Catheterization and Cardiovascular Interventions 69:000–000 (2007)

CLINICAL ALERT

Late Stent Thrombosis: Considerations and Practical Advice for the Use of Drug-Eluting Stents: A Report From the Society for Cardiovascular Angiography and Interventions Drug-eluting Stent Task Force

John McB. Hodgson,[1]* MD, FSCAI, Gregg W. Stone,[2] MD, FSCAI, A. Michael Lincoff,[3] MD, FACC, Lloyd Klein,[4] MD, FSCAI, Howard Walpole,[5] MD, FSCAI, Randy Bottner,[6] MD, FSCAI, Bonnie H. Weiner,[7] MD, FSCAI, Martin B. Leon,[2] MD, FSCAI, Ted Feldman,[8] MD, FSCAI, Joseph Babb,[9] MD, FSCAI, and Gregory J. Dehmer,[10] MD, FSCAI

Key words: Drug-eluting Stent; thrombosis; percutaneous coronary intervention; complications

INTRODUCTION

Recent analyses have suggested that implantation of drug-eluting stents (DES) is associated with a higher rate of very late stent thrombosis when compared with bare metal stents. This complication is evident with both sirolimus-eluting stents as well as polymer-based paclitaxel-eluting stents, but the precise magnitude of this risk and whether this applies to all patients or only a subset of those who have received DES is incompletely characterized. This alert is designed to provide the practicing interventional cardiologist with practical advice in light of this new information.

It is not the purpose of this document to provide an exhaustive review of the literature on DES and the risk of stent thrombosis; however a brief summary is appropriate. While exact definitions have been variable in different trials, late stent thrombosis generally refers to stent thrombosis occurring at least 1 month following stent implantation, while very late stent thrombosis refers to events occurring more than 12 months following stent placement. Following bare metal stent implantation, stent thrombosis is rare after 2 weeks, and dual antiplatelet therapy (aspirin and a thienopyridine) was typically prescribed for 3–6 weeks. In contrast, sporadic reports of late stent thrombosis in patients receiving DES have occurred over the past few years. These events often (but not always) occurred in the setting of premature discontinuation of dual antiplatelet therapy. In March 2006, the BASKET-LATE trial was reported, describing a significantly greater composite occurrence of cardiac death and non-fatal myocardial infarction in patients treated with DES when compared with bare-metal stents after clopidogrel had been discontinued at 6 months [1]. Other meta-analyses of the existing DES trials also showed an increase in late events in the DES cohort although these analyses were limited by incomplete data in publications, abstracts, and Internet sources [2,3]. In October 2006, an independent patient-level meta analysis of the four pivotal randomized Cypher stent trials and the five pivotal randomized Taxus stent trials was publicly presented. These analyses demonstrated an increased rate of stent thrombosis with both sirolimus-eluting and paclitaxel-

[1] St. Joseph's Hospital and Medical Center, Phoenix, AZ
[2] Columbia University, New York, NY
[3] Cleveland Clinic Foundation, Cleveland, Oh
[4] Rush University Medical Center, Chicago, Il
[5] Heart Group, Nashville, TN
[6] Savannah Cardiology, Savannah, Ga
[7] UMass Worcester, Worcester, Ma
[8] Evanston Northwestern Healthcare, Evanston, Il
[9] East Carolina University, Greenville, NC
[10] Texas A&M School of Medicine, Temple, Tx

*Correspondence to: John McB. Hodgson, MD, Chief, Academic Cardiology, St. Joseph's Hospital and Medical Center, 350 West Thomas Road, Phoenix, AZ 85013. E-mail: jhodgson@tsg-ed.com

Received 20 December 2006; Accepted 20 December 2006

DOI 10.1002/ccd.21093
Published online in Wiley InterScience (www.interscience.wiley.com).

eluting stents between 1 and 4 years of follow-up, though the overall incidence of death and myocardial infarction was similar between DES and bare metal stents [4].

Although the process of re-examining data from the pivotal randomized trials of DES continues, there appears to be a clear finding that DES are associated with a higher rate of late stent thrombosis than bare metal stents when used "on-label" (as tested in the randomized approval trials). The magnitude of very late stent thrombosis is not well defined, but is in the range of 0.2% excess events per year after year 1 through year 4. Real-world experiences suggest that "off-label" use of drug-eluting stents in more complex lesions such as bifurcation lesions and in patients with acute myocardial infarction are associated with an even higher rate of early and late stent thrombosis [5,6]. Moreover, whether the late thrombosis risk with DES continues indefinitely or terminates after 4 years is unknown.

