Effect of Length and Diameter of Drug-Eluting Stents Versus Bare-Metal Stents on Late Outcomes

Robert J. Applegate, MD, FACC; Matthew T. Sacrinty, MPH; Michael A. Katcher, MD, FACC; Renato M. Santos, MD, FACC; Sanjay K. Gandhi, MD, FACC; William C. Little, MD, FACC

Background—The risk of restenosis and other adverse cardiac events with bare-metal stents (BMS) is increased with smaller stent diameters and longer stent lengths. Drug-eluting stents (DES) may reduce this effect in select patients; however, whether this benefit occurs in high-risk lesions and patients in routine practice is not clear.

Methods and Results—Clinical outcomes (target-vessel revascularization [TVR], stent thrombosis, nonfatal myocardial infarction [MI], and cardiac death) at 2 years stratified by stented length and diameter were compared in 949 consecutive patients who received BMS and 1236 consecutive and comparable patients who received DES for single lesions. The longest tertile of BMS (>23 mm) was associated with increased hazard of TVR, ST, and nonfatal MI or death compared with shorter tertiles of BMS, which was abolished by DES. DES compared with BMS was independently associated with a lower hazard of TVR (HR, 0.34 [0.20 to 0.58]) and nonfatal MI or death (HR, 0.60 [0.39 to 0.92]) in the longest length tertile (>23 mm). No clear association of stented tertile diameter and clinical outcomes for either stent type was observed. However, DES compared with BMS was independently associated with a lower hazard of TVR for all diameter tertiles, and a lower hazard of nonfatal MI or death (0.66 [0.44 to 0.99]) in the largest diameter tertile (>3.4 mm).

Conclusions—Independent of adverse patient and lesion characteristics, DES demonstrated significantly lower hazard of TVR and nonfatal MI or death at 2 years compared with BMS within the longest stented lengths (>23 mm) and largest diameters (>3.4 mm). (Circ Cardiovasc Intervent. 2009;2:35-42.)

Key Words: angioplasty ■ mortality ■ stents

Stent length and diameter have been demonstrated to have an important effect on restenosis and rates of target-vessel revascularization (TVR) with bare-metal stents (BMS).1–3 Drug-eluting stents (DES) have been shown to reduce restenosis and TVR compared with BMS across a wide spectrum of stent lengths and diameters.4,5 However, these data have been obtained from randomized clinical trials of highly selected patients with limited lesion and stent lengths. Recent concerns about adverse events late after placement of a DES have resulted in an increase in the use of BMS and more selective use of DES.6–8 However, there are only very limited data examining the effect of stent length and diameter late with DES in routine clinical practice including use in patients and for lesions that would not have been included in randomized clinical trials.9,10 To examine the effect of stent type on the relationship of stent length and diameter and clinical outcomes we assessed the 2-year clinical outcomes of patients receiving a stent for a single lesion in comparable consecutive patients treated with BMS and DES.

Clinical Perspective see p 42

Methods

The authors had full access to and take full responsibility for the integrity of the data. All authors have read and agree to the manuscript as written.

