

YEAR IN CARDIOLOGY SERIES

The Year in Cardiovascular Surgery

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It is a great challenge to take over the responsibility of providing readers of the *JACC* with this annual review that highlights key contributions in the cardiovascular surgery literature. This task has been handled with remarkable and enviable efficiency by Robert H. Jones, MD, over the past 5 years. During the series, Dr. Jones altered the format from time to time, generally focusing on reports linking outcomes of patients to decisions about whether an operation should be done. Recognizing the increasing awareness of patients regarding the “how” of surgical procedures, he also sought to highlight relevant data that would help practicing cardiologists counsel patients regarding surgical strategy.

This year we will continue to highlight articles describing outcomes as well as strategy in cardiovascular surgery that practicing cardiovascular specialists will find informative and relevant to patient care. We have organized original articles around general topics, and provide insight into the potential relevance or methodological flaws that readers should consider when evaluating their significance.

Surgery for Valvular Heart Disease

Restrictive annuloplasty and ischemic mitral regurgitation.

FUNCTIONAL MITRAL STENOSIS. Dobutamine stress echocardiography (DSE) and 6-min walk tests (6MWT) were performed in 24 patients \approx 1 year after ischemic mitral valve repair by a strategy of downsized “restrictive” ring annuloplasty combined with coronary artery bypass graft surgery (CABG) (1). None of the patients had significant recurrence of mitral regurgitation. When compared with controls with coronary artery disease matched for age, sex, and left ventricular function, however, very significant differences ($p < 0.001$) were noted in resting and stress peak mitral valve gradients (resting: 13 ± 4 mm Hg vs. 4 ± 1 mm Hg; DSE: 19 ± 6 mm Hg vs. 6 ± 3 mm Hg) and pulmonary artery pressures (resting: 42 ± 13 mm Hg vs. 27 ± 8 mm Hg; DSE: 58 ± 12 mm Hg vs. 38 ± 11 mm Hg). The resting peak mitral gradient correlated with systolic pulmonary artery pressures and 6MWT distance in the restrictive

annuloplasty group, suggesting that some patients may trade moderate or severe ischemic mitral regurgitation for functional mitral stenosis after restrictive annuloplasty (Fig. 1).

LEFT VENTRICULAR REVERSE REMODELING AND IMPROVED SURVIVAL.

Long-term results were reported for 108 patients with ischemic mitral regurgitation who underwent restrictive mitral annuloplasty and CABG (2). Actuarial 1-, 3-, and 5-year survival rates were $87 \pm 3.4\%$, $80 \pm 4.1\%$, and $71 \pm 5.1\%$. Pre-operative left ventricular end-diastolic diameter (LVEDD) >65 mm was strongly associated with poorer survival (hazard ratio: 3.4; 95% confidence interval [CI]: 1.5 to 7.4; $p = 0.002$) (Fig. 2). Late echocardiography was performed in all survivors ($n = 75$), with a mean follow-up interval of 3.8 years (range 2.1 to 6.0 years). Mitral regurgitation grade was $<2+$ in 85% of patients, and mitral stenosis was not observed (transmitral gradient mean 3.9 ± 1.7 mm Hg). In the ≤ 65 mm LVEDD group, all survivors showed evidence of decreased ventricular size and reverse remodeling, which contrasted with only 25% of patients in the LVEDD >65 mm group.

COMMENT. Ischemic mitral regurgitation results from leaflet tethering due to papillary muscle displacement secondary to ventricular remodeling. These studies highlight the debate around treating a “ventricular disease” at the mitral annular level. One unique feature of both studies is that surgeons systematically downsized semirigid complete rings and eliminated mitral regurgitation in a durable fashion in most patients, in contrast to a large body of previous literature where surgeons utilized flexible bands or rings. Functional mitral stenosis has not previously been reported with this strategy, suggesting the need for further investigation. Given the paucity of data supporting a survival benefit for surgical treatment of ischemic mitral regurgitation, patients with advanced ventricular remodeling with LVEDD >65 mm should be considered for adjunctive or alternative strategies rather than restrictive mitral annuloplasty and CABG alone.

Thromboembolic complications after mitral surgery.

The long-term risk of ischemic stroke and bleeding was determined in 1,344 consecutive patients (mean age 65 ± 12 years) after mitral valve surgery (897 mitral valve repairs, 231 mechanical mitral valve replacements, 216 biological mitral valve replacements) (3). The rate of ischemic stroke was lowest after mitral valve repair versus mitral valve

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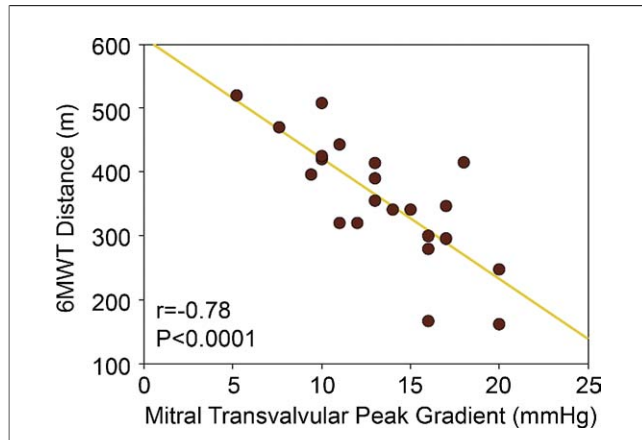


Figure 1 6MWT Distance Versus Resting Mitral Peak Transvalvular Gradient After Restrictive Annuloplasty

6MWT = 6-min walk test. Modified and reprinted with permission from Magne et al. (1).

replacement with biologic or mechanical prostheses ($6.1 \pm 0.9\%$ vs. $8.0 \pm 2.1\%$ and $16.1 \pm 2.7\%$ at 5 years, respectively; $p < 0.001$) (Fig. 3). Mechanical mitral valve replacement was an independent risk factor for increased long-term bleeding risk (relative risk: 2.5, 95% CI: 1.5 to 3.9), which was reduced after mitral valve repair (relative risk: 0.39, 95% CI: 0.25 to 0.61).

COMMENT. An invited editorial brought up significant points, including the increased stroke risk among patients undergoing mitral valve surgery (including repair) during the first 30 days after surgery compared with age-matched

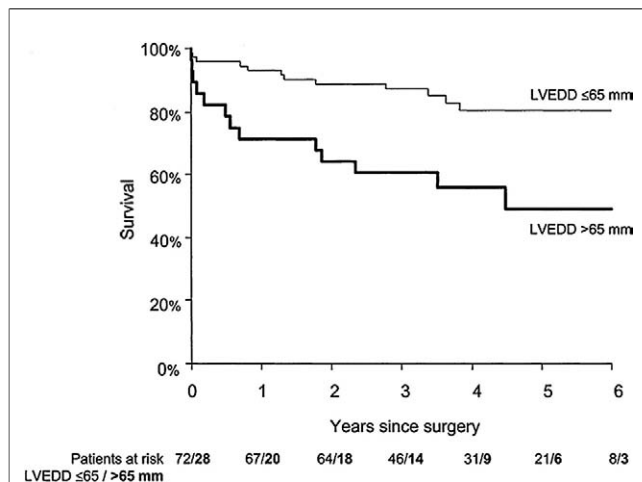


Figure 2 Actuarial Survival After Restrictive Annuloplasty and Pre-Operative Left Ventricular Size

Survival in 2 different pre-operative left ventricular end-diastolic diameter (LVEDD) cohorts undergoing restrictive mitral annuloplasty and coronary artery bypass surgery for ischemic mitral regurgitation, comparing LVEDD >65 and ≤ 65 mm (hazard ratio: 3.4; 95% confidence interval: 1.5 to 7.4; $p = 0.002$). Patients at risk per cohort are shown under the x-axis (LVEDD >65 mm in bold). Reprinted with permission from Braun et al. (2).

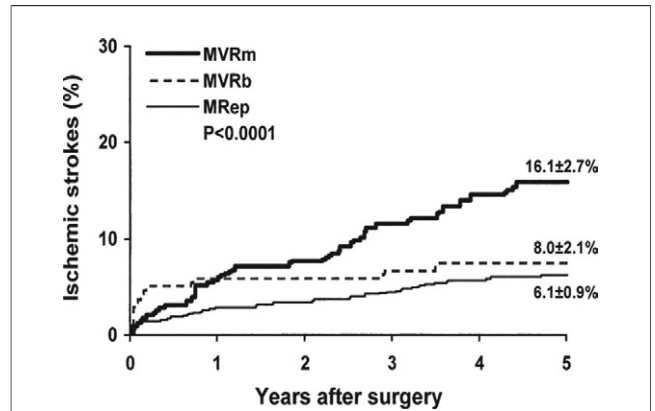


Figure 3 Incidence of First Ischemic Stroke After Surgery for Mitral Regurgitation

The numbers with each curve indicate the 5-year estimated rate of ischemic stroke \pm SE. MRep (light solid line) = mitral valve repair; MVRb (dashed line) = mitral valve replacement, biological; MVRm (heavy solid line) = mitral valve replacement, mechanical. Reprinted with permission from Russo et al. (3).

patients: this point may have implications for the debate over early intervention in asymptomatic patients (4). Emphasis was also placed on the need to “balance” the risk of bleeding and thromboembolism during the early post-operative period. This study re-emphasizes the importance of documenting “late morbidity” when evaluating efficacy of a cardiac surgical procedure, and reinforces the desirability of mitral repair over mechanical valve replacement in most patients.

Left ventricular ejection fraction (LVEF) after surgery for mitral valve prolapse. Post-operative echocardiographic findings (mean period between surgery and echocardiogram was 5 ± 1.8 days) after mitral repair ($n = 779$) or mitral valve replacement ($n = 82$) for leaflet prolapse were analyzed retrospectively to determine early changes in ventricular size and function (5). Although left ventricular and left atrial size were significantly decreased post-operatively compared with pre-operative measurements, LVEF decreased by a mean of 8.8% (Table 1). Multivariate analysis identified pre-operative atrial fibrillation (AF), advanced New York Heart Association functional class, greater left ventricular dimensions, lower LVEF, and larger left atrial size as independent predictors of a lower post-operative LVEF.