The presumed mechanism of late susceptibility to stent thrombosis is delayed or incomplete re-endothelialization and possibly an inflammatory response to the stent polymer [7], although other factors such as strut fractures and stent malapposition may contribute. The occurrence of stent thrombosis is associated in most cases (some estimates up to 60–70%) with premature discontinuation of dual antiplatelet therapy (before the prescribed course of 3 months for Cypher and 6 months for Taxus stents), though some episodes have occurred long after the prescribed duration of antiplatelet therapy has been completed. Some of these episodes (but not all) occurred in the setting of heightened platelet reactivity from a surgical procedure or major illness requiring the thienopyridine discontinuation; the extent to which this contributed to the stent thrombosis episode is unknown.

It is important to understand when trying to interpret these events that a uniform definition of late stent thrombosis was not in place for the many trials included. Moreover, the pivotal Cypher and Taxus trials did not count secondary thrombotic events occurring after a target lesion revascularization. Thus, a new standard definition set for late stent thrombosis has been developed (Academic Research Consortium) and is being applied to further analyses [8] (Table I). However, even these criteria have been questioned for including "possible" events that may be unrelated to the original DES implantation and therefore would overestimate the magnitude of the problem.

It is important to re-emphasize that while very late stent thrombosis rates are higher with DES, overall death and myocardial infarction rates have been similar to those of bare metal stents in the pivotal randomized trials up to 4 years after implantation [4]. However, data within these trials were obtained in patients with less complex lesion subsets. It is estimated that up to 60% of DES usage now occurs in "off-label" situations and lesions subsets not studied in the pivotal trials. Some of the combined analyses suggest that death and myocardial infarction may be increased in these more complex lesions subsets which now constitute the majority of DES use. Late stent thrombosis is associated with a high rate of myocardial infarction and mortality [1]. Restenosis after bare metal stenting is also not as benign as previously believed, presenting as an acute myocardial infarction in as many as 10% of patients [9]. A detailed summary of the current data was compiled for the recent FDA Circulatory Devices advisory panel [10].

TABLE I. Academic Research Consortium (ARC) Proposed Standard Definitions of Coronary Stent Thrombosis

Acute: within 24 hr
Subacute: 24 hr to 30 days
Late: after 30 days
Very late: after 12 months

Definite/Confirmed
- Acute coronary syndrome AND

Either
- Angiographic confirmation of stent thrombosis or occlusion

Or
- Pathologic confirmation of acute stent thrombosis

Probable
- Unexplained death within 30 days
- Target vessel infarction without angiographic confirmation of stent thrombosis or other identified culprit lesion

Possible
- Unexplained death after 30 days

Stent thrombosis may further be considered primary (occurring before target lesion revascularization) or secondary (occurring after target lesion revascularization)

Dual Antiplatelet Therapy

Faithful adherence to dual antiplatelet therapy (aspirin and a thienopyridine such as clopidogrel) is difficult to accomplish. In one multicenter study of patients with acute myocardial infarction treated with DES, 13.6% of patients discontinued dual anti-platelet therapy by 30 days [11]. Patients who discontinued therapy before 30 days had a higher rate of re-hospitalization and mortality when compared with those who continued therapy. Factors contributing to dual antiplatelet discontinuation included anemia or need for surgery, but importantly also included many socioeconomic factors (such as education level, cost for prescriptions, understanding of instructions, and misinformation from healthcare professionals). A large single center registry has also found and increase in adverse events in patients with DES who were no lon-

Catheterization and Cardiovascular Interventions DOI 10.1002/ccd.
Published on behalf of The Society for Cardiovascular Angiography and Interventions (SCAI).

ger taking clopidogrel after either 6 or 12 months (includes both premature and scheduled cessation of therapy) when compared with a matched group of patients receiving bare metal stents [12].