Patients at our institution undergoing percutaneous coronary intervention from April 2002 to April 2005 were included in the study. One thousand four hundred and fifty-one patients underwent coronary artery stenting and received BMS. One thousand eight hundred eighty-three patients received DES after these stents were fully available (April 2003). To avoid potential confounding we excluded patients who underwent stent treatment for multiple lesions and/or in multiple vessels. Patients were also excluded if they received both BMS and DES (n=44) or were unavailable for follow up (BMS=33; DES=45). Patients were not excluded from the study for any other reason. Thus, 949 BMS and 1236 DES patients underwent percutaneous coronary intervention and received stent therapy for a single lesion and comprised the control and study groups, respectively. The Institutional Review Board of Wake Forest University Baptist Medical Center approved this study. We have previously reported 9-month and 2-year follow-up of the overall cohort of these patients.11,12
Percutaneous coronary intervention was performed according to standard techniques. Choice of stent type, and stent lengths and diameter were at the discretion of the Interventionalist performing the procedure. Because sirolimus-eluting stents were available much earlier than paclitaxel-eluting stents, they comprised most of DES used in the study; sirolimus-eluting stents—1,067; paclitaxel-eluting stents—168; both were performed. Anticoagulation during percutaneous coronary intervention was accomplished with unfractionated heparin or bivalirudin per standard protocol. Patients received glycoprotein IIb/IIIa receptor inhibition according to usual protocol with abciximab or eptifibatide at the discretion of the interventionalist. All patients were treated with aspirin (81 to 325 mg a day) before percutaneous coronary intervention and indefinitely thereafter. Patients also received clopidogrel (300 to 600 mg as a loading dose, given before or immediately after the procedure, followed by 75 mg/day). Clopidogrel was given for a minimum of 1 month in BMS-treated patients, for a minimum of 3 months for sirolimus-eluting-stent-treated patients, and for a minimum of 6 months for paclitaxel-eluting-stent-treated patients. Additional clopidogrel use was at the discretion of the physician responsible for clinical care of the patient.

Before hospital discharge, patient and procedural data and hospital outcomes were entered into the Wake Forest University Baptist Medical Center Cardiovascular Information Services Database. Collection of data and outcomes measures conformed to the American College of Cardiology National Cardiovascular Database Registry definitions for cardiovascular data. Clinical follow-up was obtained as follows: independent chart review was available for 80% of patients; scripted phone interviews were obtained in 18% of patients; and review of the Social Security Death Index for which the death records were the only available follow-up data censored before 2 years. Multivariate models were constructed by including all significant univariate predictors of outcomes at 2 years to account for incidence curves. Cox proportional hazards modeling was used to test for differences between DES and BMS treated patients. Additional clopidogrel use was at the discretion of the physician responsible for clinical care of the patient.

Before hospital discharge, patient and procedural data and hospital outcomes were entered into the Wake Forest University Baptist Medical Center Cardiovascular Information Services Database. Collection of data and outcomes measures conformed to the American College of Cardiology National Cardiovascular Database Registry definitions for cardiovascular data. Clinical follow-up was obtained as follows: independent chart review was available for 80% of patients; scripted phone interviews were obtained in 18% of patients; and review of the Social Security Death Index for which the death records were the only available follow-up data censored before 2 years. Multivariate models were constructed by including all significant univariate predictors of outcomes at 2 years to account for incidence curves. Cox proportional hazards modeling was used to test for differences between DES and BMS treated patients. Additional clopidogrel use was at the discretion of the physician responsible for clinical care of the patient.

Before hospital discharge, patient and procedural data and hospital outcomes were entered into the Wake Forest University Baptist Medical Center Cardiovascular Information Services Database. Collection of data and outcomes measures conformed to the American College of Cardiology National Cardiovascular Database Registry definitions for cardiovascular data. Clinical follow-up was obtained as follows: independent chart review was available for 80% of patients; scripted phone interviews were obtained in 18% of patients; and review of the Social Security Death Index for which the death records were the only available follow-up data censored before 2 years. Multivariate models were constructed by including all significant univariate predictors of outcomes at 2 years to account for incidence curves. Cox proportional hazards modeling was used to test for differences between DES and BMS treated patients. Additional clopidogrel use was at the discretion of the physician responsible for clinical care of the patient.

Before hospital discharge, patient and procedural data and hospital outcomes were entered into the Wake Forest University Baptist Medical Center Cardiovascular Information Services Database. Collection of data and outcomes measures conformed to the American College of Cardiology National Cardiovascular Database Registry definitions for cardiovascular data. Clinical follow-up was obtained as follows: independent chart review was available for 80% of patients; scripted phone interviews were obtained in 18% of patients; and review of the Social Security Death Index for which the death records were the only available follow-up data censored before 2 years. Multivariate models were constructed by including all significant univariate predictors of outcomes at 2 years to account for incidence curves. Cox proportional hazards modeling was used to test for differences between DES and BMS treated patients. Additional clopidogrel use was at the discretion of the physician responsible for clinical care of the patient.