Table 1 Echocardiographic Changes in the Early Post-Operative Setting After Mitral Valve Surgery

Variable	Pre-Operative*	Post-Operative*	Overall Change*	p Value
LVEF, %	62.9 \pm 9.9	53.1 \pm 11.3	-8.8 \pm 10.7	<0.001
LVEDD, mm	69.9 \pm 7.6	53.1 \pm 7.7	-7.5 \pm 7.3	<0.001
LVESD, mm	36.9 \pm 7.1	36.6 \pm 8.2	-0.5 \pm 6.5	0.26
Left atrial size, mm	52.3 \pm 9.2	48.0 \pm 8.7	-5.0 \pm 7.4	<0.001

*Expressed as mean \pm SD. Reprinted with permission from Suri et al. (5).

LVEDD = left ventricular end-diastolic dimension; LVEF = left ventricular ejection fraction; LVESD = left ventricular end-systolic dimension.

Table 2	Linearized Recurrence Rates (in Percent Per Year) for Mitral Regurgitation After Mitral Valve Repair		
	All Patients	FED	Barlow
Overall	3.2	2.6	6
Without surgical risk	2.4	2.2	2.9
With surgical risk	4.7	3.6	14.9

When only patients without surgical risk factors are included, the rates for fibroelastic disease (FED) and Barlow's disease are similar for degenerative mitral valve repair. Reprinted with permission from Flameng et al. (6).

COMMENT. This large series suggests that the typical patient experiences almost a 10% decline in LVEF during the early post-operative period after degenerative mitral valve repair. No difference was observed in post-operative changes in ventricular dimensions or function between patients undergoing chordal-sparing valve replacement and mitral repair. No data were presented to clarify the potential recovery of left ventricular function in patients with decreased LVEF immediately after mitral surgery.

Durability of mitral valve repair for degenerative disease. The long-term durability of mitral valve repair for degenerative disease was compared between cohorts of patients with fibroelastic deficiency (n = 265) and Barlow's disease (n = 83) (6). At 10 years, the freedom from reoperation was 94.4%, but the

freedom from mitral regurgitation more than grade 2/4 was only 64.9%. After accounting for surgical factors, including nonuse of annuloplasty rings in some patients, there was no significant difference between the linear rate of recurrent mitral regurgitation more than grade 2/4 for fibroelastic deficiency versus Barlow's disease (2.2% vs. 2.9%, p > 0.5) (Table 2). The primary mechanisms for recurrent mitral regurgitation were new leaflet prolapse, thickening, and calcification.

COMMENT. The etiologic differentiation of degenerative mitral valve disease has important implications for timing of surgical intervention, operative strategy, and matching complexity of disease to surgical expertise (7); and this paper is the first to attempt to define outcomes according to degenerative mitral etiology, as opposed to leaflet involvement (e.g., bileaflet, anterior leaflet, posterior leaflet) or repair technique (e.g., chordal replacement or shortening, annuloplasty ring or suture annuloplasty). An invited editorial highlighted the significant pathologic and surgical differences between Barlow's disease and fibroelastic deficiency (Fig. 4), and noted that certain patients were likely misclassified as Barlow's disease or fibroelastic deficiency, limiting the robustness of the study (8). The observed recurrence rate of significant mitral regurgitation suggests the need for

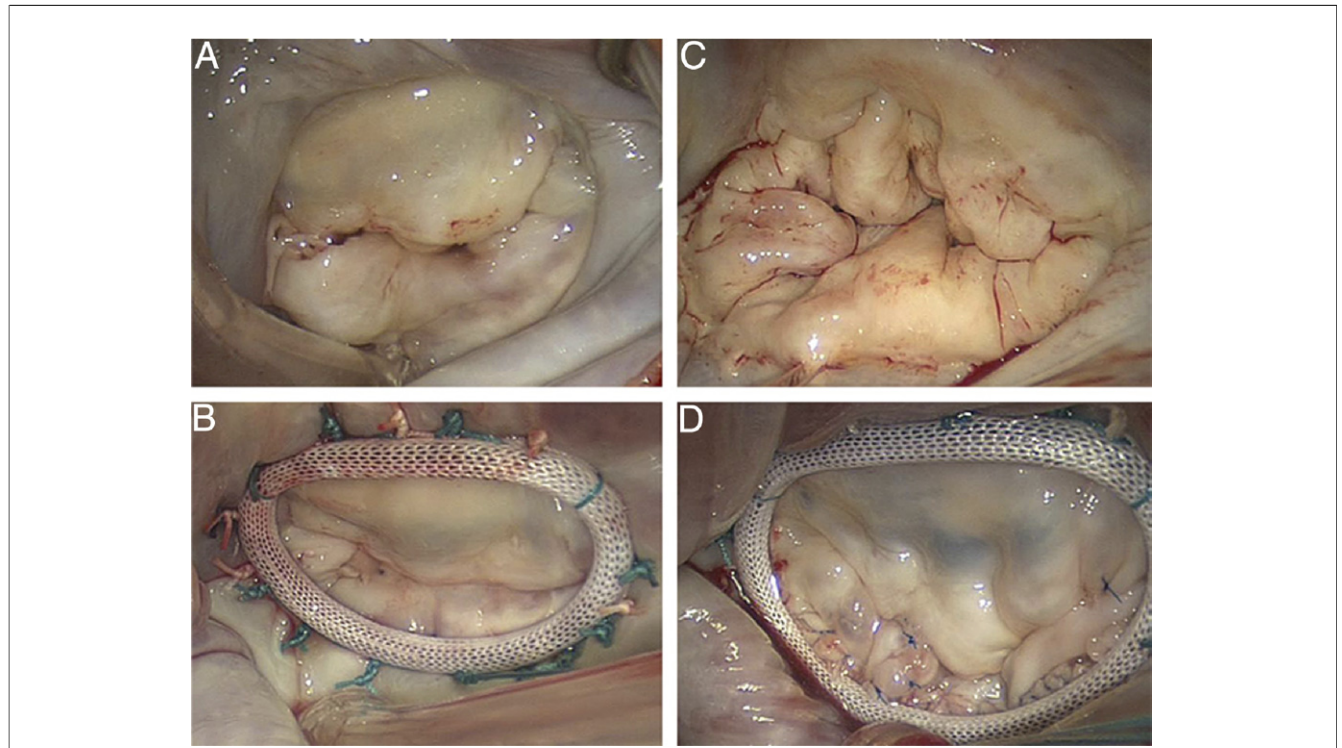


Figure 4 Etiologic Comparison of Degenerative Mitral Valve Disease

The pathology of degenerative mitral valve disease and thus the skill required to achieve a successful repair varies with etiology: (A) fibroelastic deficiency resulting in chordal rupture with single segment prolapse (P1). The pathology is limited to the P1 segment and the valve was easily repaired with a limited triangular resection and ring annuloplasty (B). (C) In contrast, Barlow's disease typically occurs in younger patients (age <65 years) and is characterized by multisegment prolapse and marked excess tissue; repair techniques are more complex and include extensive resection, annular plication, sliding plasty, commissuroplasty, and large ring annuloplasty (D). Modified with permission from Adams and Anyanwu (8).

continued evolution of repair techniques and supports the principle of reference centers for mitral valve repair, particularly for patients with Barlow's disease.

Valve replacement for low flow/low gradient aortic stenosis. Outcomes after aortic valve replacement were reported for 217 patients with severe aortic stenosis (valve area <1 cm²), poor left ventricular function (LVEF ≤35%), and low mean aortic gradient (≤30 mm Hg) (9). Operative mortality declined over the study period (20%, 1990 to 1999, vs. 10%, 2000 to 2005; p = 0.04). Predictors of excess mortality included very low pre-operative mean gradient (≤20 mm Hg) and multivessel coronary disease. In the subgroup that underwent DSE (n = 83), perioperative mortality was 38% among patients without contractile reserve versus 8% among patients with contractile reserve; multivessel disease and lack of contractile reserve were independent predictors of perioperative mortality.

COMMENT. This retrospective study involving 11 European centers is the largest to date analyzing outcomes in this difficult patient subgroup. A clear explanation for the decline in operative mortality in recent years was sought, but was not obvious. Dobutamine stress echocardiography may be a useful tool for risk stratification in this setting and may have been increasingly utilized in recent years. Data regarding post-operative functional status and quality of life were not available.

Transcatheter aortic valve implantation. MANAGEMENT AND OUTCOMES IN REFERRED PATIENTS. Experience with 105 high-risk patients referred to a transcatheter aortic valve implantation (TAVI) program was described (10). Therapeutic modalities included continued medical management

(n = 52, 49.5%), balloon aortic valvuloplasty (BAV) (n = 16, 15.2%), conventional aortic valve replacement (n = 16, 15.2%), and TAVI (n = 21, 20%). TAVI was limited to selected patients meeting inclusion criteria for transcatheter trials or compassionate use. The Society of Thoracic Surgeons (STS) predicted mortality risk score was greatest for the patients who underwent BAV. The 30-day mortality was 6.3% for conventional aortic valve replacement, 9.5% for TAVI, 12.5% for BAV, and 13.5% for patients under medical management. Overall mortality was highest for the BAV (37.5%) and medical management groups (42.3%) after average follow-up of 159 ± 147 days (Fig. 5).