As many as 50% of patients are either low- or non-responders to clopidogrel and/or aspirin when assessed in vitro [13,14]. Testing is now available for both clopidogrel and aspirin responsiveness, but is not widely utilized. The extent that platelet hyporesponsiveness contributes to stent thrombosis is undetermined.

The issues surrounding discontinuation of dual antiplatelet therapy are being actively addressed in a forthcoming AHA Science Advisory related to the premature discontinuation of dual antiplatelet therapy in patients with DES (expected publication in early 2007).

PRACTICAL ADVICE: PATIENT SELECTION

Proper patient selection for percutaneous coronary intervention (PCI) must take into account three issues. First, objective evidence of cardiac symptoms, ischemia or otherwise generally acceptable indications for revascularization must be present in accordance with published guidelines for the performance PCI. These guidelines should serve as the basis for the selection of patients for any revascularization [15]. In patients without pre-intervention documentation of inducible or active ischemia, it is reasonable to measure fractional flow reserve before intervention to confirm the presence of a flow-limiting stenosis appropriate for treatment. In short lesions located in the proximal third of the three major epicardial arteries, intravascular ultrasound-determined lesion lumen area of less than 4 mm^2 may also indicate a lesion with a high likelihood of producing inducible ischemia [16].

Second, it must be emphasized that the patients included in the major randomized trials of DES had relatively lower risk lesions and clinical characteristics. This was appropriate for these initial trials, but extrapolation of DES use (and results) to lesion subtypes or patient groups outside those studied in the randomized trials must be done cautiously. Proper patient selection now should involve an assessment of the balance between restenosis risk and thrombosis risk (and the consequences of restenosis and thrombosis). Many factors, such as diabetes, long lesions, small vessels, chronic kidney disease and lesions in saphenous vein grafts, have been identified that portend a higher risk of restenosis and may shift the benefit:risk ratio in favor of DES. These subgroups may also have a higher risk of very late thrombosis. It is important for the clinician to consider the risk:benefit ratio for each individual patient. This medical decision-making process should be carefully documented in the medical record.

Finally, consideration must be given to the patient's ability to comply with long-term dual antiplatelet therapy. Social, medical, and financial barriers to proper adherence must be considered before a DES is selected for implantation, and in particular, the likelihood of future bleeding risk or need for surgical/invasive procedures should be carefully assessed. DES implantation should be avoided if there is any doubt that the patient can comply with prolonged dual antiplatelet therapy.

It is important to realize that the clinical and lesion specific factors predicting an increased risk of early and late stent thrombosis have not been fully elucidated. Nonetheless, table two lists patient and lesion characteristics that currently have been associated with an increased risk of thrombosis after DES implantation. These factors should be reviewed when selecting stent type in an individual patient. After careful consideration of all factors, some high-risk patients may be best considered for surgical revascularization. Interventionalists are encouraged to involve patients, whenever possible, in these discussions and to explain the benefits and risks of any proposed treatment.

PRACTICAL ADVICE: STENT IMPLANTATION

DES are mechanically similar (if not identical) to their bare metal counterparts. Multiple studies have outlined the risk factors for restenosis and sub-acute stent thrombosis in bare metal stents. In nearly every study, stent expansion was found to be an independent risk factor for restenosis. Intravascular ultrasound easily identifies stent under expansion, yet remains infrequently used (approximately 7% of cases in the United States). The recently reported STLLR trial documented geographic miss as an additional risk for adverse outcomes following drug-eluting stent implantation [17]. The importance of complete lesion coverage with DES has been emphasized since their initial approval; however in the STLLR study, 66.5% of implantations were associated with geographic miss. Those with geographic miss had a significantly higher incidence of myocardial infarction during follow-up. Thus, despite a belief that angiographic-guided implantation of DES is satisfactory, the STLLR trial suggests that alternative methods to ensure appropriate lesion coverage might improve outcomes. In this regard, the use of intravascular ultrasound to document appropriate longitudinal lesion coverage and adequate stent expansion ($>80\%$ of the reference lumen area) is reasonable and may improve early and late results of DES implantation, although randomized studies have not been performed.