Before hospital discharge, patient and procedural data and hospital outcomes were entered into the Wake Forest University Baptist Medical Center Cardiovascular Information Services Database. Collection of data and outcomes measures conformed to the American College of Cardiology National Cardiovascular Database Registry definitions for cardiovascular data. Clinical follow-up was obtained as follows: independent chart review was available for 80% of patients; scripted phone interviews were obtained in 18% of patients; and review of the Social Security Death Index for which the death records were the only available follow-up data censored before 2 years. Multivariate models were constructed by including all significant univariate predictors of outcomes at 2 years to account for incidence curves. Cox proportional hazards modeling was used to test for differences between DES and BMS treated patients. Additional clopidogrel use was at the discretion of the physician responsible for clinical care of the patient.

Before hospital discharge, patient and procedural data and hospital outcomes were entered into the Wake Forest University Baptist Medical Center Cardiovascular Information Services Database. Collection of data and outcomes measures conformed to the American College of Cardiology National Cardiovascular Database Registry definitions for cardiovascular data. Clinical follow-up was obtained as follows: independent chart review was available for 80% of patients; scripted phone interviews were obtained in 18% of patients; and review of the Social Security Death Index for which the death records were the only available follow-up data censored before 2 years. Multivariate models were constructed by including all significant univariate predictors of outcomes at 2 years to account for incidence curves. Cox proportional hazards modeling was used to test for differences between DES and BMS treated patients. Additional clopidogrel use was at the discretion of the physician responsible for clinical care of the patient.

### Statistical Methods

Because stents are only available in discrete lengths and diameters, we assessed the effect of stented length and diameter by grouping patients into categories of increasing stented length and diameter. Stented length was defined as the stent length specified by the manufacturer at nominal pressures. In the case of overlapping stents, it was defined as the sum of these lengths. Stented diameter was defined as the stent diameter specified by the manufacturer at nominal pressures if no postdilation was performed. If postdilation was performed, the diameter was defined as the diameter of the postdilation balloon as specified by the manufacturer at nominal pressures. Tertiles of increasing stented length and diameter were chosen for subsequent analysis, which seemed to provide the best balance of number of patients within each group and combined size of BMS and DES patients within a group. Descriptive statistics (means and standard deviation of continuous factors, frequency counts and relative frequencies of categorical factors) were calculated and compared using the Wilcoxon rank sum test for continuous factors and χ² testing for categorical factors. Kaplan–Meier plots of cumulative incidence of major adverse cardiac events were constructed from index procedure to 2 years of follow-up. The log-rank test was used to test for differences between DES and BMS incidence curves. Cox proportional hazards modeling was used to assess independent predictors of outcomes at 2 years to account for follow-up data censored before 2 years. Multivariate models were constructed by including all significant univariate predictors of clinical outcomes and known clinical predictors of outcome. Non-significant covariates were removed from the model in a backwards stepwise fashion until all variables left in the model were either statistically ($P<0.05$) or clinically significant predictors of outcome. The proportional hazards assumption was tested for all variables by examining log-log survival curves. No variables in the final models violated the proportional hazards assumption. SAS, Version 9.1 Statistical Software Package (SAS Institute, Cary, NC) was used for all statistical analyses.

### Results

The baseline clinical characteristics of the BMS and DES groups are shown in Table 1. Acute coronary syndromes were present overall in 74% of patients. (Table 1) BMS were used more often than DES in ST elevation MI (STEMI) (23% versus 19%, $P=0.021$) and saphenous vein graft (SVGs) (9% versus 5%, $P<0.001$), with lower mean left ventricular ejection fractions in BMS (47±16
versus 49±12, *P*=0.016). All other baseline characteristics were similar among the 2 stent groups. Patient and procedural characteristics, however, were not uniformly distributed among the stented length and diameter tertiles. Male gender, STEMI at presentation, and treatment of SVG were all more common in the longest stented length and largest stented diameter tertiles compared with the first tertiles. Male gender, STEMI at presentation, and treatment of SVG were all more common in the longest stented length and largest stented diameter tertiles compared with the first tertiles. 

