

# Cardiology

## **Intravascular Ultrasound Results from the Reduced Anticoagulation Vein Graft Study (RAVES)**

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RAVES was a multicenter registry designed to test the safety of sole antiplatelet (ASA and ticlopidine) therapy after Palmaz-Schatz coronary stent implantation followed by high-pressure adjunct PTCA in 200 pts with vein graft lesions. Intravascular ultrasound (IVUS) was performed at the completion of the procedure not to guide, but to “document” final results. The adequacy of stent implantation was judged by 3 IVUS parameters: full stent expansion (minimum stent area  $\geq 80\%$  reference lumen area), complete stent-vein graft apposition, and stent symmetry (minimum/maximum stent diameter  $> 0.7$ ).

Results were compared to blinded quantitative coronary angiography [QCA: measurement of reference and minimum lumen diameters (MLD), in mm, and diameter stenosis].

In 38%, stent implantation failed to meet 1 of the 3 criteria, most often a stent area  $< 80\%$  reference lumen area. Importantly, achieving optimal IVUS stent implantation criteria was not associated with reduced subacute stent thrombosis (0% overall!) or improved QCA final MLD. Other IVUS findings included infrequent (9%) stent-edge dissections and a surprisingly large average plaque burden ( $41 \pm 10\%$ ) outside the stented segment.

	IVUS	QCA	$\Delta$	<i>r</i>	<i>p</i>
Reference	$3.67 \pm 0.68$	$3.03 \pm 0.59$	$0.69 \pm 0.49$	0.681	$< 0.0001$
MLD	$3.09 \pm 0.55$	$2.85 \pm 0.51$	$0.30 \pm 0.50$	0.567	$< 0.0001$
Stenosis	$15 \pm 11\%$	$4 \pm 14\%$	$10 \pm 15$	0.369	$< 0.0001$

*Conclusion.* Documentary IVUS after high-pressure stenting in vein graft lesions (1) shows consistently greater lumen dimensions compared with QCA and (2) suggests that achieving “optimal” IVUS parameters may have little effect on subacute thrombosis and final lumen diameters.

## **The Relationship Between Creatine Kinase Elevation after Single Vessel Intervention and Long Term Outcome. Causation or Association?**

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*Background.* Elevation of creatine kinase (CK) after percutaneous coronary intervention (PCI) has been shown to be associated with adverse late outcome. However, it remains controversial whether this relationship is a causation or an association.

*Methods.* In 1997, all consecutive patients who underwent successful elective stent implantation in a single native coronary artery and who were free of stent thrombosis within one month of the procedure were the subject of this analysis. Total CK was systematically determined before the procedure and serially up to 48 hours post-procedure. The MB fractions were measured only in those who had elevated CK (CK  $> 225$  units). Patients were contacted by phone at a follow-up interval of 30–36 months.

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*Results.* A total of 362 patients satisfied the inclusion criteria. Of those, 311 patients (Group I) had no CK rise (CK < 225) post procedure while 51 patients (Group II) had elevated peak post-procedural CK (CK > 225, MB > 4%). Mortality was higher in Group II (7.8% vs 2.6%,  $p = 0.05$ ); however, patients in Group II were older (66.0 yrs vs 62.5 yrs,  $p < 0.05$ ) and had lower ejection fraction (EF) (49% vs 53%,  $p = 0.05$ ). To determine the independent predictors of mortality, we constructed a logistic regression model that included diabetes mellitus, number of diseased coronary arteries, CK elevation, age and EF. The independent predictors are shown in the table below.

### Multivariate Predictors of Mortality

	Regression Coefficient ± Standard Error	<i>p</i> value
Age	0.076 ± 0.035	0.028
Ejection Fraction	-0.049 ± 0.027	0.066

$R^2 = 0.045$ ,  $p = 0.011$ .

*Conclusion.* These data suggest that the relationship between CK elevation and mortality is that of an association rather than a causation. Older age and lower EF seem to be the only independent predictors of mortality.

## Coronary Interventions: Is Being a Woman a Risk Factor?

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Increased awareness to women's health issues has prompted considerable interest in assessing the outcome of coronary artery disease in the female population. Our purpose was to evaluate whether outcome in coronary interventions can be a gender related phenomenon.