Coronary calcium markedly impairs the ability to expand stents. Similar issues may arise in ostial locations. Although non randomized studies examining the

Catheterization and Cardiovascular Interventions DOI 10.1002/ccd.
Published on behalf of The Society for Cardiovascular Angiography and Interventions (SCAI).

use of direct stenting without predilation suggest that this technique is safe and effective in selected lesions, careful lesion preparation may be important in more complex lesions to ensure stent delivery and complete expansion. This may include balloon predilation, or occasionally cutting balloon atherotomy, or plaque debulking using rotational atherectomy. Preliminary dilation of the stenosis before stent placement is a possible safeguard against the unexpected inability to fully expand a stent within a fibrotic or calcific lesion. Pre-intervention ultrasound imaging and a careful fluoroscopic review for calcium before stenting can be useful. Under expansion of any stent due to failure of lesion preparation should be avoided.

While DES offer important benefits in terms of restenosis, clinically acceptable target lesion revascularization results can be obtained with bare-metal stents in many low risk lesion or patient groups [18]. Thus, the option of bare metal stent implantation should be carefully considered on a case by case basis.

PRACTICAL ADVICE: DUAL ANTIPLATELET THERAPY

At the FDA Circulatory Devices Advisory Board meeting on December 7th and 8th, 2006 the panel recommended the continuation of dual antiplatelet therapy for 12 months after implantation of drug-eluting stents, based, in large part, on the ACC/AHA/SCAI Class I indication already in existence for PCI in patients who are not at high-risk for bleeding [15]. We support that recommendation. We also recommend operators seriously consider the Class IIb indication that patients in whom stent thrombosis may be catastrophic or lethal, platelet aggregation studies may be considered and the dose of clopidogrel increased to 150 mg per day if less than 50% inhibition of platelet aggregation is demonstrated [15], although the clinical utility of these practices is not established. Furthermore, pre-intervention testing of the responsiveness of a patient to antiplatelet agents may be considered for higher thrombosis-risk patients or lesion subsets as discussed in the patient selection section (Table 2). Unfortunately, no evidence-based medicine presently exists to guide alternative drug management or device selection in patients in whom a point of care test demonstrates platelet hyporesponsiveness to aspirin and/or clopidogrel.

There is no evidence to suggest that patients who have received a DES and have completed and discontinued their course of dual antiplatelet therapy without incident should restart a theinopyridine. These patients should remain on aspirin indefinitely for secondary prevention.

TABLE II. Patient and Lesion Features Associated with Increased Risk of Drug-Eluting Stent Thrombosis

Patient
• Dual antiplatelet discontinuation
• Diabetes
• Acute coronary syndrome/myocardial infarction
• Low ejection fraction
• Renal failure
Lesion
• Bifurcation
• Longer stent length
• Residual dissection
• Small stent diameter and/or severe under expansion
• Stent malapposition

Patients with previously implanted DES who are currently taking dual antiplatelet therapy present a significant management challenge to the interventional cardiologist or primary care provider when a situation arises that requires cessation or interruption of anti-platelet therapy (for example, when elective or urgent surgery is required). There are no existing studies that examine alternative management strategies. Each practitioner must therefore rely on personal knowledge of the individual patient, the specific reason(s) for anti-platelet therapy discontinuation and other relevant factors in making the recommendation for how to manage the situation. Unlike available recommendations for alternative anticoagulant "bridging" strategies when warfarin therapy must be temporarily discontinued, there are no existing data or recommendations for the practitioner to minimize risk of stent thrombosis when anti-platelet therapy must be stopped. Consequently, there has been and continues to be no definitive standard of care for the management of these patients under these circumstances. Discussion of the risk and benefit with the surgeon or other practitioner should be undertaken to determine if the procedure could be performed with reasonable safety without discontinuation of antiplatelet agents. In the patient considered at high risk for stent thrombosis involving a large area of myocardium, short acting intravenous glycoprotein IIb/IIIa inhibitors have been empirically suggested prior to and after surgery for platelet inhibition during the period when the patient is "unprotected" between clopidogrel discontinuation to re-initiation. The safety and efficacy of this practice has not been formally studied, however. Similarly, there are no data to support "bridging" with low molecular weight heparin.

