Can Angiographic Complete Revascularization Improve Outcomes for Patients with Decreased LV Function ?

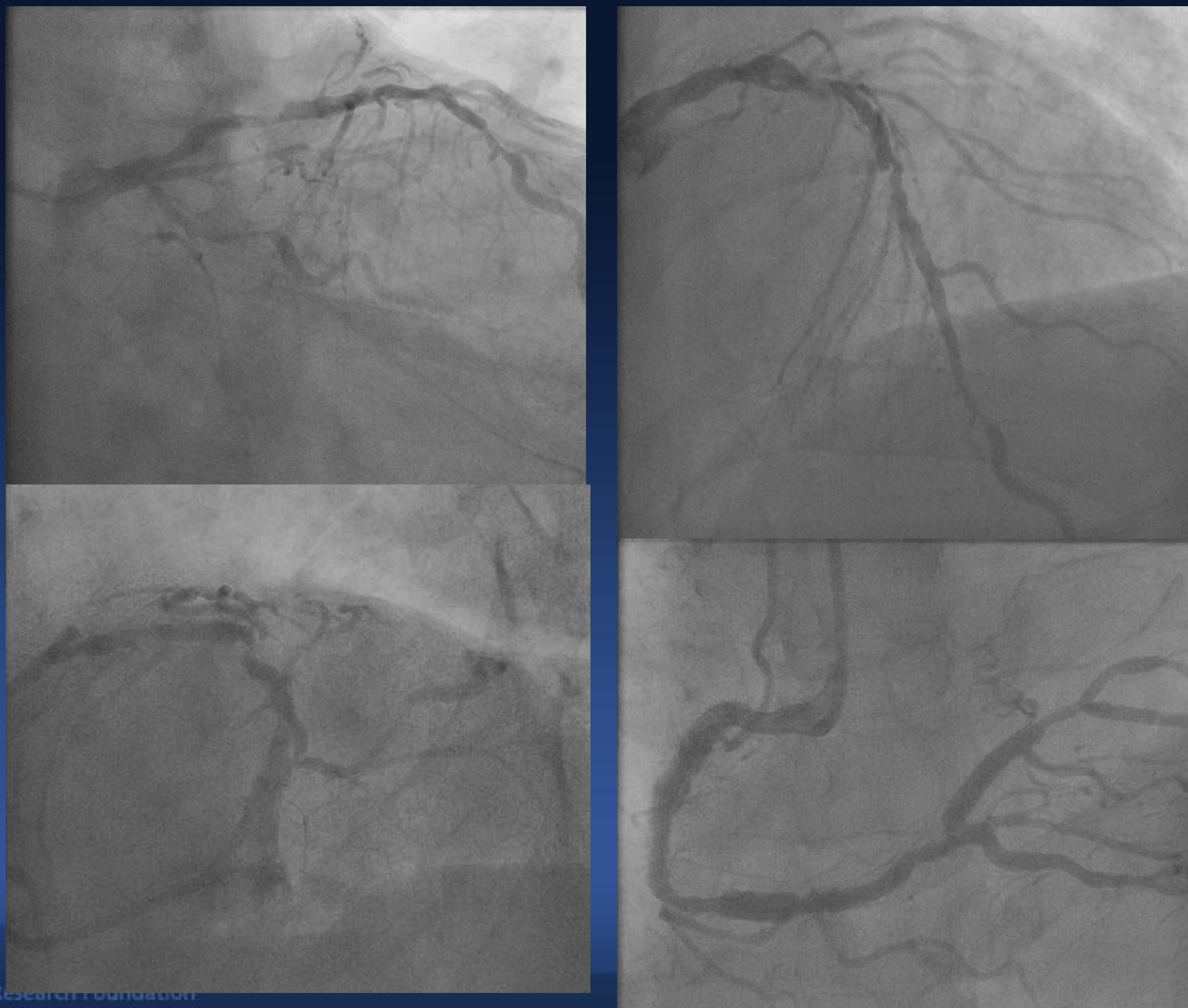
NO !

Young-Hak Kim, MD, PhD

Heart Institute, University of Ulsan College of Medicine
Asan Medical Center, Seoul, Korea

Where should be revascularized ?

M / 68, Stable angina, EF 40%, LAD wall



Relevant Clinical Scenarios
Considering Complete Revascularization (CR)

- Stable CAD
  - Normal LV function
  - Decreased LV function
- Acute Coronary Syndrome
  - Single Culprit Lesion with MVD
  - >1 "Culprit" with/or without other non-culprit MVD
  - No identifiable culprit, MVD (severe progression of untreated stable CAD)
- Shock with true MVD

Today's Question

- Benefit of revascularization for pts. with LV dysfunction
- Impact of angiographic CR for stable patients
- Benefit of ischemia-guided revascularization