*Methods.* We analyzed the results of percutaneous revascularization in 247 consecutive women (374 lesions) and 2113 men (3468 lesions) treated between 1995 and 1998. All patients were treated with antiplatelet therapy. 6 month angiographic follow-up was obtained in 75% of patients.

*Results* (see table). Sub-analysis shows that differences in clinical outcome became insignificant ( $p = NS$ ) when vessel size in the two groups was matched.

	Female	Male		Female	Male
Mean age*	64 ± 10	59 ± 10	Ref diam, mm*	2.8 ± 0.5	2.9 ± 0.6
EF, %	62 ± 11	61 ± 11	Pr MLD, mm*	0.7 ± 0.5	0.8 ± 0.6
Unst ang, %*	38	28	Fin MLD, mm*	2.7 ± 0.8	2.8 ± 0.8
Asymp. pt, %*	11.7	17.9	B/A ratio	1.2 ± 0.2	1.2 ± 0.2
Hyperten, %*	61.5	49.3	Pro success%*	94.8	98.3
Elev. cholest, %	64.3	58.6	Fin CSA, mm*	7.7 ± 2.6	9.5 ± 3.3
Diabetes, %*	14.9	8.3	St thromb, %*	2.0	0.8
Smoker,*	34.4	60.5	TLR, %	27.2	27.7
MVD, %*	53.3	63.7	Restenosis, %	37.2	34.6
Compl. les, %	66.2	63.3	MACE, %, Hospital*	3.6	0.9
Ost and prox location, %*	56.7	48.6	1 month*	4.8	1.3
Les leng, mm	12.7 ± 9	13 ± 8	6 month*	9.8	4.7

\* $p < 0.05$ ; MLD minimal lumen diameter; MIP maximal inflation pressure; MVD multivessel disease; TLR target lesion revascularization; 6 month MACE = post procedure MI, CABG, death.

*Conclusion.* Female patients have a significantly lower procedural success and higher incidence of acute, intermediate and long-term MACE, most probably because of the differences in clinical and lesion characteristics, with smaller vessel size playing a major role.

## Is There Need for Intravascular Ultrasound after High-Pressure Dilatations of Palmaz-Schatz Stents?

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Use of intravascular ultrasound (IVUS) in conjunction with angiographic assessment of Palmaz-Schatz stents (PSSs) provided the rationale for routine post-deployment high pressure dilatation (HPD) of PSSs. To address the question of whether routine HPD obviates the need for IVUS, we reviewed IVUS and quantitative angiographic (QCA) data in 91 pts with 96 lesions. HPD was performed in all pts (mean pressure  $16.7 \pm 1.6$  atm; range 14–20 atm) with 1–1.1 balloon; artery ratio. Further improvements were necessary in 45/96 vessels after post-HPD IVUS secondary to suboptimal stent geometry (32), protruding tissue (5), and dissection/additional stenoses (8). 8 vessels required additional PSSs and 37 further HPDs (17 with the same and 20 with a larger balloon). IVUS ( $n = 45$ ) and QCA ( $n = 30$ ) were repeated after each HPD.

	Post HPD	Final	<i>p</i> value
QCA MLD (mm)	$2.66 \pm 0.54$	$2.92 \pm 0.50$	0.055
QCA stenosis (%)	$5.95 \pm 8.86$	$-1.82 \pm 9.98$	0.0007
IVUS MLD (mm)	$2.81 \pm 0.41$	$3.10 \pm 0.39$	0.001
IVUS stenosis (%)	$19.6 \pm 9.2$	$9.85 \pm 12.2$	0.0002
CSA (mm <sup>2</sup> )	$7.5 \pm 1.89$	$8.97 \pm 2.03$	0.001
Symmetry	$0.88 \pm 0.07$	$0.90 \pm 0.062$	0.21

*Conclusions.* In nearly half of PSSs, IVUS following HPD identified suboptimal results which were improved with further intervention. A prospective randomized trial will be necessary to verify if this strategy alters clinical outcome.