PRACTICAL ADVICE: MEDICAL-LEGAL CONCERNS

Since the issue of late DES thrombosis has been publicized, several solicitations for potential class action suits against the stent manufacturers have been

advertised. It is our opinion that there are no grounds for valid legal action against physicians or stent manufacturers related to the implantation of DES and late thrombosis. The suspicion that patients with DES may be at increased risk for very late thrombosis was only very recently described. There was no pre-existing data to suggest the occurrence of late stent thrombosis. DES were carefully studied in well-performed randomized controlled clinical trials and subsequently approved by the FDA. When any suggestion of issues with these devices has arisen, prompt alerts were issued to the medical community. The FDA (twice in 2003, again in early 2006) and the American College of Cardiology (March 16, 2006) have both issued public health alerts emphasizing the need for strict antiplatelet therapy adherence and proper implantation technique. In fact, the American College of Cardiology clearly recommended "patients taking Plavix™ for any reason should consult with their cardiologist or other health care provider before stopping this medication." In addition, the AHA issued a press release "Stopping medication too soon after receiving a drug-eluting stent raises the risk of death" in June, 2006.

The standard of care has been 3–6 months of clopidogrel following DES implantation (dependent on the type of stent implanted) as approved by the FDA and recommended in the directions for use included with each stent. The FDA, physician investigators, and industry representatives around the world have been carefully evaluating and considering the new concern about very late DES thrombosis. Recommendations are being communicated to physicians objectively and rapidly.

The practitioner is advised to carefully discuss the risks and benefits of the selected stent (or surgical) procedure, why it is believed superior to other revascularization options, and clearly document this thought process in an accepted consent form. Patient education regarding the importance of uninterrupted dual antiplatelet therapy is also critical. As with all therapies in medicine, the best protection against legal action should complications arise is close communication between the physician and patient, with careful documentation of the decision process in the medical record. This is especially important when considering "off-label" use of DES.

PRACTICAL ADVICE: FURTHER STUDIES

The safety of DES is of concern to everyone, physician, manufacturer and patient alike. To better address this concern, several large multicenter trials are ongoing, and several others will begin recruitment soon. We applaud this approach and encourage active participation by the interventional community. The HORIZONS-AMI trial is randomizing 3,000 patients with acute myocardial infarction to DES vs. bare metal stents. The E-Select Registry and INSIGHT randomized trial will be a 30,000 patient global registry incorporating a United States randomized trial of standard vs. long duration clopidogrel. The PROTECT randomized trial will be an 8,000 patient global randomized trial of the Endeavor vs. the Cypher stent with a primary endpoint of stent thrombosis. Finally, the STENT Thrombosis study will enroll at least 10,000 consecutive patients receiving DES in whom aspirin and clopidogrel responsiveness will be assessed at baseline and throughout a 2–5 year follow-up for stent thrombosis.

In addition, at the recent FDA Advisory Board meeting, questions were raised about the appropriateness of multivessel stenting, especially in comparison with coronary artery bypass surgery. This question is also under rigorous investigation. The FREEDOM trial is randomizing 2,400 patients with diabetes mellitus and multivessel disease to DES implantation vs. bypass surgery. The SYNTAX trial is randomizing 1,700 patients with triple vessel or unprotected left main disease to DES implantation vs. bypass surgery. Until such time as these trials produce clear data for further recommendations we advise the practicing interventionalist to thoughtfully document the indications for intervention and the medical decision making process by which the specific revascularization strategy was chosen.

SUMMARY

In light of the observed small increased incidence of very late thrombosis seen after DES implantation we advise the following:

1. Prior to any stent implantation, patients should meet criteria for PCI according to published guidelines.
2. The decision to implant a DES vs. an alternative revascularization strategy (including bare metal stents or surgical revascularization) must be made on an individual patient basis after consideration of the relative risks and benefits of each therapy.
3. Careful evaluation of the patient with respect to compliance and the risks of long-term dual antiplatelet therapy must be performed prior to implanting a DES.
4. Careful attention must be paid to stent implantation technique. The use of intravascular ultrasound, screening for calcification, and careful lesion preparation are encouraged.
5. Following DES implantation, dual antiplatelet therapy should be prescribed for no less than 3 months

Catheterization and Cardiovascular Interventions DOI 10.1002/ccd.
Published on behalf of The Society for Cardiovascular Angiography and Interventions (SCAI).

