs and effects were discounted at 3% annually using monthly compounding.

Clinical Parameters

Transition probabilities are of central importance in a Markov model. The transition probabilities from the stent state to the health states MI, PCI, CABG, and death were obtained by transforming point estimates for event rates and their corresponding standard deviations into monthly probabilities (for 0–30 days after the index procedure, for 30 days to 1 year, for year 1–2, and for year 2–3; for details, see Appendix Tables 1, 2, and 3) [27]. PCI was defined as any percutaneous target vessel revascularization. From the meta-analysis, outcome data were available for the time period 30 days following the initial stenting procedure, and for the years 1, 2, and 3 after the index procedure. Likewise, we obtained values for the relative risks for the same transitions. We used the method of moments fitting [28] to fit beta distributions to the transition probabilities derived from the meta-analysis, and fitted lognormal distributions to all relative risk parameters in the model. The remaining transition probabilities were taken from published studies [29–34] and are provided in Table 1. We assumed that the transition probabilities from the PCI state to the health states MI, CABG, and death were the same as for patients in the “stent” state.

Costs

All costs in the model were obtained as reimbursement rates for diagnosis-related groups (DRGs) from the US Centers for Medicare and Medicaid Services [35]. We used reimbursement rates for the DRGs 121 and 122 (circulatory disorders with acute myocardial infarction with/without major complications discharged alive), 547–550 (coronary bypass with/without cardiac catheterization with/without major cardiovascular diagnosis [CV DX]), 556 (PCI with non-DES without CV DX), and 557 and 558 (PCI

Table 1 Model parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean (SD) base-case†</th>
<th>Distribution</th>
<th>Source base-case</th>
<th>Mean (SD) sensitivity analysis‡</th>
<th>Source sensitivity analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transition probabilities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MI → Death (30 days)</td>
<td>0.13</td>
<td>—</td>
<td>[30]</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>MI → Death (after 30 days)</td>
<td>0.00569</td>
<td>—</td>
<td>[30]</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>CABG → Death (30 days)</td>
<td>0.015</td>
<td>—</td>
<td>[36]</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>CABG → Death (after 30 days)</td>
<td>0.00255</td>
<td>—</td>
<td>[36]</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>CABG → MI (first 30 days)</td>
<td>0.0276</td>
<td>—</td>
<td>[32]</td>
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<td>—</td>
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<tr>
<td>CABG → MI (after 30 days)</td>
<td>0.00077218</td>
<td>—</td>
<td>[32]</td>
<td>—</td>
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<td>Utilities (QALYs)</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>MI</td>
<td>0.0104 (0.00047)</td>
<td>Beta</td>
<td>[3]</td>
<td>0.00658</td>
<td>[39]</td>
</tr>
<tr>
<td>PCI</td>
<td>0.0104 (0.00047)</td>
<td>Beta</td>
<td>[3]</td>
<td>0.00658</td>
<td>[39]</td>
</tr>
<tr>
<td>CABG</td>
<td>0.0208 (0.00063)</td>
<td>Beta</td>
<td>[3]</td>
<td>0.00658</td>
<td>[39]</td>
</tr>
<tr>
<td>Costs (US dollars)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCI with BMS</td>
<td>18,469 (3,781)</td>
<td>Gamma</td>
<td>[35]</td>
<td>14,609 (2.602)</td>
<td>[35]</td>
</tr>
<tr>
<td>PCI with DES</td>
<td>24,536 (5,042)</td>
<td>Gamma</td>
<td>[35]</td>
<td>18,429 (2.910)</td>
<td>[35]</td>
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<td>Acute MI</td>
<td>15,999 (3,851)</td>
<td>Gamma</td>
<td>[35]</td>
<td>11,150 (1.704)</td>
<td>[35]</td>
</tr>
<tr>
<td>CABG</td>
<td>51,050 (10,972)</td>
<td>Gamma</td>
<td>[35]</td>
<td>37,576 (5.882)</td>
<td>[35]</td>
</tr>
</tbody>
</table>

Note: Transition probabilities are shown as monthly probabilities. SD, standard deviation; MI, nonfatal myocardial infarction; CABG, coronary artery bypass graft surgery; PCI, percutaneous coronary intervention.