## Coronary Flow Reserve in Angiographically Normal Vessels Is Related to Patient Demographics and the Degree of Atherosclerosis

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Atherosclerosis and coronary risk factors impair coronary endothelium-dependent vasodilation. However, the relationship of clinical parameters to adenosine-induced (AD) coronary flow reserve (CFR), a measure of resistance vessel smooth muscle cell function, has not been evaluated. We studied AD-induced (intracoronary 12–24 mg bolus) increases in coronary blood flow with a 0.014 in. doppler Flo-wire (cardiometrics) in a non-diseased, non-infarct related coronary artery (<30% stenosis). A total of 303 patients with coronary disease undergoing coronary intervention of another vessel were evaluated as part of the DESTINI study. CFR was calculated as the ratio of AD-induced APV/basal APV (APV — average peak velocity from the Flo-wire). The CFR of the non-diseased vessel ranged from 1.0 to 6.2 (mean  $2.5 \pm 0.7$ ). By multivariate regression analysis attenuation of the CFR was present in the following conditions: female sex ( $p = 0.002$ ), increasing age ( $p = 0.014$ ), multivessel coronary artery disease ( $p = 0.005$ ),

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and decreased ejection fraction ( $p = 0.001$ , overall  $R = 0.41$  for the model). By multivariate analysis total cholesterol, diabetes, hypertension or cigarette smoking were not independently related to CFR. The CFR in the nondiseased vessel was very closely related to the CFR in the stenosed artery both prior to ( $p < 0.01$ ), and following the coronary intervention ( $p < 0.0001$ ).

*Conclusion.* Coronary flow reserve is related to clinical factors such as female sex, increasing age and severity of coronary disease as well as LV dysfunction in non-diseased coronary arteries. This may have important implications for clinical studies that use the CFR to evaluate success with interventional procedures.

### Aerobic Training Indices Precede Changes in Venous NO<sub>2</sub>-NO<sub>3</sub> Levels

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Animal studies demonstrated rapid adaptation of the NO synthase system following short term exercise training. We examined changes in venous NO<sub>2</sub>-NO<sub>3</sub> and aerobic training indices during short term exercise training in sedentary humans. Maximum oxygen consumption (VO<sub>2</sub> max) during graded treadmill exercise was measured in 16 house staff. Pre- and max-exercise bloods were obtained for NO<sub>2</sub>-NO<sub>3</sub> measurement, following a 24 hr NO<sub>2</sub>-NO<sub>3</sub> free diet. Eight were assigned randomly to control (C) and 8 to training (T), consisting of 4 consecutive days of treadmill exercise for 45 minutes at the respiratory anaerobic threshold. The following day all subjects were retested, after a 24 hr NO<sub>2</sub>-NO<sub>3</sub> free diet. No difference was noted in max HR between groups for either test. VO<sub>2</sub> max increased in T ( $2863 \pm 228$  to  $3013 \pm 250$ , ml/min) and decreased in C ( $3121 \pm 331$  to  $2932 \pm 296$ ) (group by time effect,  $p = .004$ ). VO<sub>2</sub> at a HR of 150 increased significantly in T ( $126 \pm 49$  ml/min,  $p = .036$ ) but not in C ( $104 \pm 106$ ,  $p = .36$ ). Resting and maximum venous blood levels of NO<sub>2</sub>-NO<sub>3</sub>, measured by chemiluminescence, were unchanged in either group. ( $\mu$ M, mean  $\pm$  s.e.m.)

	Test 1, REST	Test 1, MAX	Test 2, REST	Test 2, MAX
Control	$27.4 \pm 9.6$	$29.9 \pm 3.4$	$33.0 \pm 4.4$	$31.9 \pm 3.4$
Exercise	$27.4 \pm 4.9$	$27.6 \pm 5.1$	$21.7 \pm 4.9$	$32.6 \pm 9.7$

These data indicate that modest aerobic training precedes any change in venous NO<sub>2</sub>-NO<sub>3</sub> levels.

### Personnel Exposure during Gamma Endovascular Brachytherapy

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*Purpose.* The use of <sup>192</sup>Ir brachytherapy for the treatment of in-stent restenosis of the coronary arteries has shown promising clinical results. This paper investigates the radiation exposure of catheterization laboratory staff associated with performing gamma endovascular brachytherapy.

*Methods and Materials.* Staff were monitored using personal monitors (shielded from X-rays) during the performance of eleven procedures using nominal 10 GBq <sup>192</sup>Ir sources. Staff positions in the lab were simultaneously tracked by video cameras. Direct measurements were also made using a survey meter. Treatments were administered in a conventional cardiac-catheterization laboratory.