(Cypher) or 6 months (Taxus) for patients meeting the FDA approved indications. In such patients who are not at high risk for bleeding, we strongly recommend the continuation of dual antiplatelet therapy for 12 months. Until the issue of very late stent thrombosis is further studied, we recommend that patients at higher risk for stent thrombosis be considered for dual antiplatelet therapy for longer than 12 months after careful review of the risks and benefits.

6. The discontinuation of dual antiplatelet therapy (either transiently or permanently) requires careful consideration of the relative risks of continuation (primarily bleeding and cost) and the potential risks of late stent thrombosis. This decision must be individualized. There are no tested "bridging" strategies.
7. The medical decision making process, risks and benefits of all appropriate therapies, and the need for dual antiplatelet therapy should be discussed with the patient and documented in the medical record.
8. Patients should be reassured that the implantation of a DES, after careful consideration with their physician, remains a very effective method for the treatment for symptoms associated with the disabling problem of coronary artery disease.

REFERENCES

1. Pfisterer M, Brunner-La Rocca HP, Buser PT, Rickenbacher P, Hunziker P, Mueller C, Jeger R, Bader F, Osswald S, Kaiser C, for the BASKET-LATE investigators. Late clinical events after clopidogrel discontinuation may limit the benefit of drug-eluting stents. J Am Coll Cardiol 2006;48:2584–2591.
2. Camenzind E. Safety of drug-eluting stents: Insights from meta analysis. Available at www.escardio.org/knowledge/congresses/congressreports/hotlinesandctus/707009_Camenzind.htm Accessed December 13, 2006.
3. Nordmann AJ, Briel M, Bucher HC. Mortality in randomized controlled clinical trials comparing drug-eluting vs. bare metal stents in coronary artery disease: A meta analysis. Eur Heart J 2006;27:2784–2814.
4. Leon MB, Stone GW. Presentation at TCT October 25, 2006. Available at www.tctmd.com/csportal/appmanager/tctmd/main?_nfpb=true&_pageLabel=TCTMDContent&hdCon=1453648. Accessed December 13, 2006.
5. Serruys P. Presentation at the European Congress of Cardiology in Barcelona (September 2006). Discussed in Clappers and Verheugt. Hotline sessions of the 28th European Congress of Cardiology/World Congress of Cardiology. Eur Heart J 2006;27:2896–2899.
6. Bavry AA, Kumbhant DJ, Helton TJ, Borek PP, Mood GR, Bhatt DL. Late thrombosis of drug-eluting stents: A meta-analysis of randomized clinical trials. Am J Med 2006;119:1056–1061.
7. Joner M, Finn AV, Farb A, Mont EK, Kolodgie FD, Ladich E, Kutys R, Skorija K, Gold HK, Virmani R. Pathology of drug-eluting stents in humans: Delayed healing and late thrombotic risk. J Am Coll Cardiol 2006;48:193–202.
8. Cutlip D. Presented at TCT on October 25, 2006. Available at www.medscape.com/viewarticle/546575. Accessed December 13, 2006.
9. Chen M, John J, Chew D, Lee D, Ellis S, Bhatt D. Bare metal stent restenosis is not a benign clinical entity. Am Heart J 2006;151:1260–1264.
10. Available at www.fda.gov/ohrms/dockets/ac/06/briefing/2006-4253b1-index.htm. Accessed December 13, 2006.
11. Spertus JA, Kettelkamp R, Vance C, Decker C, Jones PG, Rumsfeld JS, Messenger JC, Khanal S, Peterson ED, Bach RG, Krumholz HM, Cohen DJ. Prevalence, predictors, and outcomes of premature discontinuation of thienopyridine therapy after drug-eluting stent placement: Results from the PREMIER registry. Circulation 2006;113:2803–2809.
12. Eisenstein EL, Anstrom KJ, Kong DF, Shaw LK, Tuttle RH, Mark DB, Kramer JM, Harrington RA, Matchar DB, Kandzari DE, Peterson ED, Schulman KA, Califf RM. Clopidogrel use and long-term clinical outcomes after drug-eluting stent implantation. JAMA 2006, Dec 5; [epub ahead of print].
13. Nguyen TA, Diodati JG, Pharand C. Reisitance to clopidogrel: A review of the evidence. J Am Coll Cardiol 2005;45:1157–1164.
14. Michos ED, Ardehali R, Blumenthal RS, Lange RA, Ardehali H. Aspirin and clopidogrel resistance. Mayo Clin Proc 2006;81:518–26.
15. Smith SC Jr, Feldman TE, Hirshfield JW Jr, Jacobs AK, Kern MJ, King SB III, Morrison DA, O'Neill WW, Schaff HV, Whitlow PL, Williams DO. ACC/AHA/SCAI 2005 guideline update for percutaneous coronary intervention: A report of the American College of Cardiology/ American Heart Associan Task Force on Practice Guidelines (ACC/AHA/SCAI Writing Committee to update the 2001 Guidelines for Percutaneous Coronary Intrervention) American College of Cardiology Web Site. Available at www.acc.org/clinical/guidelines/percutaneous/update/index_rev.pdf
16. Nishioka T, Amanullah AM, Luo HUAI. Clinical validation of intravascular ultrasound imaging for assessment of coronary stenosis severity: Comparison with stress myocardial perfusion imaging. J Am Coll Cardiol 1999;33:1870–1878.
17. Costa MA. Impact of stent deployment techniques on long-term clinical outcomes of patients treated with sirolimus-eluting stents. Presentation at TCT 10-2006. Incidence of geographical miss in patients treated with sirolimus-eluting stents: Insights from the STLLR trial. Am J Cardiol 2004;94(suppl 6A):206E.
18. Ellis SG, Bajzer CT, Bhatt DL, Brener SJ, Whitlow PL, Lincoff AM, Moliterno DJ, Raymond RE, Tuzcu EM, Franco I, Dushman-Ellis S, Lander KJ, Schneider JP, Topol EJ. Real-world bare metal stenting: Identification of patients at low or very low risk of 9-month coronary revascularization. Catheter Cardiovasc Interv 2004;63:135–140.