Procedural characteristics are also shown in Table 1. The average number of stents was 1.1±0.3 for BMS, and 1.1±0.4 for DES, *P*=0.90, with 91% single stents for BMS, and 91% single stents for DES, *P*>0.999. The average stented length for BMS was 21±12 mm, and for DES 24±9 mm, *P*<0.001. The average stent diameter for BMS was 3.2±0.5 mm, and for DES was 3.1±0.4 mm, *P*=0.08. Medication use during the follow-up period was available for most of the patients in the study (Table 2). Aspirin was used in 90% of the BMS patients and 90% of the DES patients, *P*=0.90, at 2 years. At 2 years clopidogrel use was 40% for BMS and 40% for DES, *P*=0.89. Statin use at 2 years was 85% for BMS and 82% for DES, *P*=0.20.

We evaluated the cumulative incidence of selected outcomes at 2 years for 3 stented length tertiles of BMS compared with DES (Table 3). For BMS, there were higher rates of stent thrombosis and nonfatal MI or death in the longest stented length tertile compared with the shortest stented length tertile at 2 years. Directionally similar changes were observed for TVR and death, but were not statistically significant. By contrast, for DES, there were no significant differences in any of the clinical outcomes among the different stented length tertiles. Kaplan–Meier plots of cumulative incidence of TVR and nonfatal MI or death for DES compared with BMS within each of the stented length tertiles are shown in Figure 1. TVR and nonfatal MI or death were lower for DES compared with BMS within all stented length tertiles and were statistically significant for the longest stented length tertile (>23 mm).

The cumulative incidence of selected outcomes for stented diameter tertiles at 2 years is also shown for BMS and DES in Table 3. For both BMS and DES there were no clear relationships between stented diameter and outcome for any of the clinical outcome variables. Kaplan–Meier plots of the cumulative incidence of TVR and nonfatal MI or death for DES compared with BMS within each of the stented diameter tertiles are shown in Figure 2. TVR was lower for DES compared with BMS for all stented diameter tertiles, whereas nonfatal MI or death was numerically lower for DES compared with BMS in the shortest 2 diameter tertiles and significantly lower for the largest diameter tertile (>3.4 mm).

The Cox proportional hazard univariate analysis of DES compared with BMS of nonfatal MI or death to 2 years for each stented length tertile stratified by lesion subgroups is shown in Figure 3. In the shortest tertile of stented length, there were no significant differences for nonfatal MI or death between BMS and DES for any of the lesion subgroups. However, as the tertile of stented length increased, there was a trend toward lower hazard of nonfatal MI or death with DES compared with BMS. Within the longest tertile of stented length, the hazard of nonfatal MI or death was significantly lower for DES (>3.4 mm).

### Table 2. Post-Index PCI Medications Use by Stent Type

<table>
<thead>
<tr>
<th>Medication</th>
<th>BMS</th>
<th>DES</th>
<th><em>P</em> Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clopidogrel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At 1 month</td>
<td>398/407 (98)</td>
<td>684/696 (98)</td>
<td>0.568</td>
</tr>
<tr>
<td>At 1 year</td>
<td>172/392 (44)</td>
<td>336/680 (49)</td>
<td>0.081</td>
</tr>
<tr>
<td>At 2 years</td>
<td>154/383 (40)</td>
<td>269/676 (40)</td>
<td>0.894</td>
</tr>
<tr>
<td>Aspirin</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At 1 month</td>
<td>361/370 (98)</td>
<td>279/285 (98)</td>
<td>0.781</td>
</tr>
<tr>
<td>At 1 year</td>
<td>328/355 (92)</td>
<td>255/269 (95)</td>
<td>0.231</td>
</tr>
<tr>
<td>At 2 years</td>
<td>311/346 (90)</td>
<td>239/265 (90)</td>
<td>0.901</td>
</tr>
<tr>
<td>Statin</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At 1 month</td>
<td>344/405 (85)</td>
<td>553/696 (79)</td>
<td>0.024</td>
</tr>
<tr>
<td>At 1 year</td>
<td>335/390 (86)</td>
<td>558/680 (82)</td>
<td>0.104</td>
</tr>
<tr>
<td>At 2 years</td>
<td>325/381 (85)</td>
<td>556/676 (82)</td>
<td>0.201</td>
</tr>
</tbody>
</table>