*Results.* The dosimeter readings were analyzed in combination with the radiation survey and time motion survey. Procedural times in the laboratory cardiologist, oncologist, physicist, and support staff were, respectively,  $26 \pm 24$ ,  $401 \pm 132$ ,  $486 \pm 148$ ,  $7 \pm 13$  seconds per case (mean  $\pm$  standard deviation). Readings of the personnel monitors were low and therefore subject to significant uncertainty. The respective doses are estimated to be less than 10, 10, 7, 5  $\mu$ Sv per procedure. Auxiliary shields reduced the dose to support staff, located outside of the catheterization laboratory, to less than 0.5  $\mu$ Sv per procedure.

*Conclusions.* The radiation dose received by laboratory personnel during a representative <sup>192</sup>Ir endocoronary brachytherapy procedure is estimated to be less than 0.1% of the annual radiation worker's maximum permissible dose (1% of the general public's MPD). This level is justifiable provided that the use of <sup>192</sup>Ir benefits patients by producing an improved clinical outcome relative to the use of a less pen-

etrating radionuclide or the application of alternative therapies. Further optimization of the delivery procedure is expected to reduce staff dose.

## Personnel Exposure during Gamma Endovascular Brachytherapy

S. BALTER, M. E. OETGEN, R. LIPSZTEIN, J. F. DALTON, A. SACHER, G. NEW, M. COLLINS, J. W. MOSES

*Purpose.* Recent studies have demonstrated that the use of  $^{192}\text{Ir}$  brachytherapy for the treatment of in-stent restenosis of the coronary arteries appears to be effective. This study investigates the radiation dose received by the staff associated with this therapy.

*Methods and Materials.* Cath lab staff were monitored using specially shielded personal monitors during the performance of eleven brachytherapy cases using nominal 10 GBq  $^{192}\text{Ir}$  sources. Staff positions in the lab were simultaneously tracked by video cameras. Direct measurements were also made with a survey meter. Treatments were administered in an ordinary cardiac catheterization laboratory.

*Results.* The cardiologists elected to spend an average of 36 seconds per procedure at the patient's groin for final precision source adjustment. The oncologist and physicist spent more time in the lab, but at a greater distance from the patient's chest. Staff in-lab times were prolonged due to the research protocol. The doses received by the cardiologist, oncologist, and physicist were less than 10, 10 and 7  $\mu\text{Sv}$  per procedure. The dose received by support staff was less than 5  $\mu\text{Sv}$ . This is reduced to 0.5  $\mu\text{Sv}$  in areas outside the laboratory protected by a therapy shield.

*Conclusions.* Neglecting occupational dose attributable X-ray controlled angioplasty, several hundred procedures per year may be performed before accumulating a significant fraction of the occupational maximum permissible dose (10,000  $\mu\text{Sv}$ ). The doses reported here are acceptable if the use of  $^{192}\text{Ir}$  benefits the patient by producing an improved clinical outcome. Technical improvements in the  $^{192}\text{Ir}$  treatment devices are likely to significantly reduce staff dose.

## Effect of Very Early Radionuclide Myocardial Perfusion Imaging on Hospital Length of Stay of Patients Presenting to the Emergency Room with Chest Pain

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Patients presenting to the emergency room with chest pain who are not clearly having an acute ischemic event are often admitted for observation and testing. In this observational study, we determined the effect of having access to very early myocardial perfusion imaging on the hospital course of patients presenting with chest pain.

*Methods.* Patients presenting to the emergency room for evaluation of chest pain which raised suspicion of coronary disease were followed. Patients with EKG evidence of acute ischemia or infarction, evidence of prior Q wave MI, or an elevation of CPK-MB #1 were not included in the study. Myocardial perfusion imaging (either with exercise or dipyridamole infusion) was performed at the request of the patient's cardiologist and when the laboratory was available; the protocol included an initial rest image, with exclusion from stress testing if an abnormality was seen. Two groups were followed: Group 1 ( $n = 45$ ) included patients who had imaging; 3 patients had an abnormal test, and were excluded for further analysis with regard to length of stay. Group 2 ( $n = 23$ ) included patients in whom the imaging study was requested, but could not be done secondary to inability of the laboratory to accommodate the test.