PROGRESS WITH SUCCESSIVE DEVICE GENERATIONS. A single institution reported their experience with TAVI in 136 consecutive high-risk aortic stenosis patients with successive generations of an aortic prosthesis (CoreValve ReValving Prosthesis, CoreValve, Irvine, California) (11). Each generation was reduced in caliber (25- to 21- to 18-F) to facilitate vascular access and device deployment. The procedural success rate (defined as stable device placement with absence of major adverse clinical cardiac events [MACCE], including cardiac tamponade within 24 h of the procedure) increased from generation 1 and 2 versus 3 from 70.0% and 70.8% to 91.2%, respectively (p = 0.003). Of note, the periprocedural stroke rate decreased from ≈10% with the first-generation devices to <5% with the third-generation device. Similarly, periprocedural mortality decreased from 10% and 8% with first- and second-generation devices to 0%

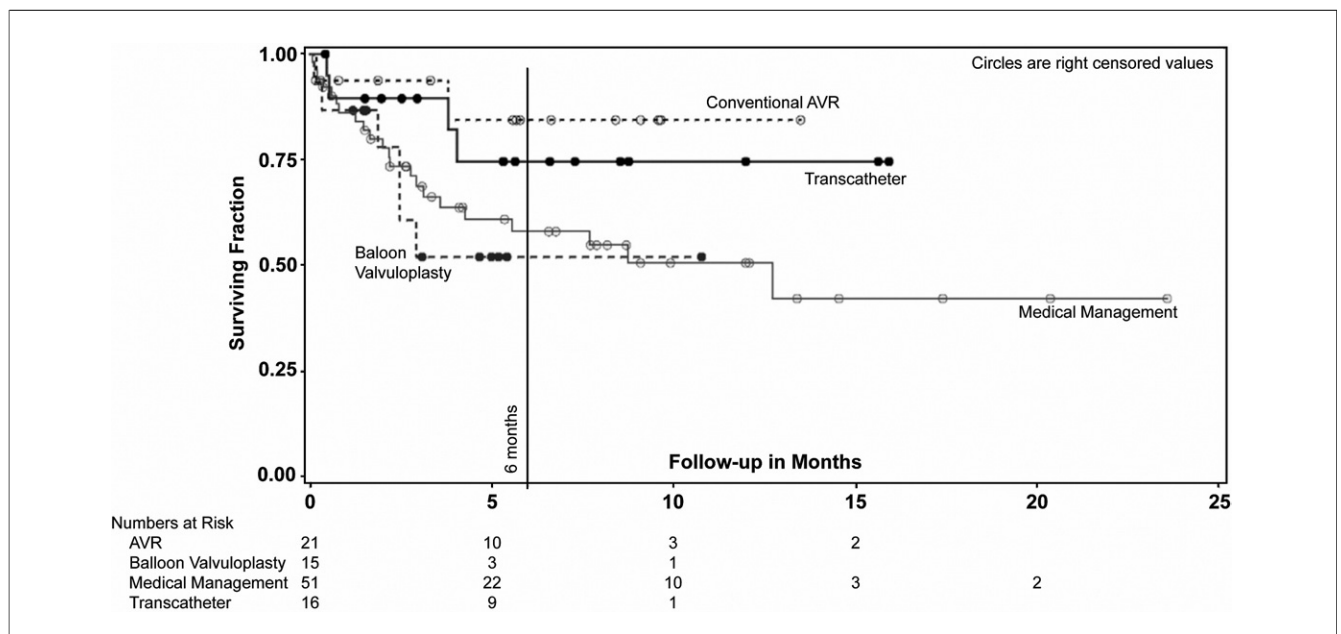


Figure 5 Survival According to Treatment Strategy in High-Risk Severe Aortic Stenosis

The circles are right-censored values. Transcatheter refers to transcatheter aortic valve implantation. AVR = aortic valve replacement. Reprinted with permission from Dewey et al. (10).

for the 18-F device. The 30-day mortality rate for the 18-F device was 10.8% (STS score predicted mortality 8.6%).

TRANSAPICAL TRANSCATHETER AORTIC VALVE IMPLANTATION. Initial results in a multicenter trial with transapical TAVI (Edwards Sapien Transcatheter Heart Valve, Edwards Lifesciences, Irvine, California) through a small left anterolateral thoracotomy in 40 high-risk elderly patients (mean age 83 years) were reported (12). Thirty-five of 40 valves were successfully seated; 2 valves embolized, requiring open retrieval; and 1 case with severe residual aortic regurgitation required standard aortic valve replacement. Kaplan-Meier survival was $81.8 \pm 6.2\%$ at 1 month and $71.7 \pm 7.7\%$ at 3 months.

In another study, results with transapical TAVI (Edwards Lifesciences) were described for 50 high-risk patients with symptomatic, severe aortic stenosis in a single center (13). Mean patient age was 82.4 ± 4.6 years, 39 (78%) were female, and the average EuroSCORE (European System for Cardiac Operative Risk Evaluation) predicted mortality risk was 27.6%. Cardiopulmonary bypass was used in 16 of 50 (32%) patients, and 3 patients required conversion to sternotomy to deal with surgical complications. Overall survival at 30 days, 6 months, and 1 year was $92 \pm 3.8\%$, $73.0 \pm 6.2\%$, and $71.4 \pm 6.5\%$, respectively, and all patients had documented satisfactory valve function at echocardiographic evaluation. No perioperative strokes were noted, and there was a trend toward improved survival among the patients during the latter half of the study.

COMMENT. These studies are the largest to date in the rapidly emerging field of TAVI. Initial experience certainly suggests that TAVI is a viable approach and may at least be comparable to conventional aortic valve replacement in very high risk surgical patients. Although the results do not match those of conventional aortic valve replacement, it is likely that the highest-risk patients in current TAVI series would not have been accepted for conventional surgery, so the 2 groups are not directly comparable. There is evidence that evolving technology, improved patient selection, and growing procedural experience will result in improved outcomes.

Bicuspid regurgitant aortic valve repair. A systematic surgical approach to valve repair was applied in 63 consecutive patients (mean age 40 ± 12 years) with pure aortic valve regurgitation (unicuspid valve, $n = 4$; bicuspid valve, $n = 59$) (14). A systematic segmental morphology-specific approach was applied to bicommissural aortic valve repair, taking into consideration cusp morphology, commissural variations, and root pathology. One of 4 unicuspid and 41 of 59 (69%) bicuspid valves were initially repaired. Four patients required reoperation for recurrent aortic regurgitation $\geq 3+$ (3 early and 1 at 8 months), with 1 re-repair and 3 replacements. Early failures were attributed to tissue quality and fragility. A review of echocardiographic findings and surgical tech-

nique identified cusp mobility/pliability as a predictor of repairability.

COMMENT. An invited editorial highlighted the general weaknesses, such as small patient numbers, limited follow-up, and lack of clarity as to precise criteria that would eliminate the option of repair, inherent in early pioneering surgical studies (15). Nonetheless, this attempt to apply a “mitral repair-like” systematic lesion-specific approach to aortic valve repair in the setting of isolated bicuspid regurgitation is an important first step.

Surgery for Coronary Artery Disease

Comparison of CABG and percutaneous coronary intervention. STENT VERSUS CABG FOR LEFT MAIN CORONARY ARTERY DISEASE. The early and midterm outcomes of 105 patients with unprotected left main coronary disease randomly assigned to percutaneous coronary intervention (PCI [$n = 52$, 35% with DES]) or CABG ($n = 53$) between 2001 and 2004 were reviewed (16). The MACCE-free 1-year survival was comparable between PCI and CABG (71.2% vs. 75.5%, respectively; $p = 0.29$). Left main in-stent restenosis occurred in 5 patients. Four patients were treated with repeat PCI, and 1 patient underwent CABG. No early or late stent thrombosis occurred.

In another study, the outcomes of 1,102 patients with unprotected left main coronary disease who underwent PCI (DES, 71.1%; bare metal stent, 28.9%) and 1,138 patients who underwent CABG in 12 major cardiac centers in Korea between January 2000 and June 2006 were compared using propensity score matching (17). In the overall matched cohort, there was no significant difference between the stenting and CABG groups in the risk of death or the risk of composite outcome of death, myocardial infarction (MI), and stroke (Fig. 6) during the 3-year follow-up period. The rates of target vessel revascularization were significantly higher in the group that received stents than in the group that underwent CABG (hazard ratio: 4.76; 95% CI: 2.80 to 8.11).

COMMENT. The broader off-label application of PCI to patients with left main coronary disease remains controversial. Left main PCI appears to be feasible, safe, and associated with a high technical success rate. The rate of major adverse events was similar between PCI and CABG for left main disease after a follow-up period averaging 3 years, suggesting it is a viable treatment option for high-risk patients with limited life expectancy. The incidence of target vessel revascularization remains higher in the PCI group; a State-of-the-Art review pointed out that this may not come without penalty in the long term, especially for patients with distal left main or bifurcation lesions (18). There remains a crucial need for data from adequately powered, prospective, randomized trials comparing the 2 revascularization strategies in

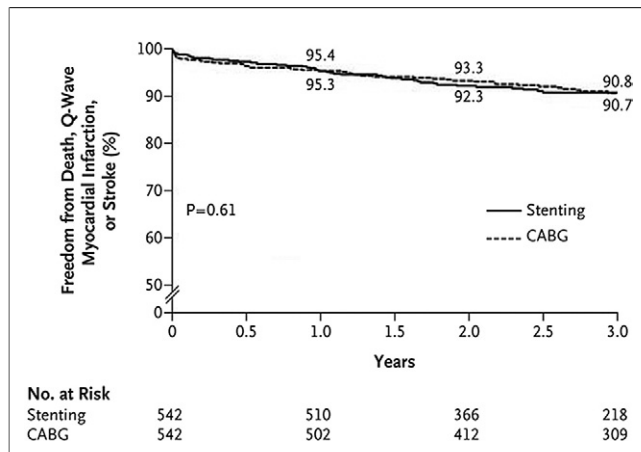


Figure 6 Outcomes Among Patients Matched for Propensity Scores After Left Main PCI or CABG

Outcomes for freedom from death, Q-wave myocardial infarction, or stroke. Event-free survival rates (at 1, 2, and 3 years) were derived from paired Kaplan-Meier curves. The **solid line** represents coronary artery bypass graft surgery (CABG); the **dashed line** represents stenting. PCI = percutaneous coronary intervention. Modified and reprinted with permission from Seung et al. (17).

patients with severe multivessel disease (19). For example, the SYNTAX (Synergy Between PCI and TAXUS DES and Cardiac Surgery) trial, first reported at the 2008 European Society of Cardiology meeting in Munich, found that DES was less effective than CABG for preventing the 1-year primary end point of MACCE in patients with left main and 3-vessel disease. The equipoise of PCI and CABG for this high-risk and complex subgroup remains unclear, and patients should be carefully informed that the evidence so far favors CABG, with more evidence to follow from future trials.

DRUG-ELUTING STENTS VERSUS CABG IN MULTIVESSEL CORONARY DISEASE. The incidence of adverse outcomes (death, death or MI, or repeat revascularization) was compared for all patients with multivessel coronary artery disease who received DES (n = 9,963) or underwent CABG (n = 7,437) in New York State between October 2003 and December 2004 (20). Differences in baseline risk factors were adjusted using a propensity model. At 18 months, among patients with 3-vessel disease who underwent CABG, as compared with patients who received a stent, the adjusted hazard ratio for death was 0.80 (95% CI: 0.65 to 0.97), and the adjusted survival rate was 94.0% versus 92.7% (p = 0.03); the adjusted hazard ratio for death or MI was 0.75 (95% CI: 0.63 to 0.89); and the adjusted rate of survival free from MI was 92.1% versus 89.7% (p < 0.001) (Fig. 7). Similar significant differences in survival and freedom from MI favoring CABG were observed among patients with 2-vessel disease.