*Each time interval is represented as No. of using medication/No. of alive (%).*

### Table 3. Cumulative Incidence of MACE Outcomes at Two Years by Stented Length and Diameter Categories

<table>
<thead>
<tr>
<th>Stented Length, mm</th>
<th>Trend <em>P</em> Value</th>
<th>Stented Diameter, mm</th>
<th>Trend <em>P</em> Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥18.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMS</td>
<td>10.9%</td>
<td>8.6%</td>
<td>15.2%</td>
</tr>
<tr>
<td>DES</td>
<td>8.1%</td>
<td>5.4%</td>
<td>5.6%</td>
</tr>
<tr>
<td>Stent thrombosis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMS</td>
<td>0.7%</td>
<td>3.8%</td>
<td>2.7%</td>
</tr>
<tr>
<td>DES</td>
<td>1.1%</td>
<td>1.7%</td>
<td>1.4%</td>
</tr>
<tr>
<td>Nonfatal MI or death</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMS</td>
<td>13.8%</td>
<td>17.6%</td>
<td>19.8%</td>
</tr>
<tr>
<td>DES</td>
<td>12.6%</td>
<td>11.5%</td>
<td>9.9%</td>
</tr>
<tr>
<td>All cause death</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMS</td>
<td>10.4%</td>
<td>13.2%</td>
<td>11.0%</td>
</tr>
<tr>
<td>DES</td>
<td>9.1%</td>
<td>7.9%</td>
<td>6.0%</td>
</tr>
</tbody>
</table>
lower for almost all of the lesion subgroups evaluated including de novo lesions and SVGs.

The Cox proportional hazard univariate analysis of DES compared with BMS, of nonfatal MI or death to 2 years for each of the stented diameter tertiles stratified by lesion variables is shown in Figure 4. The hazard ratio for TVR favored DES compared with BMS within each diameter tertile, and for almost all of the lesion subgroups evaluated.
within these tertiles. Similar reductions in the hazard of nonfatal MI or death DES compared with BMS were observed within each of the stented diameter tertiles, which was significant in the largest stented diameter tertile (3.4 mm).

To control for potential confounding when assessing the effect of DES versus BMS within categories of stented length and diameter simultaneously, we constructed separate Cox PH multivariate models of TVR and nonfatal MI or cardiac death for each strata of stented length and diameter (Table 4). The point estimate of DES versus BMS HR for TVR and nonfatal MI or death was numerically lower for almost all of the stented length and diameter tertiles. The most significant association of DES with TVR and nonfatal MI or death was seen in the longest length tertile (>23 mm) and largest diameter tertile (>3.4 mm), HRs, 0.26 (0.09 to 0.75) and 0.36 (0.18 to 0.73), respectively. We were not able to assess multivariate models for ST and cardiac death stratified by stented length and diameter categories because of small numbers of these events resulting in several strata with no events in one or both stent types.

**Discussion**

In this large, contemporary experience of single lesion coronary stent procedures, we observed an adverse relationship between increasing stented length on 2-year clinical outcomes.

![Figure 3](https://example.com/figure3.png)

**Figure 3.** Cox proportional univariate analysis of TVR and nonfatal MI or death DES compared with BMS for tertiles of stented length, stratified by lesion subgroups.