*Results.* There was no significant difference between groups with respect to presenting characteristics or laboratory tests. The mean length of hospital stay of patients in Group 1 ( $13.2 \pm 1.1$  hours) was significantly lower ( $p < .001$ ) than for Group 2 ( $51.8 \pm 6.5$  hours). In Group 2, 16/23 had stress testing prior to discharge; all were negative.

*Conclusion.* Very early stress myocardial perfusion imaging of selected patients presenting to the emergency room with chest pain can have a significant impact on hospital length of stay.

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### Rotational Atherectomy for Intra-Stent Restenosis: Initial Experience

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Optimal treatment for restenosis within stented coronary arteries remains unknown. Recurrence rates as high as 87% have been reported when balloon angioplasty (BA) has been used to treat diffuse intra-stent restenosis (ISR). Plaque ablation might be more effective in treating ISR.

*Methods.* Technical and angiographic data was gathered from 10 centers where rotational atherectomy (RA) is performed for ISR.

*Findings.* In this registry, 50 lesions with ISR in 45 pts were treated with RA. In 86% the lesion was characterized as diffuse (>7 mm). Palmaz-Schatz stents were used in 45 lesions with Gianturco-Roubin used in 3, Wallstent and Wiktor in 1 each. The mean time from stent implantation was 6 months. The mean age was  $62 \pm 11$  years with 79% male, 18% having diabetes, 47% hypertension, 55% elevated cholesterol and 37% smokers. All pts had symptomatic restenosis leading to the index intervention. A mean of 2.3 burrs were used per lesion, with a mean final burr size of  $2.1 \pm 0.3$  mm, giving a burr/artery ratio of 0.72. Adjunctive BA was used in 65% with a final balloon size of  $3.4 \pm 0.4$  mm to  $10 \pm 6$  atmospheres. Intravascular ultrasound was used to direct burr and balloon sizing in 35%. Quantitative coronary angiography revealed a mean lesion length of  $16 \pm 9$  mm, reference lumen diameter of  $2.8 \pm 0.5$  mm, and increase in minimum lumen diameter from  $0.7 \pm 0.4$  to  $2.0 \pm 0.5$  mm after RA and  $2.4 \pm 0.7$  mm final result. All pts had successful procedures. Two pts were treated with additional stents for distal dissections, without clinical sequelae.

*Conclusions.* This initial experience with rotational atherectomy for diffuse intrastent restenosis suggests that the technique is safe and effective in the short term. Whether this will affect long-term clinical outcomes will need to be assessed, as will optimal techniques.

### A Cardiologist Looks at Sleep Apnea

B. BURACK

Sleep apnea was studied in 223 consecutive patients followed 5 years and sub-group of 43 patients followed 10 years. Median age death was 60.8 years compared to average of 78.2 years. No deaths occurred under age 61 years in those treated, whereas 52% of deaths in untreated group were below age 61. Sleep apnea (SA) is the final pathway of periodic breathing and increased airway resistance characteristic of cardiovascular disease (CVD). The combination of CVD and SA is lethal. A mortality rate 2.1 times greater than USA average of CVD was found with majority occurring at night. Clues to adverse effects of apnea occur prior to clinical findings. 64 patients with SA diagnosis underwent resting radionuclide ventriculography (GRV) while awake. Right ventricle (RV) ejection fractions were 43% and left ventricle (LV) ejection fraction 70%. Hypokinesis of wall motion was present in LV in 17% and in RV 50%. There was dilatation of RV in 36% and 17% in LV. Degree of dysfunction was related to body mass and apnea indices. Hypertension and increased risk of stroke occurs in 33% of patients with apnea. Fall in systolic and diastolic pressure was immediate in patients Rx with tracheostomy and in subsequent reports C-PAP Rx. SA tachy-brady arrhythmia leads to unnecessary pacemaker Rx for the brady and/or asystole of the apnea. Dangerous drug Rx or defibrillators for tachycardia recovery period may occur. Little attention has been paid to Rx for increased airway resistance, periodic breathing, and Cheyne Stokes respiration in congestive heart failure (CHF). CHF pathophysiology has similarities to AP. Responsiveness to C-PAP, avoidance of O<sub>2</sub> Rx considered. Early morning and late afternoon hours, peaks in mortality, myocardial infarctions and strokes related to circadian rhythms with hormonal, catecholamine, blood pressure, heart rate, and platelet adhesiveness changes has no organized Rx approach by the USA cardiology community.