Cost data for the base-case represent average DRG reimbursement rates for the following 10 top-rated US hospitals: Cleveland Clinic, Cleveland, OH; Mayo Clinic, Rochester, MN; Brigham and Women’s Hospital, Boston, MA; Massachusetts General Hospital, Boston, MA; Texas Heart Institute at St. Luke’s Episcopal Hospital, Houston, TX; Duke University Medical Center, Durham, NC; Stanford Hospital and Clinics, Stanford, CA; Barnes-Jewish Hospital/Washington University, St. Louis, MO; UCLA Medical Center, Los Angeles, CA; William Beaumont Hospital, Royal Oak, MI.

Cost data for the base-case represent average DRG reimbursement rates for the following 10 randomly chosen US hospitals: Northern Michigan Hospital, Petoskey, MI; Manchester Memorial Hospital, Manchester, CT; Reynolds Memorial Hospital Inc., Glen Dale, WV; MetroWest Medical Center, Natick, MA; Saint Luke’s Hospital of Kansas City, Kansas City, MO; Whitter Medical Center, Whittier, CA; Sumter Regional Hospital, Americus, GA; St. Mary’s Hospital, Centralia, IL; Alexian Brothers Medical Center, Elk Grove Village, IL; Madison County Hospital, London, OH.
with DES (without or with major CV DX). Reimbursement rates for DES are independent of the type of DES used. For events where more than one DRG was available (i.e., cases with and without complications), we combined the costs from all relevant DRGs weighted by the number of cases in 2006 [35]. We assumed that physician fees would account for the same percentage share per event as reported by Mahoney et al. [36]. For our base case, we used average Medicare reimbursement rates of 10 top-rated cardiology hospitals in the United States [37]; in a sensitivity analysis, we used average reimbursement rates from a random sample of 10 US hospitals from the same source [35]. Costs are provided in Table 1. We assumed that there would be no difference in resource use for antiplatelet medication because clopidogrel or ticlopidine were used for the same time period in patients treated with DES and BMS in all trials of the meta-analysis. Thus, costs for medications and follow-up visits were not included into the model.

Based on data for our sample of US hospitals, we fitted gamma distributions to reflect parameter uncertainty of the unit costs of the procedures. All costs are reported in US dollars of the financial year 2007.

Outcomes

The outcome of the two strategies was measured in natural units and quality-adjusted life-years (QALYs). This generic instrument weighs the length of life by the quality of life a patient has while being in a specific health state. QALYs combine both, morbidity, and mortality into a single parameter, and therefore allow comparing the effect of treatments across different disease areas.

We calculated QALYs using the approach by Bagust et al. [14]. We assumed a baseline quality of life value of 0.86 for patients without an event. We estimated disutility values (i.e., a short-term drop in patients’ quality of life) for patients with PCI and CABG (Table 1) based on the results of the Arterial Revascularization Therapies Study (ARTS) trial. In this trial, quality of life values were obtained based on the EuroQol 5 Dimensions (EQ-5D) questionnaire at baseline and 1, 6, and 12 months after stenting or CABG surgery for coronary artery disease [3]. We calculated disutility values by taking the difference in health-related quality of life values between a patient with and without an event. Thus, the calculated disutility values reflect the loss in patients’ quality of life for up to 6 months after the event. No loss in quality of life was assumed to occur 6 months after the event. For patients experiencing a myocardial infarction, we attributed an ongoing disutility of 0.01 per month starting at the time of the event until end of follow-up based on a community-based study reporting self-perceived quality of life after myocardial infarction [38].

In a sensitivity analysis, we used disutility values per event as reported in a health-technology assessment from the United Kingdom on the number of patients undergoing multiple percutaneous coronary reinterventions. Based on data from the Baseline Stent Kosten Effektivitaets Trial (BASKET) [15], we assumed that there are about 5% more percutaneous interventions due to multiple interventions in individual patients. The model was developed with Microsoft EXCEL and Microsoft Visual Basic 6.5 (Microsoft Corporation, Redmond, WA).