COMMENT. This large comparative observational study of recent outcomes from a state-wide database with man-

datory reporting (“real-world data”) indicates that CABG may be associated with lower midterm rates of death, death or MI, and repeat revascularization for patients with 3- and 2-vessel coronary disease. An accompanying editorial comments on the potential for selection bias, as the New York Database may not capture all relevant predictive variables, particularly those that govern physician decisions in deciding which revascularization strategy to recommend (21). For example, dementia was not included in the risk-adjusted model, although it may have biased physicians toward PCI and may be linked to worse prognosis. During the study period, the duration of antiplatelet therapy was shorter than is now recommended to decrease the rate of DES thrombosis, potentially negatively affecting PCI outcomes. Cerebrovascular events were not reported in this study, and no long-term follow-up data are available.

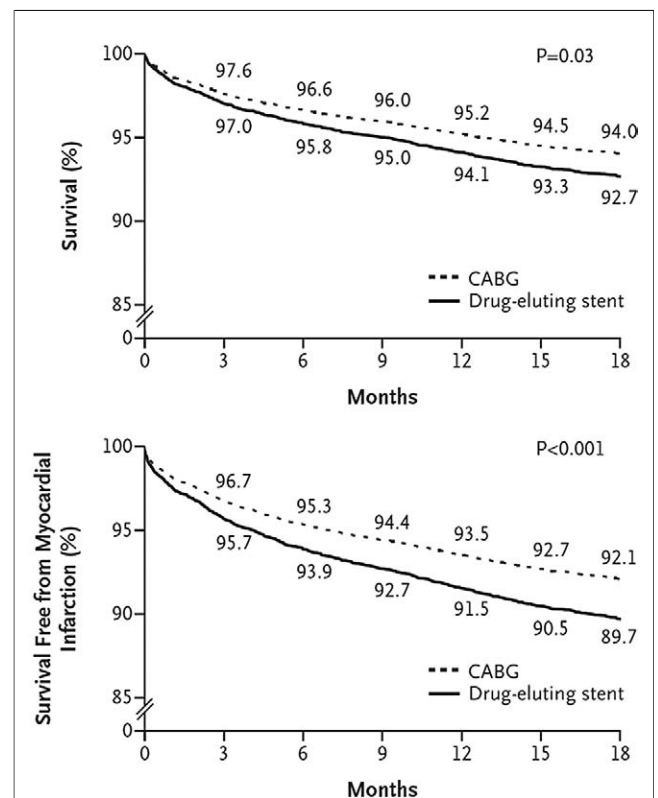


Figure 7 Adjusted Curves for Long-Term Survival and Survival Free From MI

Adjusted curves for (**upper panel**) long-term survival and (**lower panel**) survival free from myocardial infarction (MI). The **dashed lines** represent coronary artery bypass graft surgery (CABG); the **solid lines** represent drug-eluting stents. Survival curves were adjusted for age; sex; ejection fraction; hemodynamic state; history or no history of MI before the procedure; presence or absence of cerebrovascular disease, peripheral arterial disease, congestive heart failure, chronic obstructive pulmonary disease, diabetes mellitus, and renal failure; and involvement of the proximal left anterior descending artery. Modified and reprinted with permission from Hannan et al. (20).

PCI VERSUS INTERNAL MAMMARY ARTERY GRAFTING FOR LAD DISEASE. The SIMA (Stenting Versus Internal Mammary Artery Grafting) trial reported the 10-year clinical outcomes of a cohort of 123 patients with proximal left anterior descending artery (LAD) disease prospectively randomly assigned to bare-metal stenting ($n = 62$) or single-vessel internal mammary artery (IMA) grafting to the LAD ($n = 59$) (22). At 10 years, the incidences of death and MI were identical at $\approx 10\%$ in both groups; repeat revascularization of the LAD was required in 15 patients in the PCI group (25%) compared with none in the CABG group ($p < 0.001$), and the incidence of non-LAD revascularization was similar, with 3 patients in each group (5%) (Table 3). Eight patients from the PCI group underwent CABG as an additional revascularization procedure. At 10 years, most of the patients in both groups were either asymptomatic (93%) or reporting mild angina (7%).

COMMENT. Very long-term outcome data comparing revascularization strategies for isolated proximal LAD disease are scarce. The results suggest that CABG and PCI are comparable, albeit with a much higher rate of repeat revascularization within the first few years with bare-metal PCI. Drug-eluting stents might decrease the incidence of repeat revascularization with PCI in a similar cohort, but data are lacking. No patient required repeat LAD reintervention after IMA grafting, underlining the efficacy of this intervention. It is also interesting to note that, despite aggressive statin therapy becoming prevalent only in the later part of the study, only 5% of patients required subsequent non-LAD revascularization. The risk of disease progression in patients undergoing isolated LAD revascularization appears to be quite low.

Risk modification in CABG patients. AGGRESSIVE STATIN THERAPY FOR PATIENTS AFTER CABG. A total of 4,654 patients with previous CABG were randomly allocated to receive atorvastatin 80 mg/day ($n = 2,316$) or 10 mg/day ($n = 2,338$) and followed up for a median of 4.9 years (23). The primary event rate, defined as the occurrence of a major cardiovascular event (death from coronary artery disease, MI, resuscitated cardiac arrest, or stroke) and the need for

repeat revascularization were analyzed in this substudy of the TNT (Treating to New Targets) trial. After CABG, aggressive lowering of low-density lipoprotein (LDL) cholesterol to a mean of 79 mg/dl with atorvastatin 80 mg/dl reduced the risk of major cardiovascular events by 27% (9.7% vs. 13.0%, $p = 0.0004$) and the need for repeat coronary revascularization by 30% (11.3% vs. 15.9%, $p = 0.0001$), compared with treatment with atorvastatin 10 mg/dl. The safety of both regimens was comparable.

THE IMPACT OF OBESITY ON CABG PATIENTS RECEIVING STATINS. A follow-up analysis of the Post-CABG trial was conducted to clarify the impact of obesity on the progression of vein graft disease and events after CABG in patients randomly assigned to either aggressive (lovastatin 40 to 80 mg/day; target LDL 60 to 80 mg/dl) or moderate (lovastatin 2.5 to 5 mg/day; target LDL 130 to 140 mg/dl) cholesterol-lowering therapy (24). Higher body mass index was associated with late angiographic progression of vein graft disease in the low-dose lovastatin group ($p < 0.001$) but not in the high-dose group; no association between higher body mass index and clinical events was observed.

COMMENT. These 2 subgroup analyzes from the TNT and Post-CABG trials confirm that intensive LDL cholesterol-lowering treatment is associated with improved long-term outcomes after CABG. The Post-CABG study was the first randomized trial to document that aggressive lipid-lowering treatment in CABG patients was associated with a deceleration of vein graft deterioration. The subgroup analysis suggests that high-dose statin therapy may be protective against obesity-related acceleration of vein graft atherosclerosis. The analysis from the TNT trial confirms that aggressive LDL cholesterol-lowering treatment is associated with significant event reduction for most clinical cardiovascular end points if the LDL cholesterol level is maintained below 80 mg/dl.

PRE-OPERATIVE HEMOGLOBIN A1c AND CABG OUTCOMES. The potential role of pre-operative hemoglobin (Hb) A1c as an independent factor for adverse outcomes after primary elective CABG was investigated in a cohort of 3,089 patients (HbA1c $< 7.0\%$, $n = 2,275$ [74%], and HbA1c $\geq 7.0\%$, $n = 814$ [26%]) using multivariate logistic regression analysis (25). An elevated HbA1c level was predictive of hospital mortality after CABG (odds ratio [OR]: 1.40 per unit increase, $p = 0.02$). Patients with HbA1c values of 8.6% or more have adjusted odds of death 4.41 times higher than patients with values below that threshold. Similar threshold values of pre-operative HbA1c appeared to predict major post-operative complications: renal failure (6.7%, OR: 2.10), cerebrovascular accident (7.6%, OR: 2.23), and deep sternal wound infection (7.8%, OR: 5.29).

COMMENT. The impact of diabetes mellitus on early outcome after CABG remains controversial. Several recent clinical series have shown similar outcomes after surgical revascularization for diabetic and nondiabetic patients with

Table 3 Stent Versus CABG for Proximal LAD Disease

	Stent (n = 62)	CABG (n = 59)	p Value
Death	5	4	0.4
Cardiac death	2	1	
Noncardiac death	3	3	
Q-wave MI	0	1	0.9
Non-Q-wave MI	3	2	
TLR	13	0	< 0.0001
TVR	2	0	
Non-LAD PTCA	3	3	
Any event	26 (42%)	10 (17%)	< 0.0001

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CABG = coronary artery bypass grafting; LAD = left anterior descending; MI = myocardial infarction; PTCA = percutaneous transluminal coronary angioplasty; TLR = target lesion revascularization; TVR = target vessel revascularization.

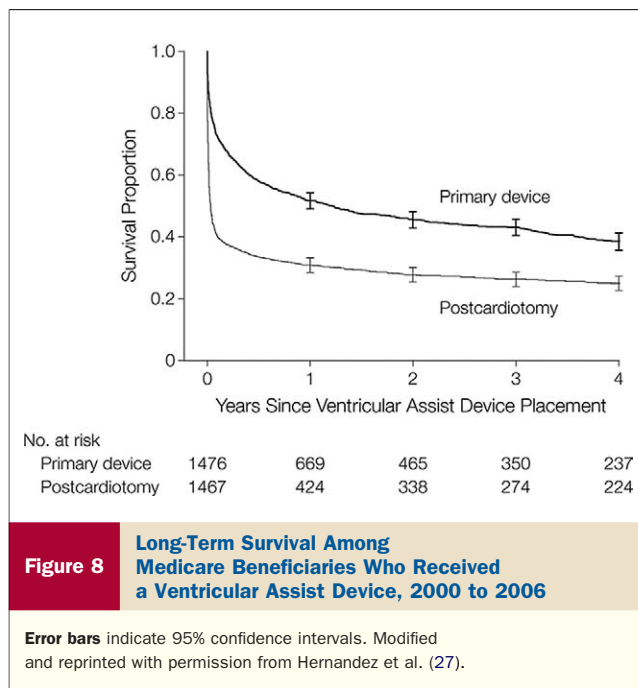
the exception of higher rates of sternal wound infection. Other data including that from the STS database, however, suggest that CABG in diabetic patients is associated with increased post-operative mortality and morbidity. Further studies with significantly larger number of patients are required to determine whether HbA1c may be useful for pre-operative risk stratification and to determine whether pre-operative “normalization” of this marker leads to improved surgical outcomes.