Catheterization and Cardiovascular Interventions DOI 10.1002/ccd.
Published on behalf of The Society for Cardiovascular Angiography and Interventions (SCAI).

J_ID: Z7V Customer A_ID: 06-0418 Cadmus Art: CCI 21093 Date: 5-JANUARY-07 Stage: I Page: 7

APPENDIX
SCAI/ACC/AHA Writing Committee to Develop a Clinical Alert on Drug Eluting Stents—Relationships With Industry

Name	Consultant	Educational and research grants	Scientific advisory board	Speakers' bureau	Steering committee	Stock holder/ equity position
Dr. Joseph Babb	None	Cordis, Guidant Foundation	None	None	None	None
Dr. Randy Bottner	None	None	None	None	None	None
Dr. Gregory J. Dehmer	None	None	None	None	None	None
Dr. Ted Feldman	Abbott, Boston Scientific, Cardiac Dimensions, Cordis, Edwards, Guidant, Myocor	Abbott, Atritech, Boston Scientific, Cardiac Dimensions, Cordis, Evalve, EV3, Guidant, St Jude	None	None	None	None
Dr. John McB. Hodgson	Volcano Corporation	Boston Scientific, GE Medical, Lilly, RADI, Volcano Corporation	Volcano Corporation	Boston Scientific, GE Medical, Pfizer	None	BioInfo, Accelerator, Technology Solutions Group, Teach Image, Volcano Corporation
Dr. Lloyd Klein				Kinolta, Merck, Pfizer		
Dr. Martin B. Leon			Boston Scientific, Cordis, Medtronic			Cordis, Johnson and Johnson
Dr. A. Michael Lincoff	Eli Lilly, Medicines Company		Conor Medsystems: DSME member	Medicines Company		
Dr. Gregg W. Stone	BMS Imaging, Boston Scientific, Abbott, Volcano	Abbott, Boston Scientific, Volcano	Abbott, Boston Scientific, Volcano		Abbott, Boston Scientific, Xtent	Devax, Xtent
Dr. Howard Walpole				Bristol Meyer-Squibb/Sanofi		
Dr. Bonnie H. Wiener	Imaging Core Lab Services	Boston Biomedical Associates, Boston Scientific				

This table represents the relationships of members with industry that were reported in writing during the document development process. It does not necessarily reflect relationships with industry at the time of publication.

ID: 40320 Date: 5/1/07 Time: 04:44 Path: J:/Production/CCD#/Vol00000/060460/3B2/C2CCD#060460