## New Tapered Stent Reduces Myointimal Hyperplasia in Atherosclerotic Rabbit

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**Objective.** Intracoronary stents are often implanted in tapered coronary arteries. The objective of the study was to evaluate the long term results of new tapered stent implantation in an atherosclerotic rabbit model.

**Methods.** Five V-Flex stents (Global Therapeutics, Broomfield, CO) and four tapered stents (Contour Medical, Milwaukee, WI) were implanted in distal aortas of rabbit and quantitative angiography and histomorphology were performed at 60 days following stent implantation.

**Results.** QA and morphometry revealed that myointimal hyperplasia was greater in distal portions of V-Flex stents than in proximal segments. In the aortas subjected to tapered stent implantation there was no difference in degree of myointimal hyperplasia between proximal and distal segments of stent; however, there was different myointimal response between distal portions of standard and tapered stents.

	Proximal MLD at 8 weeks (mm)	Distal MLD at 8 weeks (mm)	Proximal intimal thickness (mm)	Distal intimal thickness (mm)
V-Flex	1.81 ± 0.21	0.97 ± 0.18	2.68 ± 0.35	3.51 ± 0.21
Tape red	1.85 ± 0.83	1.79 ± 0.29	2.75 ± 0.61	2.81 ± 0.38
<i>p</i>	0.90	0.002	0.80	0.002

**Conclusion.** Standard stent placement in tapering aortas results in greater degree of myointimal response within the distal portion of the stent and newly designed tapered stents reduce myointimal hyperplasia in distal portion of stented rabbit aortas.

## In-Hospital and 6-Month Follow-Up Costs of Universal vs. Provisional Stenting: Results from the DESTINI Trial

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Coronary stenting (S) has been shown to reduce restenosis compared with conventional PTCA, but overall medical care costs remain higher with S. To determine whether a strategy of *provisional* stenting could reduce costs while providing comparable outcomes, 662 patients referred for percutaneous coronary revascularization were randomized to S ( $n = 332$ ) or initial PTCA followed by S if PTCA failed to achieve a <35% residual stenosis and a coronary flow reserve > 2.0 ( $n = 330$ ). Baseline clinical and angiographic characteristics were well-matched between treatment groups. Initial coronary stent implantation was performed in 93% of the stent group and 52% of the provisional stent group ( $p < 0.001$ ). In-hospital and follow-up costs were assessed prospectively for all U.S. patients ( $n = 305$ ) and are displayed below.

	Stent alone	Provisional stent	$\Delta$	<i>p</i> -value
# balloons	1.9 ± 0.9	1.6 ± 0.7	-0.3	0.01
# stents	1.3 ± 0.8	0.6 ± 0.7	-0.7	<0.001
Cath lab cost	\$6269 ± 1695	\$5748 ± 1586	-\$521	0.04
Initial hosp. cost	\$11,336 ± 3275	\$10,790 ± 3679	-\$595	0.09
6-Month f/u cost	\$1522 ± 5462	\$1106 ± 2713	-\$457	NS
6-Month total	\$12,859 ± 6856	\$11,805 ± 4392	-\$1230	0.08

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*Conclusion.* (1) Compared with universal stenting, a strategy of QCA/Doppler-guided PTCA resulted in substantial reductions in cath lab and initial hospital costs compared with universal stenting (~\$500–\$600). (2) Preliminary data suggest that late clinical outcomes are similar, and these cost savings persist at 6-month follow-up. (3) Complete 6-month cost and outcome data will be available for presentation in 11/98.

### **Pulmonary Artery Catheter Removal: A Pilot Study**

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Over the past few years, many changes have occurred in the perioperative and post-operative management of patients undergoing cardiac surgery to reduce length of stay. Clinical pathways are a tool often utilized to help organize a patient's care to assist in the "fast tracking" process.

In January 1999, a clinical pathway for cardiac surgery patients was developed at LHH. One of the changes in the post-operative management of patients was early ambulation. Current practice in open heart surgery prohibits ambulation of patients with a pulmonary artery (PA) catheter. Past practice entailed removal of the PA catheter by an MD or Physician Assistant, and timing of removal was often affected by the availability of these individuals.