Graft patency after CABG. A 1-year coronary angiography follow-up study was performed on a cohort of 1,920 patients from the PREVENT IV (Project of Ex-Vivo Vein Graft Engineering via Transfection IV) trial to determine independent factors associated with graft patency after primary on- or off-pump CABG (26). After confounding factors were adjusted for, target artery quality, graft type and quality, endoscopic harvest technique, and sequential grafting were found to be independent predictors of vein graft failure defined as $\geq 75\%$ graft stenosis. The rate of vein graft failure was 25.3% in the on-pump group compared with 25.7% in the off-pump group ($p = 0.6$). Poor vein graft quality and endoscopic vein harvest were both associated with increased graft failure in all CABG patients and affected off-pump patients more than on-pump patients (OR: 1.89 and 1.78 vs. 1.09 and 1.27, respectively).

COMMENT. Several risk factors for graft failure after CABG such as target and graft quality, and graft type (saphenous vein vs. internal mammary artery) are well established. A provocative finding in this study was that endoscopic vein harvest, popularized during the last decade because of fewer leg wound complications and better cosmesis, was associated with an increased rate of graft failure, particularly among off-pump patients. Additional studies are required to confirm these findings and to identify the potential injury mechanisms associated with endoscopic vein harvesting.

Surgery for Advanced Heart Failure

Long-term ventricular assist device (VAD) outcomes in the Medicare population. A retrospective analysis of Medicare claims for VAD reimbursement between 2000 and 2006 identified 1,476 patients (mean age 63 ± 13.4 years) for whom a device was used as a primary therapy and 1,467 patients (mean age 69 ± 10 years) who received a VAD for treatment of post-cardiotomy shock (low cardiac output after heart surgery), in a total of 570 U.S. hospitals (27). Of the primary device group, 65% were operated on in heart transplant hospitals, compared with only 35% in the post-cardiotomy group. More than 50% of implants were done in hospitals that did < 5 of these operations per year, with a median volume of 1 implant per hospital per year. The 1-year survival (with device, after device removal, or with transplantation) was 52% in the primary device group versus 31% in the post-cardiotomy group (Fig. 8). Factors associated with worse survival included age > 65 years, peripheral vascu-



lar disease, renal disease, and an annual hospital volume of < 5 implants (post-cardiotomy group only). One-year Medicare payments for inpatient care of primary device patients and post-cardiotomy patients were \$222,039,342 and \$150,887,516, respectively.

COMMENT. High mortality and costs after VAD implantation in the Medicare cohort is a complex issue that is only partially explained by the inherent risk of this population. The observation that the median volume of implants per hospital was 1/year is likely a major contributor to the suboptimal outcomes experienced with VAD therapy in this cohort. A report this year from a high-volume VAD center documenting a 77% 1-year survival among 23 patients with a mean age of 68 years supports the premise that higher volumes yield superior outcomes with VAD therapy (28).

Data were not available regarding the generation of VAD implanted in the Medicare cohort, but older first-generation devices were likely implanted in the majority of patients given the time period. One can anticipate newer generation continuous-flow devices, which are being increasingly utilized, will result in great reduction in mortality and morbidity associated with VAD therapy. For example, another high-volume center this year reported an 87% 6-month survival among 47 patients who received second-generation axial flow-pumps between 2005 and 2007 (29). The notably poor outcome for post-cardiotomy elderly Medicare patients, coupled with the high costs, raises an economic and ethical debate as to the allocation of health care resources to VAD therapy for this subgroup.

Myoblast transplantation. Initial results of the MAGIC (Myoblast Autologous Grafting in Ischemic Cardiomy-

opathy) trial were reported (30). One hundred twenty patients with ischemic cardiomyopathy undergoing CABG were randomly allocated to injection of either low-dose ($n = 33$) or high-dose ($n = 30$) autologous skeletal myoblast cells or placebo ($n = 34$) into akinetic, nonrevascularized myocardium (23 patients did not receive assigned intervention). Myoblast injections did not yield any difference in primary end points (global and regional left ventricular function at 6 months) in the treatment arms compared with the control arm (Fig. 9). There was also no difference in the New York Heart Association functional class or quality of life among the 3 groups. There was no significant increase in incidence of major adverse events in the intervention group. There was a trend toward a decrease in left ventricular size, but also a higher incidence of ventricular arrhythmias, in the high-dose treatment arm.

COMMENT. A “Clinical Perspective” published with this article (30) highlighted the significant points learned from this rigorous randomized, prospective, double-blinded study: 1) implanted myoblasts may increase paracrine signaling; 2) it remains suspect that there is any positive impact on patient outcomes; and 3) further optimization of the “best cells,” their method of delivery, and strategies enabling the enhancement of graft survival and functional integration remain to be defined.

Post-infarction cardiogenic shock—role of CABG. Data from the STS database for 14,956 patients reported to have been in cardiogenic shock at the time of CABG surgery were analyzed (31). During the study period (2002 to 2005), patients in cardiogenic shock represented 2.1% of patients in the STS database undergoing CABG,

but accounted for 14% of all CABG deaths. Operative mortality was 20% for isolated CABG procedures, and the mortality was highest if the patient underwent surgery within 24 h of MI (26%). Mortality decreased to 20% if patients underwent CABG 1 to 21 days after MI, and fell to 18% if surgery took place >21 days later. Mortality was higher when concurrent procedures were performed, rising to 33% for CABG plus valve surgery, and to 58% for CABG plus ventricular septal defect repair (Fig. 10). Less than 3% of cardiogenic shock patients received ventricular assist devices.

COMMENT. CABG as treatment for cardiogenic shock complicating MI remains associated with a high early mortality rate. A simple bedside risk score was also presented that accurately stratified patients into those with low (<10%) to very high (>60%) mortality. The highest risk subgroups may benefit from wider application of newer generation temporary ventricular assist devices.

Cardiac transplantation—expanding the donor pool. Donor left ventricular hypertrophy and donor cocaine use are relative contraindications to heart donation. In a retrospective review of 427 heart transplants performed with hearts from donors without ($n = 365$) or with ($n = 62$) left ventricular hypertrophy (classified based on septal or posterior wall thickness as mild, 1.2 to 1.3 cm, $n = 26$; moderate, 1.4 to 1.7 cm, $n = 33$; or severe, >1.7 cm, $n = 3$), there was no significant difference in 1-year (97% vs. 91%, $p = 0.2$) or 5-year (84% vs. 70%, $p = 0.07$) survival (32). Regression of left ventricular hypertrophy in the transplanted hearts was observed over time under tailored medical therapy.

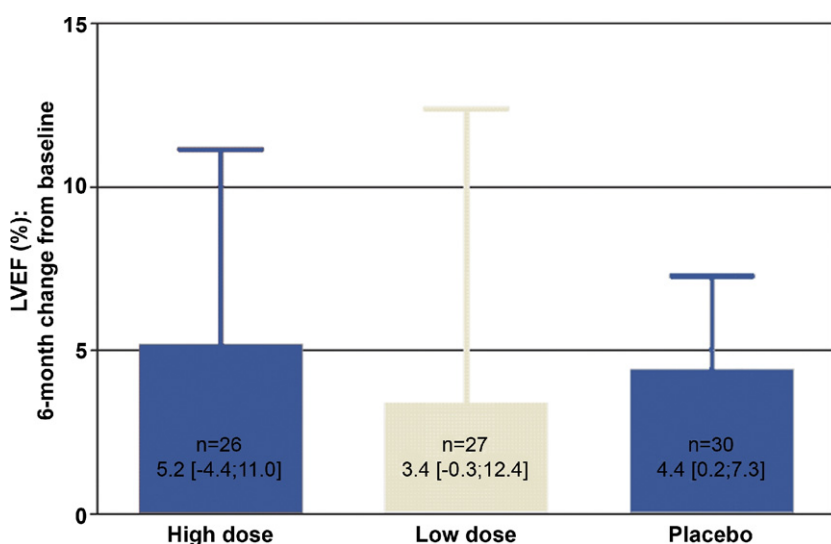


Figure 9 6-Month Change From Baseline in LVEF After Myoblast Transplantation

Data are given as median and interquartile range. The pooled treatment groups and the placebo group were compared with a Wilcoxon test. The associated probability value was 0.62 for left ventricular ejection fraction (LVEF). Modified with permission from Menasche et al. (30).