![Figure 4](https://example.com/figure4.png)

**Figure 4.** Cox proportional univariate analysis of TVR and nonfatal MI or death DES compared with BMS for tertiles of stented diameters, stratified by lesion subgroups.
outcomes with BMS, which was almost entirely abolished with DES. Moreover, DES compared with BMS was associated with a reduced hazard of TVR and nonfatal MI or death at 2 years for stented lengths >23.0 mm, which was consistently observed for all lesion subgroups evaluated. Similarly, DES compared with BMS was associated with a reduced hazard of TVR for all stented diameters and nonfatal MI or death for the largest stented diameter tertile (>3.4 mm). For both stent types long stented lengths (>23 mm), and large stented diameter (>3.4 mm) were associated with more high-risk adverse patient and lesion characteristics than shorter lengths and smaller diameters. However, the relative benefit of DES compared with BMS was maintained after adjusting for these potential confounders. Thus, the strategy of routine use of DES rather than BMS as evaluated in this study at 2 years was associated with lower rates of TVR for all stented lengths and diameters, and was associated with reduced hazard of nonfatal MI or death for stented lengths >23.0 mm, and stented diameters >3.4 mm.

The detrimental effect of increasing bare metal stent lengths on rates of restenosis has been recognized as a substantial limitation of this therapy, particularly in patients with diabetes. 1–3 Although the initial pivotal trials evaluating the safety and efficacy of DES compared with BMS demonstrated that DES reduced rates of restenosis for all stented lengths and diameters studied, the actual stented lengths were restricted by study protocol.4,5 Moreover, the patients were highly selected. The vast majority of patients currently undergo percutaneous coronary intervention in the setting of an acute coronary syndrome, and these higher-risk patients often are treated with DES for “off-label” indications including lesions >28 mm, bifurcation disease, etc.14,17 The TAXUS V study evaluated longer lesions, up to 46 mm in length, and observed that paclitaxel-eluting stents reduced restenosis at 9 months compared with BMS, even when multiple overlapping stents were compared.18 Similarly, in the TAXUS VI study, with stented lengths of 33.4 mm, restenosis rates at 9 months were lower with paclitaxel-eluting stents compared with BMS.19 Kereiakes et al 20 evaluated data pooled from 5 studies comparing restenosis after sirolimus-eluting stents and BMS, observed lower rates of restenosis with sirolimus-eluting stents with lesion lengths of 18 to 36 mm and 36 to 54 mm. Our observations are consistent with these latter studies and demonstrate the ability of DES to abolish the detrimental length dependent effect on restenosis observed with BMS in routine clinical practice, the majority of whom were treated for “off-label” indications.14

Several studies have also evaluated the rates of restenosis after stenting of “large” diameter vessels. They observed equivalent rates of restenosis with BMS and DES,11,12,21 In the observational study of Steinberg et al 11, evaluating clinical outcomes after stent placement (>3.5 mm), the major adverse cardiovascular event rate at 1 year was 8.5% for BMS, and 7.7% with DES, P = 0.80. Ellis et al 22 hypothesized that larger vessel diameters accommodated greater late loss as seen with BMS, preserving lower rates of TVR. Our observations, however, differ from these previous studies. The reasons for this apparent dichotomy are not readily evident, but several factors may be important. First, both BMS and DES were used in more patients with high-risk clinical and lesion characteristics in this study compared with these previous studies, and were “off-label” in >80%. In “off-label” patients DES may be relatively more beneficial compared with BMS than in “on-label” patients,17,23 regardless of stent length and diameter. Second, long stented lengths >23 mm with diameters >3.4 mm were more frequently used in this study compared with the other studies, with a marked protective effect of DES compared with BMS associated with these particular stents. Further studies will be needed to more fully assess the relative benefit of DES in large diameter stents, particularly stratified by stent length.

Multiple patient and procedural factors have been associated with increased rates of angiographic restenosis and need for repeat revascularization after implantation of BMS. 24,25 The presence of diabetes and chronic kidney disease has both been observed to increase the risk of restenosis.24,26 Additionally, lesion and procedural factors, including long and calcified lesions, and greater strut thickness, smaller stent diameter and longer stent lengths have all been associated with increased rates of angiographic and clinical restenosis.27 These adverse factors seem to interact in a synergistic fashion with the highest rates of clinical restenosis occurring in
patients with both adverse patient and procedural characteristics. Our covariate stratified analysis of the benefit of DES compared with BMS for stented length tertiles indicates that DES is beneficial among all lesion subgroups evaluated including SVGs and de novo lesions. Similarly, the results of the covariate stratified analysis of DES compared with BMS for stented diameter tertiles was similar for all of the lesion subgroups analyzed.