To assist in our goal of earlier ambulation, a decision was made to develop a protocol and education program for RNs to remove PA catheters. A review of the literature revealed that advanced nursing skills improve patient outcomes. The protocol was presented to the Medical Board at LHH and implemented as a pilot project in open heart surgery. An educational program was developed for the nursing staff by the head nurse and clinical nurse specialists. The convenience sample of 147 consisted of all patients who had undergone open heart surgery and met the following inclusion criteria. The patient must not require inotropic or IABP support, have a normal acid-base balance, urine output >50 cc/hr. PAD >5 and <18, SBP >100 and <150 and have a minimum of three sets of hemodynamic profiles consistent with their known left ventricular function. Exclusion criteria included patients with documented tricuspid or pulmonic valve abnormalities, presence of a crack in the catheter or catheter knotting on chest X-ray, permanent or transvenous pacing wires.

Findings from this pilot project indicate that removal of PA catheters by RNs is a safe procedure when using an approved protocol and education program.

### **Postoperative Sternal and Donor Site Infections in the Cardiac Surgery Patient**

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Infection rates for coronary artery bypass patients with sternal and leg incisions range from .084% to 17% (National Nosocomial Infection Surveillance System). As clinical nurse specialists we were interested in determining the incision infection rate in cardiac surgery patients at our institution. The purpose of this study was to monitor all incision infections in the cardiac surgery population for a 3 month period in 1997. Utilizing a tracking form, data was collected on all cardiac surgical patients who developed sternal or leg donor site infections. For this study infection was defined as any wound necessitating specialized wound care or antibiotic treatment.

Of the 328 cardiac surgical cases performed over the 3 month period, 14 (13%) developed wound infections. Our overall infection rate was within the national benchmark. In the past year a new surgical technique for harvesting leg veins has been instituted, and we are currently collecting and analyzing data for comparison.

## Does Age Affect the Predictive Value of the Magnitude of Exercise-Related ST Depression for Thallium Results?

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The incidence of coronary artery disease is higher in an older population, which by Bayesian analysis would be expected to affect the predictive value of exercise parameters. In this study, the SPECT Th-201 scans of 148 men with  $\geq 1$  mm ST depression (horizontal/downsloping) during symptom-limited exercise (treadmill) thallium testing were reviewed to determine how age affects the usefulness of the magnitude of exercise-related ST depression for predicting thallium results. Patients with baseline ST-T changes or a prior abnormal exercise test as a reason for referral were excluded. The group was stratified based on age (above or below 65 years) and the degree of ST depression (1–2 mm vs  $>2$  mm). The incidence of reversible thallium defects (ThPOS) was then determined for each group.

For the entire group, 1–2 mm ST depression and  $>2$  mm ST depression showed the same predictive value for ThPOS. Men  $>65$  years had a significantly higher % ThPOS than men  $<65$  years (69% vs 48%,  $p = .01$ ), and the predictive value of 1–2 mm was significantly higher in men  $>65$  years than men  $<65$  years ( $p = .01$ ). However, within each age group there was no significant difference in predictive value for ThPOS between patients with 1–2 mm ST depression and patients with  $>2$  mm ST depression.

	1–2 mm ST depression	$>2$ mm ST depression	<i>p</i>
Age $<65$	12/63 ThPOS (19%)	7/23 ThPOS (30%)	NS
Age $>65$	14/40 ThPOS (35%)	8/18 ThPOS (44%)	NS

*Conclusion.* In men with an abnormal exercise EKG, increased magnitude of ST depression (1–2 mm vs  $>2$  mm) does not result in significant additional predictive value for thallium results. The increased incidence of ThPOS associated with increased age does not affect the relative predictive value of different magnitudes of ST depression for thallium results.

## Does Age Affect the Predictive Value of the Magnitude of Exercise-Related ST Depression for Thallium Results in Women?

N. L. COPLAN, A. JUNGER, V. ATALLAH, G. W. GLEIM

*Background.* Women are known to have a high incidence of false positive EKG exercise tests. Older women have an increased incidence of coronary disease, which by Bayesian analysis would be expected to affect the predictive value of exercise parameters. In this study, the SPECT Th-201 scans of 144 women with  $\geq 1$  mm ST depression (horizontal/downsloping) during symptom-limited exercise (treadmill) thallium testing were reviewed to determine the usefulness of the magnitude of exercise-related ST depression for predicting thallium results and the effect of age on this parameter.