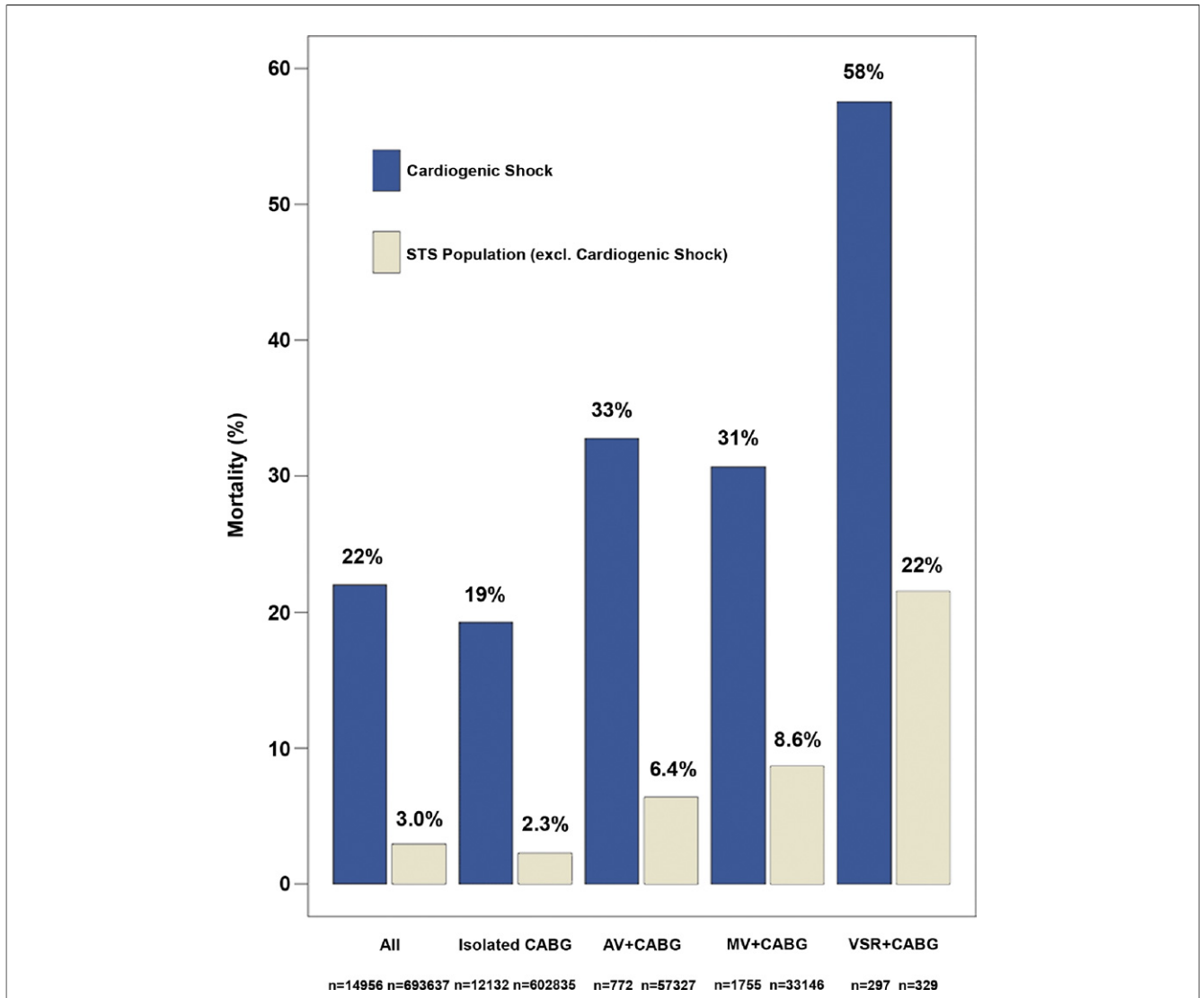


Figure 10 In-Hospital Death Among Patients With Cardiogenic Shock Undergoing Cardiac Surgery

Cardiac surgery included coronary artery bypass graft surgery (CABG), aortic valve surgery (AV) and CABG, mitral valve surgery (MV) and CABG, and ventricular septal rupture (VSR) repair and CABG. The mortality rate of patients with cardiogenic shock (blue bars) was compared with that of patients undergoing similar procedures who were not in cardiogenic shock (beige bars) from The Society for Thoracic Surgeons (STS) database. Reprinted with permission from Mehta et al. (31).

A retrospective analysis of data from the United Network of Organ Sharing registry compared data on 931 transplants from donors with a history of cocaine abuse with those of 7,006 transplants in which the donor was never known to have used cocaine and found a similar 1-year survival regardless of whether the donor was a current (86%), past (89%), or nonuser (86%) of cocaine (33). Similar survival rates existed after adjustment for known risk factors.

COMMENT. Broadening of the donor pool to include donors regardless of past or current cocaine use seems to be safe. Donors with left ventricular hypertrophy can also be safely transplanted, but collaborative registry data would strengthen this concept. Some caution may be warranted—for example, no patients with left ventricular hypertrophy in the currently

analyzed cohort had long ischemic times (>240 min), so it may still be necessary to tailor decision making to use such donor hearts, based on available data.

Aortic Surgery

Endovascular repair of thoracic aneurysms. Results of a phase 2 multicenter study involving 140 patients with descending thoracic aneurysms treated by endovascular stent grafting between 1999 and 2001 was reported, with 94 nonrandomized patients undergoing surgical repair acting as a control group (34). At 5 years, aneurysm-related mortality was lower for the endovascular stent group compared with the control group (2.8% vs. 11.7%,

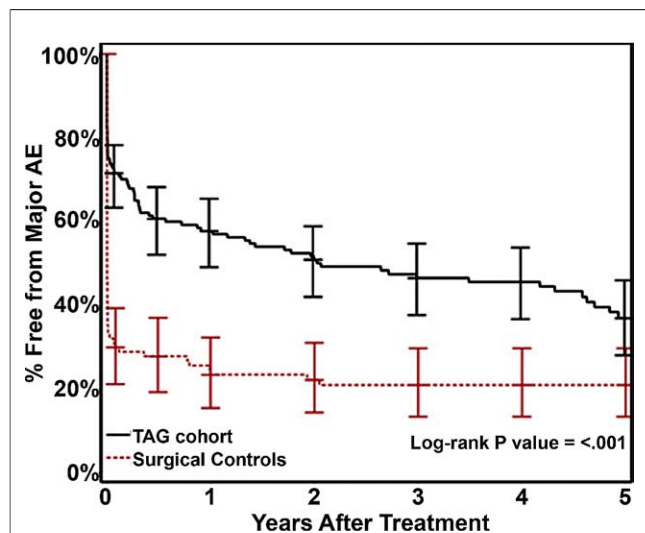


Figure 11 Freedom From Major AE (Including Death) Over Time After Aortic Stenting or Surgery

Major adverse events (AE), including death, were significantly lower among patients undergoing endovascular aortic stenting of descending thoracic aortic aneurysms (TAG cohort [solid line]) than among patients undergoing conventional open repair (surgical controls [dotted line]), primarily because of a reduction in perioperative adverse outcomes. Modified and reprinted with permission from Makaroun et al. (34).

$p < 0.008$) because of improved perioperative survival. The incidence of major adverse events, including death at 5 years, was also significantly lower in the endovascular stent group, reflecting an early reduction in major adverse events (Fig. 11). There was no statistically significant difference between groups for death from all causes.

Another single center reported a retrospective comparison between 352 endovascular repairs and 372 surgical repairs of descending thoracic and thoracoabdominal aneurysms operated on between 2001 and 2006 (35). The 30-day (5.7% vs. 8.3%, $p = 0.2$) and 1-year mortality (15.6% vs. 15.9%, $p = 0.9$) were similar between endovascular and surgical groups, respectively. There was a trend toward more spinal cord ischemic events in the surgical cohort (7.5% vs. 4.3%, $p = 0.08$).

COMMENT. The primary limitation of these studies is their nonrandomized nature, and resultant differences between treatment groups. In the latter study (35), stented patients were on average 9 years older and had more comorbidities. The multicenter study also suffered from incomplete follow-up, with more than one-quarter of patients lost to or refusing follow-up during the trial (34). It appears that endografting of descending thoracic aortic aneurysms is a safe and effective method of repair for anatomically suitable lesions, with immediate results comparable to those of open surgical repair. Results and durability for this procedure beyond 5 years are still unknown.

Atrial Fibrillation

Surgery for AF at the time of mitral surgery. Data from 10 U.S. and European centers participating in an international registry were analyzed to determine the clinical benefit of concomitant AF surgery in patients undergoing mitral valve surgery (36). Patients with follow-up of at least 1 year ($n = 972$) were divided into 3 groups based on whether they were in stable sinus rhythm (sinus rhythm documented at all follow-up visits within 1 year), stable AF (AF documented at all follow-up visits), or an unstable rhythm (all other rhythms). At the time of surgery, $>70\%$ of patients were considered to have permanent AF, with the remainder either in paroxysmal or persistent AF. Surgical techniques to treat AF varied according to the discretion of the surgeon and included different energy sources and cut-and-sew techniques. The cut-and-sew type maze procedure was found to be an independent risk factor for operative mortality (OR: 8.92, $p = 0.009$). At 1 year, 66% of patients were in stable sinus rhythm, which was associated with higher early and late survival compared with stable AF and other rhythms ($p = 0.01$, log-rank analysis) (Fig. 12), as well as greater freedom from thromboembolic events ($p = 0.01$, log-rank analysis).

COMMENT. This study was based on data from a voluntary registry, which is inherently prone to selection and reporting bias. Lesion sets were described as “maze III, non-maze biatrial, left side only, and right side only,” but each of these terms covers a wide spectrum of surgical strategies and efficacy, and without better standardization, it is difficult to assess whether the relatively low reported freedom from AF at 1 year was due to suboptimal surgical techniques. The data are further compromised by the lack of standardization of follow-up protocols. Holter monitoring was used largely on an ad hoc basis. Another confounder not accounted for was the type of mitral surgery: no data were presented on

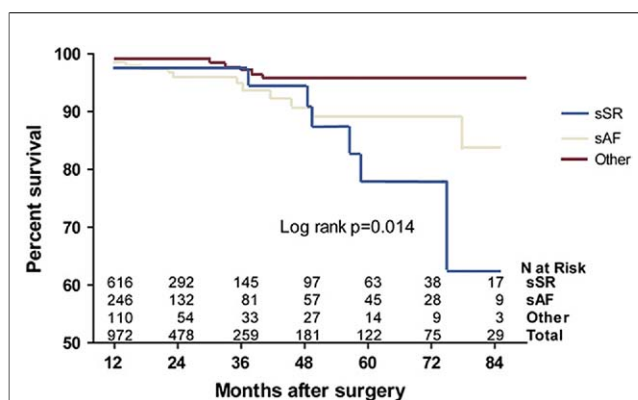


Figure 12 Actuarial Survival After Atrial Fibrillation/Mitral Surgery According to Rhythm

Patients in stable sinus rhythm (sSR [blue line]) 1 year after mitral surgery experienced significantly better long-term survival than did patients who were in stable atrial fibrillation (sAF [yellow line]) or any other rhythm (Other [red line]). Reprinted with permission from Melo et al. (36).

whether patients underwent valve replacement or repair, but since >50% of patients were noted to have rheumatic disease, one can assume a high proportion of patients received mechanical valves, which present an additional burden of risk for events (3). Nonetheless, these data emphasizes the importance of continued efforts to develop strategies for AF in the setting of mitral valve disease.