Our study has potential limitations that merit discussion. We assessed stented length and diameter based on manufacturer’s specification, and not on physical measurements made at the completion of the case. Thus, we may have both under- and overestimated stent diameters. However, stent diameters were chosen to roughly approximate the diameter of the reference vessel so significant errors are unlikely. Observational studies such as this may be subject to allocation bias. Observational studies such as ours may be subject to event bias due to potentially unequal follow-up in the treatment and control groups. However, we obtained nearly complete follow-up, so that ≥90% of the patients had follow-up available at 2 years. Our study may also be confounded by bias in selection of stent types. DES and BMS patients had very similar baseline clinical and lesion characteristics; however, we were unable to account for potential confounding from unmeasured variables. Randomized clinical trials would provide the fairest evaluation of DES efficacy and safety, but randomized clinical trial (RCT) usually exclude the very type of high-risk patients that are of interest.26 An unequal extent of underlying atherosclerosis for BMS and DES, particularly give the strategy of stenting from “normal to normal” with DES that was not prevalent with BMS use, could have biased our results. Further studies will be necessary to examine this potential bias. Finally, our study did not examine outcomes beyond 2 years. Hopefully, longer-term follow-up of cohorts such as this will provide valuable information concerning the relative incidence of late adverse events after drug-eluting coronary stent treatment.

Clinical Implications

Financial pressure has mounted on hospitals, and by extension physicians, to provide cost-effective stent therapy, and scrutiny of the late safety of DES has intensified.6,29–31 Thus, the relative benefit of DES compared with BMS has become an important factor in the choice of stent type. However, few data are available to help guide decisions for individual patients.32,33 Our observations of lower rates of nonfatal MI or death at 2 years in DES-treated patients across a wide range of stented lengths and diameters compared with BMS-treated patients is reassuring that routine use of DES is safer and more effective than routine use of BMS. When individualization of the type of stent to use is desirable, our observations strongly support the use of DES for both long (>23 mm) and large (>3.4 mm) lesions.

Acknowledgments

We gratefully acknowledge Tammy Davis for manuscript preparation; and Angelina Pack, Aruna Hulme, Sabrina Smith, and Robin Taylor for data collection and database entry.

Sources of Funding

Partial funding of the study was provided by Cordis Corporation.

Disclosures

Dr Applegate has received a research grant from Cordis, is a consultant for St Jude Medical, and received an honorarium and is a member of the Advisory Board for Abbott Vascular. Dr Kutcher received a fellowship grant from Abbott Vascular and is a member of both the Speakers’ Bureau for Sanofi Aventis and the Advisory Boards for Boston Scientific and Cordis. Dr Gandhi received honoraria from both Abbott Vascular and Boston Scientific and is a consultant and member of the Advisory Boards for Cordis and Abbott Vascular. Dr Little is a consultant for Boston Scientific. The other authors report no conflicts of interest.

References


13. Applegate RJ, Sacrinty MT, Kutchler MA, Baki TT, Gandhi SK, Santos RM, Little WC. Comparison of drug-eluting versus bare metal stents on


Effect of Length and Diameter of Drug-Eluting Stents Versus Bare-Metal Stents on Late Outcomes

_Circ Cardiovasc Interv_. 2009;2:35-42; originally published online February 10, 2009;  
doi: 10.1161/CIRCINTERVENTIONS.108.805630

_Circulation: Cardiovascular Interventions_ is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2009 American Heart Association, Inc. All rights reserved.
Print ISSN: 1941-7640. Online ISSN: 1941-7632

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circinterventions.ahajournals.org/content/2/1/35

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in _Circulation: Cardiovascular Interventions_ can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:  
http://www.lww.com/reprints

Subscriptions: Information about subscribing to _Circulation: Cardiovascular Interventions_ is online at:  
http://circinterventions.ahajournals.org//subscriptions/