Analysis

Total costs of the two strategies and the corresponding outcomes as number of QALYs experienced were recorded. The result of the analysis is expressed as the incremental net monetary benefit (INMB) for DES when compared with BMS for two different threshold values ($50,000 and $100,000) [40]. The INMB is calculated by the following standard equation:

\[
\text{INMB} = \Delta \text{effect} \times \text{threshold value} - \Delta \text{costs}
\]

INMB is therefore the difference in treatment effect of DES (incremental effect) multiplied by the willingness to pay (i.e., threshold value) per one unit of outcome gained (i.e., per QALY) minus the incremental (i.e., additional) net total health-care costs for providing DES. By multiplying the incremental effect with the threshold value, the effect is transformed into a monetary unit. For the base-case analysis, we assumed an arbitrary decision-maker’s willingness-to-pay of $100,000 per QALY. A positive INMB reflects that the intervention under analysis is cost-effective. The INMB approach yields the same results as when calculating the incremental cost-effectiveness ratio. Nevertheless, the INMB approach avoids the potential problem of averaging over positive and negative incremental effects and costs that may arise when performing a probabilistic sensitivity analysis with multiple iterations.

For the base-case analysis, we performed a probabilistic sensitivity analysis with 5000 Monte Carlo simulations [41,42] to account for parameter uncertainty that relates to the uncertainty in the analysis arising from the lack of definite knowledge about a parameter’s true value. We tested the robustness of the model toward model assumptions with univariate sensitivity analysis on estimates of clinical effectiveness, on different time horizons, on the difference of DRG reimbursement rates for BMS and DES, on health state utilities, on costs of PCI, MI, and CABG, and on discount rates for costs and health effects. Because published data on the need for percutaneous coronary reinterventions report censored data after one event, but some patients have multiple interventions, we conducted an additional sensitivity analysis on the number of patients undergoing multiple percutaneous coronary reinterventions. Based on data from the Baseline Stent Kosten Effektivitaets Trial (BASKET) [15], we assumed that there are about 5% more percutaneous interventions due to multiple interventions in individual patients. The model was developed with Microsoft EXCEL and Microsoft Visual Basic 6.5 (Microsoft Corporation, Redmond, WA).

Results

From the PSA, it was calculated that 19.01% of BMS patients require probability sensitivity analysis (PSA) a repeat PCI compared with 8.35% of SES patients and 12.44% of PES patients. The incidence of MIs over the 3-year time horizon is 4.29% in BMS patients, and 3.23% in SES, and 3.83% in PES patients. Likewise the incidence of CABG is lower in the DES group (BMS: 3.68%, SES: 2.44%, PES 2.49%). Mortality is slightly increased in SES and PES patients (BMS: 4.36%, SES: 4.49%, PES 4.92%).

The incremental effects of the DES are 0.002 (95% confidence interval [CI] –0.039 to 0.041) QALYs for the sirolimus- and –0.001 (95% CI –0.040 to 0.038) QALYs for the PES. The incremental costs are $2790 for SES and $3838 for PES.

This yields an incremental cost-effectiveness ratio of >$1,000,000 for SES. PES are dominated by BMS (i.e., PES are less effective and more costly). Table 2 provides the expected costs and health effects for the base-case analysis.

The uncertainty for the decision is graphically represented on the cost-effectiveness plane (Fig. 2). Cost-effectiveness acceptability curves provide an estimate of the probability that DES are cost-effective for a range of different willingness-to-pay values (Fig. 3). At an arbitrary willingness-to-pay of $100,000 per QALY, SES have a 8.3% probability, and PES a 2.8% probability of being cost-effective.