Atrial fibrillation after CABG. A prospective observational study of 1,832 patients undergoing CABG was conducted to determine the impact of post-operative AF on survival (37). Atrial fibrillation developed in a total of 570 (31%) patients. Compared with patients who did not have post-operative AF, hospital mortality (3.3% vs. 0.5%, respectively; $p < 0.001$) and late mortality (2.99 of 100 person-years vs. 1.34 of 100 person-years, respectively; adjusted hazard ratio: 2.13, $p < 0.001$) were increased in patients with post-operative AF. After adjustment for confounding variables, post-operative AF was found to increase the risk of cardiac mortality threefold, and quadrupled the risk of clinically significant embolic events.

COMMENT. This study is limited by its observational nature, reliance on self-reporting of post-operative arrhythmias, lack of data about the duration of AF, and lack of standardized protocols for rhythm management and anticoagulant therapy and monitoring. While the data reinforce the likelihood that post-operative AF after CABG is independently associated with mortality, the degree to which AF is a cause of the excess mortality as opposed to a marker of susceptibility for death cannot be determined. Further study is required to determine whether measures to prevent AF translate into reduced CABG mortality.

Left atrial appendage closure. A retrospective analysis of 137 patients who underwent transesophageal echocardiography after surgical closure of the left atrial appendage was performed to determine the success of atrial appendage closure techniques (38). Techniques included excision (38%), internal suture of the orifice from the left atrium (53%), and stapler exclusion (9%). Successful closure of the left atrial appendage occurred in 73% of patients after excision versus 23% with suture and 0% with staple exclusion ($p < 0.001$). Left atrial thrombus was common (41%) in patients with failed attempted closure of the left atrial appendage.

COMMENT. It is somewhat surprising that only 40% of patients in the study had successful obliteration of the left atrial appendage. The data may not be representative in that the 137-patient cohort, selected on the basis of a post-operative transesophageal echocardiography study, represented a small sample of the overall cohort ($n = 2,546$) who had left atrial appendage closure during the study period at this institution. Although excision was more successful than exclusion techniques, this approach may not be applicable to all patients, such as patients undergoing reoperation and elderly patients with fragile tissue. Although stapling techniques are particularly attractive in minimally invasive ap-

proaches to AF surgery, this study suggests they are largely ineffective, possibly because the stapler cannot generally be applied down to the true base of the appendage. There is a need for further research into alternative strategies to exclude the left atrial appendage (39); decision making regarding anticoagulation therapy management and the safety of cardioversion in the post-operative setting should not be altered unless an imaging study has confirmed the success of a surgical left atrial appendage closure procedure.

Minimally Invasive Surgery

Robotic mitral valve repair. A series of 300 patients who received robotic mitral valve repair, constituting 32% of all mitral valve operations at a single institution between 2000 and 2006, was reported (40). Robotic exclusion criteria included extensive mitral annular calcification, anticipated mitral valve replacement, severe pulmonary hypertension, poor left ventricular function (ejection fraction <20%), and significant coronary artery disease. Early complications included 2 operative deaths (0.7%), 2 strokes (0.7%), and 3 MIs (1.0%). Mean length of hospital stay was 5.2 days. At a mean follow-up of 815 days, echocardiography in 279 patients showed none, trivial, or mild regurgitation in 258 (92.4%); moderate in 15 (5.4%); and severe in 6 (2.2%). Five-year survival and freedom from reoperation were 96.6% and 93.8%, respectively.

COMMENT. This is the largest series to date demonstrating the safety and efficacy of robotic mitral valve repair performed on well-selected patients in a high-volume center. Factors contributing to the low penetration of robotic heart surgery include complexity of the technique, lack of applicability to the majority of patients needing heart surgery, logistic complexities involved in its set-up, prolonged operative times, high level of skill and training required to do the procedures, lack of definite evidence of benefit, availability of alternative conventional surgical techniques that are safe and at least as effective, and high costs (set-up costs are as high as \$1 million U.S. dollars, and additional costs of disposables per case are as high as \$2,000 U.S. dollars). One of the key expected economic benefits of robotic heart surgery—reduced hospital length of stay—does not appear to have materialized.

Transfusion and Coagulation

Red cell storage and complications after cardiac surgery. The outcomes of 2,872 patients undergoing CABG, valvular heart surgery, or both, between 1998 and 2006, who received 8,802 units of blood that had been stored for 14 days or less were compared, using propensity analysis, to the outcomes of 3,130 patients receiving 10,782 units of blood that had been stored for >14 days (41). The 2,364 patients who received a mix of newer and older blood were excluded from the analysis. The distribution of the number of red cell units transfused per patient was similar in both groups.

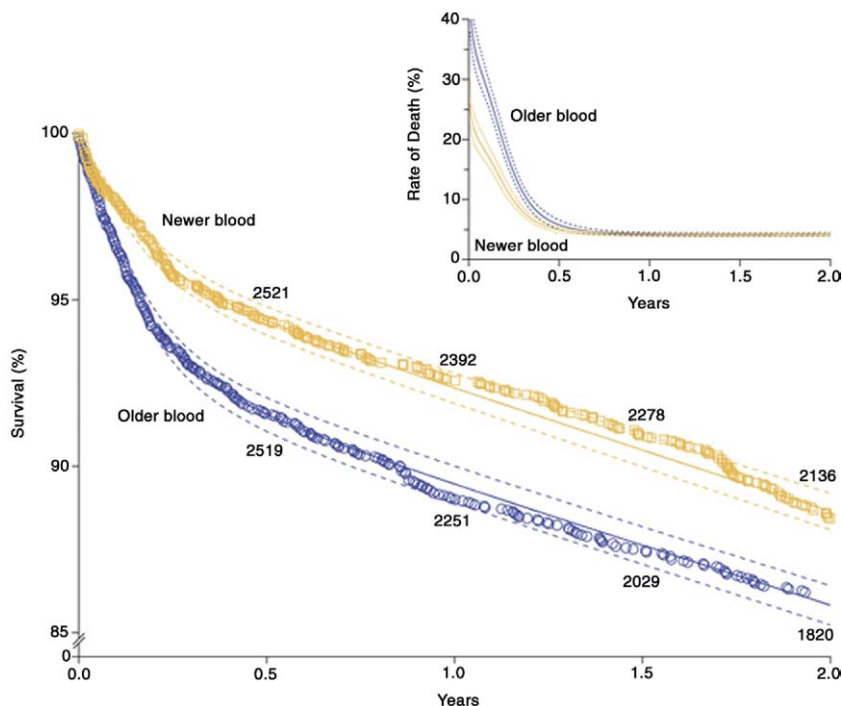


Figure 13 Kaplan-Meier Estimates of Survival and Death After Transfusion of Older or Newer Blood

Patients receiving blood exclusively older than 14 days (**blue circles and lines**) had a higher rate of death during the early post-operative period (**inset**) and experienced significantly poorer survival at 1 and 2 years after cardiac surgery than did patients who received exclusively blood that was <14 days old (**yellow circles and lines**). **Solid lines** represent estimated survival or the rate of death. **Dashed lines** represent 95% confidence intervals. The **numbers above and below the circles on the main graph** refer to the patients at risk. Reprinted with permission from Koch et al. (41).

Patients given older blood had higher in-hospital mortality (2.8% vs. 1.7%, $p = 0.004$), and higher incidences of respiratory failure (9.7% vs. 5.6%, $p < 0.001$), renal failure (2.7% vs. 1.6%, $p = 0.003$), and sepsis (4.0% vs. 2.8%, $p = 0.01$). Midterm survival was significantly lower for patients given older blood (Fig. 13).

COMMENT. The major finding of this study was that transfusion of red cells stored for >2 weeks increased the relative risk of post-operative death by 30%, as well as the risk of major perioperative morbidity. Although it may be impractical to classify blood as outdated earlier than current recommendations, this study certainly suggests the need for further investigation as well as possible alterations in blood-banking procedure and policy to limit potential harm to patients from the use of older blood.

Risk of anemia in cardiac surgery. The outcomes of 774 patients with mild to moderate anemia (defined as hemoglobin between 9.5 and 12.5 g/dl) who underwent elective cardiac surgery during 2004 at 7 institutions were compared with those of 2,512 patients without anemia who underwent cardiac surgery during the same period (42). Propensity matched outcomes analysis was applied to 515 pairs. The risk-adjusted OR obtained by propensity score matching for the composite outcome of in-hospital death, stroke, or acute renal failure in patients with anemia was 1.8 (95% CI: 1.2 to

2.7, $p = 0.005$) when compared with patients without pre-operative anemia.

COMMENT. In this analysis, even after adjusting for comorbidities and intraoperative blood transfusion, anemia (which had a prevalence of $>25\%$ in elective cardiac surgical patients in this cohort), appeared to be an independent risk factor for major adverse post-operative outcomes. Because of the retrospective nature of the study, and because neither the cause nor the duration of pre-operative anemia was described, it is impossible to determine whether anemia was a marker for severity of underlying and occult disease rather than a direct cause of adverse outcome. There were no follow-up data beyond the initial hospitalization.

Aprotinin in cardiac surgery. The post-operative outcomes of 1,343 patients undergoing CABG with or without concomitant valve surgery between 1996 and 2005, and who received aprotinin, were compared with those of 6,776 patients who received aminocaproic acid and 2,029 patients who received no antifibrinolytic therapy (43). The mortality rate in the aprotinin group was 6.4%, compared with 2.4% in the aminocaproic acid group, and 2.2% for the group receiving no antifibrinolytic agent; after risk adjustment, the hazard ratio for death of patients treated with aprotinin compared with patients receiving no antifibrinolytic therapy or patients receiving aminocaproic acid was found to be 1.32

(95% CI: 1.12 to 1.55, $p = 0.003$) and 1.27 (95% CI: 1.10 to 1.46, $p = 0.004$), respectively. Aprotinin use was also associated with a larger risk-adjusted increase in serum creatinine ($p < 0.0001$).

Another retrospective database study published simultaneously reported a relative risk of in-hospital death of 1.32 (95% CI: 1.08 to 1.63) in a propensity score matched analysis of 33,517 patients receiving aprotinin during CABG compared with 44,682 who did not (44).

The BART (Blood Conservation Using Antifibrinolytics Trial) investigators subsequently published the results of their prospective randomized trial of aprotinin and lysine analogues in cardiac surgery, with similar findings (45). Massive bleeding was less common in the aprotinin group, but at the expense of increased mortality, as the relative risk of death compared with patients receiving lysine analogues was 1.53 (95% CI: 1.06 to 2.22). The study was terminated before completion by the Data Safety Monitoring Committee, on the basis of their interim data analysis of 2,163 patients.