*Methods.* Patients with baseline ST-T changes or a prior abnormal exercise test as a reason for referral were excluded. The group was stratified based on age (above or below 65 years) and the degree of ST depression (1–2 mm vs  $>2$  mm). The incidence of reversible thallium defects (ThPOS) was then determined for each group.

*Results.* There was no significant difference in the incidence of reversible thallium defects between women with 1–2 mm ST depression and women with  $>2$  mm ST depression (26/103 vs 15/41,  $p = \text{NS}$ ). Despite the higher prevalence of ThPOS in women  $>65$  years compared to women  $<65$  years (40% vs 22%,  $p = 0.06$ ), the magnitude ST depression did not have significantly greater predictive value for ThPOS in either age group.

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	1–2 mm ST depression	>2 mm ST depression	<i>p</i>
Age <65	12/63 ThPOS (19%)	7/23 ThPOS (30%)	NS
Age >65	14/40 ThPOS (35%)	8/18 ThPOS (44%)	NS

*Conclusion.* In women with an abnormal exercise EKG, increased magnitude of ST depression (1–2 mm vs >2 mm) does not result in significant additional predictive value for thallium results. Increased age (<65 years vs >65 years) affects the incidence of ThPOS, but does not result in a significant increase in the predictive value of magnitude ST depression for thallium results.

### The ST/HR Index as a Parameter for Predicting Thallium Results in Patients with an Abnormal Exercise Electrocardiogram

N. L. COPLAN, A. JUNGER, V. ATALLAH, G. W. GLEIM

This study evaluated use of the ST/HR index in patients with an abnormal exercise-related EKG for predicting the presence of a reversible thallium defect (ThPOS) or a normal scan (ThNEG). The SPECT Thallium-201 scans of 144 women and 148 men with  $\geq 1$  mm horizontal/downsloping ST depression during symptom-limited exercise (treadmill) thallium testing were reviewed. Patients with baseline ST abnormalities or a prior exercise test as a reason for referral were not included. ThPOS was present in 41/144 (28%) of women and in 84/148 (57%) of men. ThPOS had a significantly higher age than ThNEG (women:  $65 \pm 1.6$  vs  $60 \pm 1$ ,  $p < .02$ ; men:  $62 \pm 1$  vs  $57.6 \pm 1.4$ ,  $p < .01$ ); there were no other significant differences in risk factors for CAD. There was no difference in magnitude of ST depression between ThPOS and ThNEG in men or women. ThPOS women had a significantly higher ST/HR index than ThNEG women ( $3 \pm .2$  vs  $2.2 \pm .1$ ,  $p < .01$ ); ThPOS men had a significantly higher ST/HR index than ThNEG men ( $3.4 \pm .3$  vs  $2.4 \pm .2$ ,  $p < .01$ ). Using ST/HR index of 1.6 identified 40% of ThNEG women and 27% of ThNEG men correctly, but failed to identify 22% of ThPOS women and 19% of ThPOS men. Using the ST/HR index of 2.6 improved identification of ThNEG, but showed worse results for ThPOS. The receiver operating curve characteristics suggest that the ST/HR index has limited applicability for predicting thallium results in patients with an abnormal exercise EKG.

	Women		Women		Men		Men	
ST/HR	<1.6	>1.6	<2.6	>2.6	<1.6	>1.6	<2.6	>2.6
ThPOS	9	32	17	24	16	68	36	48
ThNEG	41	62	76	27	17	47	43	21

\* $p < 0.05$

### Degree of Depression in Addition to Relative Intensity of Exercise at Onset of ST Depression Does Not Increase Predictability of Abnormal Thallium Results in Men or Women

N. L. COPLAN, I. D. WALLACH, M. ESKENAZI, E. DEPASQUALE, G. W. GLEIM

A prior study showed that patients with onset of ST depression below 85% predicted-maximal heart rate (PMHR) had higher incidence of reversible thallium defects than patients with onset ST depression at a higher relative heart rate. The SPECT thallium exercises tests of 287 patients (150 males/137 females) undergoing symptom-limited exercise were reviewed to determine how the magnitude of exercise-related ST depression in combination with the relative heart rate at onset of ST depression affects the likelihood for reversible thallium abnormalities. Admission criteria included the absence of baseline ST abnormali-