Univariate Sensitivity Analysis

In individual patient data meta-analyses comparing DES with BMS [6,8], there were no significant differences in the rates of death and myocardial infarction. Given the uncertainty around
the point estimates of the relative risks for these outcomes in our meta-analysis, we conducted a sensitivity analysis assuming no difference in the number of deaths between patients treated with BMS and DES (Table 3). Both DES then yield a small positive incremental effect, but the INMBs still remain negative. At an arbitrary willingness-to-pay of $100,000 per QALY, the INMB is then -$2,360 for SES and -$3,708 for PES, respectively. Accounting for multiple PCIs in individual patients had no qualitative effect on the overall cost-effectiveness estimates, neither for SES nor for PES. To explore the effect of different time horizons, we calculated the incremental effect for time horizons up to ~2.5 years of follow-up. Only SES, however, yield a positive incremental effect over the full time horizon of the analysis (i.e., 3 years). After 2 years, there is a decline in incremental effects for both DES, which seems to be driven by a trend toward increased mortality in patients treated with DES (Fig. 4). Both DES provide positive incremental effects (in QALYs) over a time horizon up to ~2.5 years of follow-up. Only SES, however, yield a positive incremental effect over the full time horizon of the analysis (i.e., 3 years). After 2 years, there is a decline in incremental effects for both DES, which seems to be driven by a trend toward increased mortality in patients treated with DES (Fig. 4). Both DES yield a negative incremental net monetary benefit for time horizons ranging from 0 to 3 years, assuming a decision maker’s willingness-to-pay of $100,000/QALY. The cost-effectiveness acceptability frontier is presented in Figure 5. It provides an estimate of the probability that BMS are cost-effective and shows that the baseline decision does not change for the threshold values plotted (Fig. 5).

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**Table 2** Cost, effects, INMB, and ICER

<table>
<thead>
<tr>
<th>Stent type</th>
<th>Costs (US$)</th>
<th>Effects (QALYs)</th>
<th>Incremental costs (US$)</th>
<th>Incremental effects (QALYs)</th>
<th>INMB (using $50,000 as threshold)</th>
<th>ICER (US$/QALY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMS</td>
<td>25,460 (24,446 to 26,574)</td>
<td>2.360 (2.327 to 2.379)</td>
<td>-2,603 (-6.817 to 1.498)</td>
<td>-3,988 (-8.057 to 4.21)</td>
<td>&gt;$1,000,000</td>
<td>Dominated</td>
</tr>
<tr>
<td>SES</td>
<td>28,250 (27,646 to 28,919)</td>
<td>2.362 (2.324 to 2.382)</td>
<td>2,790 (1,525 to 4,014)</td>
<td>0.002 (-0.039 to 0.041)</td>
<td>-2,696 (-4.995 to -4.42)</td>
<td>-3,913 (-6.164 to -3.54)</td>
</tr>
<tr>
<td>PES</td>
<td>29,299 (28,602 to 30,039)</td>
<td>2.358 (2.325 to 2.379)</td>
<td>3,838 (2.544 to 5,070)</td>
<td>-0.001 (-0.046 to 0.038)</td>
<td>-3,988 (-8.057 to 1.498)</td>
<td>&gt;$1,000,000</td>
</tr>
</tbody>
</table>

Mean values and 95% confidence intervals; time horizon, 3 years. BMS, bare metal stent; ICER, incremental cost-effectiveness ratio; INMB, incremental net monetary benefit; PES, paclitaxel-eluting stent; QALY, quality-adjusted life-year; SES, sirolimus-eluting stent.

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**Figure 2** Cost-effectiveness plane. Incremental costs and effects of the sirolimus-eluting (SES) and paclitaxel-eluting stent (PES). First 500 iterations of 5000 Monte Carlo simulations are displayed for each stent. QALYs, quality-adjusted life-years.

**Figure 3** Cost-effectiveness acceptability curves. Base-case analysis with a time horizon of 3 years. Results are based on 5000 Monte Carlo simulations. DES, drug-eluting stent; PES, paclitaxel-eluting stent; SES, sirolimus-eluting stent.
The DRG reimbursement rates for BMS and DES clearly influence the result. At a difference in DRG reimbursement rates of less than $3174 (current difference $6760) between BMS and DES, SES yields a positive INMB (at a willingness-to-pay of $100,000/QALY), and would therefore be superior to BMS (at a willingness-to-pay of $50,000/QALY: $3080 for SES and $1901 for PES). At the same threshold level, PES yields a positive INMB when the difference in reimbursement rates is less than $1816. DES is then likely to be cost-effective.