COMMENT. Bayer suspended marketing of aprotinin after the decision by the BART investigators to suspend their trial, and the Food and Drug Administration issued a drug recall. A surgical editorial suggested that surgeons were partly responsible for the demise of aprotinin because of uncontrolled use and overwhelming bias toward its benefit (46).

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REFERENCES

- Magne J, Senechal M, Mathieu P, Dumesnil JG, Dagenais F, Pibarot P. Restrictive annuloplasty for ischemic mitral regurgitation may induce functional mitral stenosis. *J Am Coll Cardiol* 2008;51:1692-701.
- Braun J, van de Veire NR, Klautz RJ, et al. Restrictive mitral annuloplasty cures ischemic mitral regurgitation and heart failure. *Ann Thorac Surg* 2008;85:430-6, discussion 436-7.
- Russo A, Grigioni F, Avierinos JF, et al. Thromboembolic complications after surgical correction of mitral regurgitation incidence, predictors, and clinical implications. *J Am Coll Cardiol* 2008;51:1203-11.
- Dion RA. Thromboembolic complications after surgical correction of mitral regurgitation finding a balance. *J Am Coll Cardiol* 2008;51:1212-3.
- Suri RM, Schaff HV, Dearani JA, et al. Determinants of early decline in ejection fraction after surgical correction of mitral regurgitation. *J Thorac Cardiovasc Surg* 2008;136:442-7.
- Flameng W, Meuris B, Herijgers P, Herregods MC. Durability of mitral valve repair in Barlow disease versus fibroelastic deficiency. *J Thorac Cardiovasc Surg* 2008;135:274-82.
- Adams DH, Anyanwu AC. The cardiologist's role in increasing the rate of mitral valve repair in degenerative disease. *Curr Opin Cardiol* 2008;23:105-10.
- Adams DH, Anyanwu AC. Seeking a higher standard for degenerative mitral valve repair: begin with etiology. *J Thorac Cardiovasc Surg* 2008;136:551-6.
- Levy F, Laurent M, Monin JL, et al. Aortic valve replacement for low-flow/low-gradient aortic stenosis operative risk stratification and long-term outcome: a European multicenter study. *J Am Coll Cardiol* 2008;51:1466-72.
- Dewey TM, Brown DL, Das TS, et al. High-risk patients referred for transcatheter aortic valve implantation: management and outcomes. *Ann Thorac Surg* 2008;86:1450-6, discussion 1456-7.
- Grube E, Buellesfeld L, Mueller R, et al. Progress and current status of percutaneous aortic valve replacement: results of three device generations of the CoreValve revalving system. *Circ Cardiovasc Intervent* 2008;1:167-75.
- Svensson LG, Dewey T, Kapadia S, et al. United States feasibility study of transcatheter insertion of a stented aortic valve by the left ventricular apex. *Ann Thorac Surg* 2008;86:46-54, discussion 54-5.
- Walther T, Falk V, Kempfert J, et al. Transapical minimally invasive aortic valve implantation; the initial 50 patients. *Eur J Cardiothorac Surg* 2008;33:983-8.
- Pettersson GB, Crucean AC, Savage R, et al. Toward predictable repair of regurgitant aortic valves: a systematic morphology-directed approach to bicommissural repair. *J Am Coll Cardiol* 2008;52:40-9.
- Borer JS, Girardi LN. Repair of the congenitally bicuspid regurgitant aortic valve: a strategic advance. *J Am Coll Cardiol* 2008;52:50-1.
- Buszman PE, Kiesz SR, Bochenek A, et al. Acute and late outcomes of unprotected left main stenting in comparison with surgical revascularization. *J Am Coll Cardiol* 2008;51:538-45.
- Seung KB, Park DW, Kim YH, et al. Stents versus coronary-artery bypass grafting for left main coronary artery disease. *N Engl J Med* 2008;358:1781-92.
- Taggart DP, Kaul S, Boden WE, et al. Revascularization for unprotected left main stem coronary artery stenosis stenting or surgery. *J Am Coll Cardiol* 2008;51:885-92.
- Shemin RJ. Coronary artery bypass grafting versus stenting for unprotected left main coronary artery disease: where lies the body of proof? *Circulation* 2008;118:2326-9.
- Hannan EL, Wu C, Walford G, et al. Drug-eluting stents vs. coronary-artery bypass grafting in multivessel coronary disease. *N Engl J Med* 2008;358:331-41.
- Carrozza JP Jr. Drug-eluting stents—pushing the envelope beyond the labels? *N Engl J Med* 2008;358:405-7.
- Goy JJ, Kaufmann U, Hurni M, et al. 10-year follow-up of a prospective randomized trial comparing bare-metal stenting with internal mammary artery grafting for proximal, isolated de novo left anterior coronary artery stenosis: the SIMA (Stenting Versus Internal Mammary Artery Grafting) trial. *J Am Coll Cardiol* 2008;52:815-7.
- Shah SJ, Waters DD, Barter P, et al. Intensive lipid-lowering with atorvastatin for secondary prevention in patients after coronary artery bypass surgery. *J Am Coll Cardiol* 2008;51:1938-43.
- Wee CC, Girotra S, Weinstein AR, Mittleman MA, Mukamal KJ. The relationship between obesity and atherosclerotic progression and prognosis among patients with coronary artery bypass grafts the effect of aggressive statin therapy. *J Am Coll Cardiol* 2008;52:620-5.
- Halkos ME, Puskas JD, Lattouf OM, et al. Elevated preoperative hemoglobin A1c level is predictive of adverse events after coronary artery bypass surgery. *J Thorac Cardiovasc Surg* 2008;136:631-40.
- Magee MJ, Alexander JH, Hafley G, et al. Coronary artery bypass graft failure after on-pump and off-pump coronary artery bypass: findings from PREVENT IV. *Ann Thorac Surg* 2008;85:494-9, discussion 499-500.
- Hernandez AF, Shea AM, Milano CA, et al. Long-term outcomes and costs of ventricular assist devices among Medicare beneficiaries. *JAMA* 2008;300:2398-406.
- John R, Kamdar F, Liao K, Colvin-Adams M, Boyle A, Joyce L. Improved survival and decreasing incidence of adverse events with the HeartMate II left ventricular assist device as bridge-to-transplant therapy. *Ann Thorac Surg* 2008;86:1227-34, discussion 1234-5.
- Long JW, Healy AH, Rasmusson BY, et al. Improving outcomes with long-term "destination" therapy using left ventricular assist devices. *J Thorac Cardiovasc Surg* 2008;135:1353-60, discussion 1360-1.
- Menasche P, Alfieri O, Janssens S, et al. The Myoblast Autologous Grafting in Ischemic Cardiomyopathy (MAGIC) trial: first randomized placebo-controlled study of myoblast transplantation. *Circulation* 2008;117:1189-200.
- Mehta RH, Grab JD, O'Brien SM, et al. Clinical characteristics and in-hospital outcomes of patients with cardiogenic shock undergoing coronary artery bypass surgery: insights from The Society of Thoracic Surgeons National Cardiac Database. *Circulation* 2008;117:876-85.

32. Goland S, Czer LS, Kass RM, et al. Use of cardiac allografts with mild and moderate left ventricular hypertrophy can be safely used in heart transplantation to expand the donor pool. *J Am Coll Cardiol* 2008; 51:1214–20.
33. Brieke A, Krishnamani R, Rocha MJ, et al. Influence of donor cocaine use on outcome after cardiac transplantation: analysis of the United Network for Organ Sharing Thoracic Registry. *J Heart Lung Transplant* 2008;27:1350–2.
34. Makaroun MS, Dillavou ED, Wheatley GH, Cambria RP. Five-year results of endovascular treatment with the Gore TAG device compared with open repair of thoracic aortic aneurysms. *J Vasc Surg* 2008;47:912–8.
35. Greenberg RK, Lu Q, Roselli EE, et al. Contemporary analysis of descending thoracic and thoracoabdominal aneurysm repair: a comparison of endovascular and open techniques. *Circulation* 2008;118: 808–17.
36. Melo J, Santiago T, Aguiar C, et al. Surgery for atrial fibrillation in patients with mitral valve disease: results at five years from the International Registry of Atrial Fibrillation Surgery. *J Thorac Cardiovasc Surg* 2008;135:863–9.
37. Mariscalco G, Klersy C, Zanobini M, et al. Atrial fibrillation after isolated coronary surgery affects late survival. *Circulation* 2008;118: 1612–8.
38. Kanderian AS, Gillinov AM, Pettersson GB, Blackstone E, Klein AL. Success of surgical left atrial appendage closure: assessment by trans-esophageal echocardiography. *J Am Coll Cardiol* 2008;52:924–9.
39. Salzberg SP, Gillinov AM, Anyanwu A, Castillo J, Filsoufi F, Adams DH. Surgical left atrial appendage occlusion: evaluation of a novel device with magnetic resonance imaging. *Eur J Cardiothorac Surg* 2008;34:766–70.
40. Chitwood WR Jr, Rodriguez E, Chu MW, et al. Robotic mitral valve repairs in 300 patients: a single-center experience. *J Thorac Cardiovasc Surg* 2008;136:436–41.
41. Koch CG, Li L, Sessler DI, et al. Duration of red-cell storage and complications after cardiac surgery. *N Engl J Med* 2008;358:1229–39.
42. Karkouti K, Wijeyesundera DN, Beattie WS. Risk associated with preoperative anemia in cardiac surgery: a multicenter cohort study. *Circulation* 2008;117:478–84.
43. Shaw AD, Stafford-Smith M, White WD, et al. The effect of aprotinin on outcome after coronary-artery bypass grafting. *N Engl J Med* 2008;358:784–93.
44. Schneeweiss S, Seeger JD, Landon J, et al. Aprotinin during coronary-artery bypass grafting and risk of death. *N Engl J Med* 2008;358: 771–83.
45. Fergusson DA, Hebert PC, Mazer CD, et al. A comparison of aprotinin and lysine analogues in high-risk cardiac surgery. *N Engl J Med* 2008;358:2319–31.
46. Sundt TM. The demise of aprotinin: our share of the blame. *J Thorac Cardiovasc Surg* 2008;135:729–31.

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