In our base-case analysis, we used average DRG reimbursement rates for 10 top-rated US hospitals. In a sensitivity analysis using average DRG reimbursement rates derived from a random sample of 10 US hospitals with lower reimbursement rates (Table 1), there was no qualitative change in our results.

We also explored the robustness of the model toward changes in quality of life and used the disutility values for PCI and CABG from a recent health-technology assessment report in the United Kingdom [39], disregarding long waiting times that are not existent in the United States. In this sensitivity analysis, model results did not change the conclusion that would be drawn from the analysis.

When we applied different commonly used discount rates for both health effects and costs ranging from 0% to 10%, or when we used differential discounting (i.e., using a different discount rate for health effects and costs), we found no major impact on the results.

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Discussion

Our results demonstrate that the wide use of DES is not cost-effective and cannot be advocated for patients with coronary artery disease similar to those evaluated in the pivotal RCTs comparing BMS with DES. Interestingly, both types of evaluated DES showed very small (for SES) or no positive incremental effects (for PES) when compared with BMS. At the same time, costs associated with DES are higher than costs associated with BMS, and therefore DES cannot be considered to be cost-effective.

The strength of our model is the probabilistic approach and the use of clinical effectiveness data from a large comprehensive meta-analysis of 17 trials including 8221 patients. The effectiveness part of our analysis is supported by the recent publications of individual patient data meta-analyses of trials comparing DES with BMS [6]. No other cost-effectiveness analysis on DES used data from such a large number of patients. By relying on clinical effectiveness data from such a large number of patients, our model is more precise in predicting clinical outcome events than other models relying on smaller number of patients. Furthermore, we integrated 3 years of follow-up data into our model. This is important because differences in need for target vessel revascularizations between patients treated with DES and BMS become smaller after the first year of stent implantation, whereas the risk of late stent thrombosis remains constant at a rate of 0.6% per year in patients treated with DES [43]. Therefore, any cost-effectiveness analysis restricting the time horizon to 1 year or calculating the cost per revascularizations avoided in the first year clearly results in a biased assessment of the cost-effectiveness of DES. Many of the included trials intend to follow-up patients for 5 years after the index procedure. Our analysis based on 3 years of follow-up data may not necessarily be extrapolated to an extended time horizon because the clinical effectiveness of DES may differ with longer follow-up.

In our analysis, we explicitly took parameter uncertainty into account by fitting individual probability distributions to all cost, quality of life, and epidemiologic parameters in the model. This allowed us to perform a Monte Carlo simulation that results in an estimate of the probability that DES is cost-effective for a given willingness-to-pay value. The uncertainty concerning the estimates of total health-care costs and total health effects for both BMS and DES is large. As a consequence, the decision uncertainty (i.e., the confidence interval for the estimate of the incremental net monetary benefit) is large as well. Nevertheless, this has no direct influence on the conclusion whether DES are cost-effective or not. In a situation where a decision has to be taken, the only rational way for a risk-neutral decision-maker is to adopt the strategy with a positive incremental net monetary benefit. In our analysis, DES provided a negative INMB and therefore DES cannot be considered to be cost-effective. In a situation where a decision has to be taken, the only rational way for a risk-neutral decision-maker is to adopt the strategy with a positive incremental net monetary benefit. In our analysis, DES provided a negative INMB and therefore DES cannot be considered to be cost-effective.

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perspective suggests that DES are not cost-effective compared with BMS when implanted in unselected patients with symptomatic ischemic coronary artery disease. Whether DES is cost-effective in certain subgroups needs to be addressed in future studies. Only if the difference of DRG reimbursement rates for BMS and DES is markedly reduced can the wide use of DES be recommended to a large patient population with symptomatic ischemic coronary artery disease.

Supporting information for this article can be found at: http://www.ispor.org/publications/value/ViHsupplementary.asp

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References