Contents

- **Benefit of revascularization for pts. with LV dysfunction**

- Impact of angiographic CR for stable patients

- Benefit of ischemia-guided revascularization

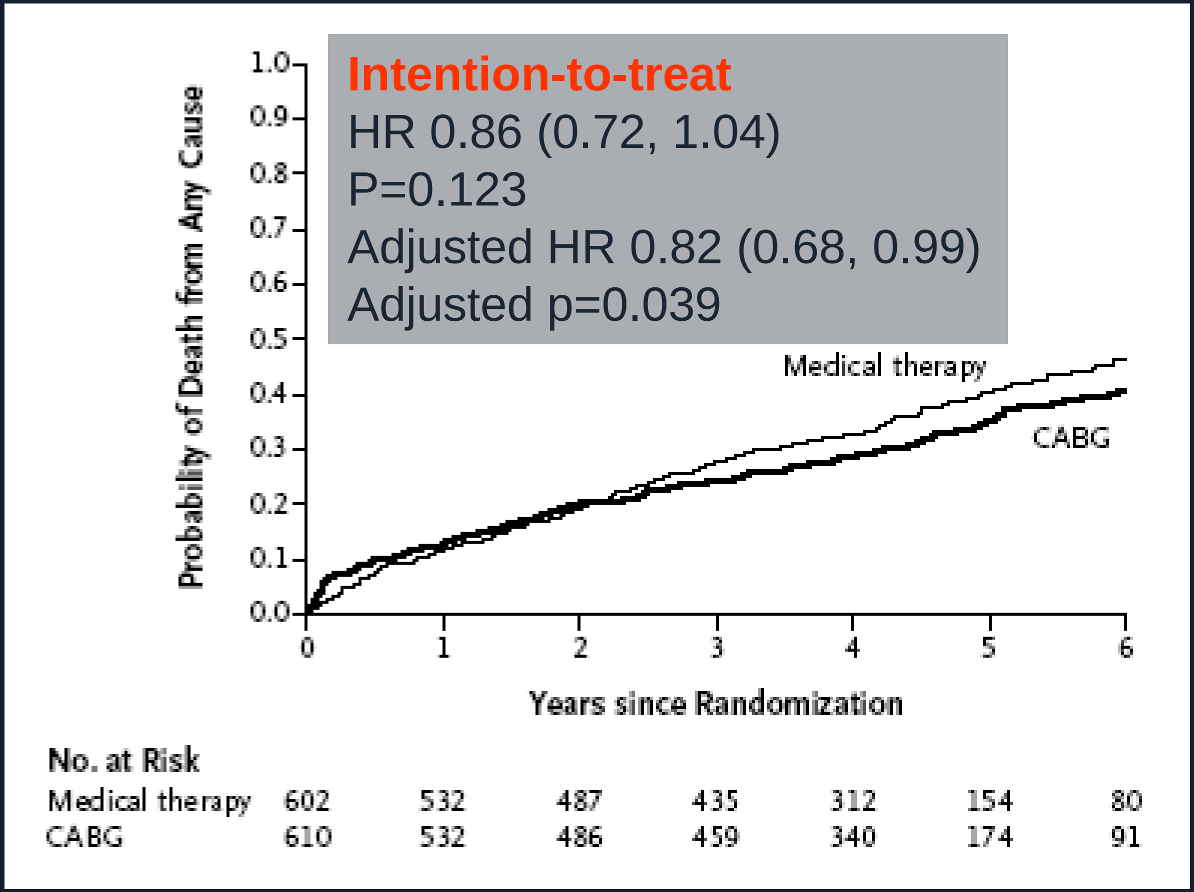
STICH
CABG+OMT vs. OMT for CAD/CHF

Enrollment period		**2002 - 2007**
Inclusion criteria		Stable CAD with HF (<35% LVEF)
Major exclusion		Class > III angina, LM
Mean age, yrs		59
Female		12%
Diabetes		40%
Hypertension		60%
Mean LV EF		28%
Multivessel disease (proximal LAD)		91% (68%)
Current CCS angina class	III, IV	5%
	II	43%
Current NYHA class	III	34%
	IV	3%

Velazquez E et al, NEJM. 2011;364:1607

STICH

Primary End Point: All-Cause Mortality



As treated
HR 0.70 (0.58, 0.84)
P<0.001

Per protocol
HR 0.76 (0.62, 0.92)
P=0.005

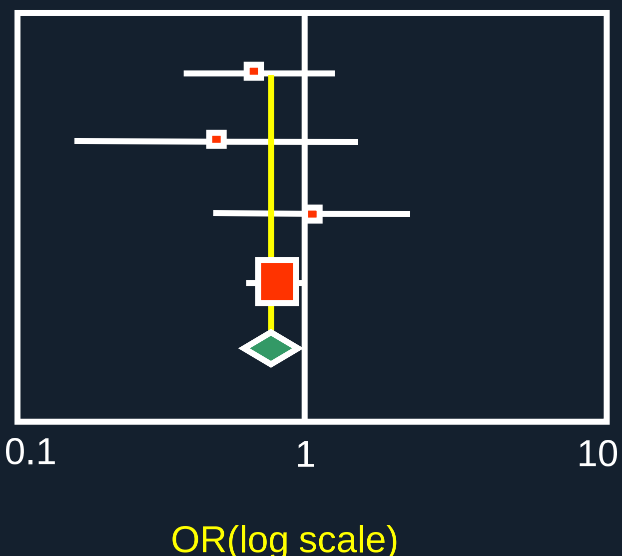
CABG is not superior to OMT for ischemic left ventricular dysfunction

Velazquez E et al, NEJM. 2011;364:1607

Meta-analysis

Impact of Revascularization on Mortality for HF

Study	Weight	OR(95% CI)
VA	14.00%	0.68(0.39-1.18)
CASS (EF 35-50-%)	4.00%	0.51(0.17-1.52)
HEART*(EF<35%)	8.00%	1.06(0.05-2.25)
STICH(EF<35%)	74.00%	0.82(0.64-1.04)
Pooled	100%	0.80(0.65-0.98)



Z=2.13, p=0.03
Hetero P=0.67, 1^2=0%

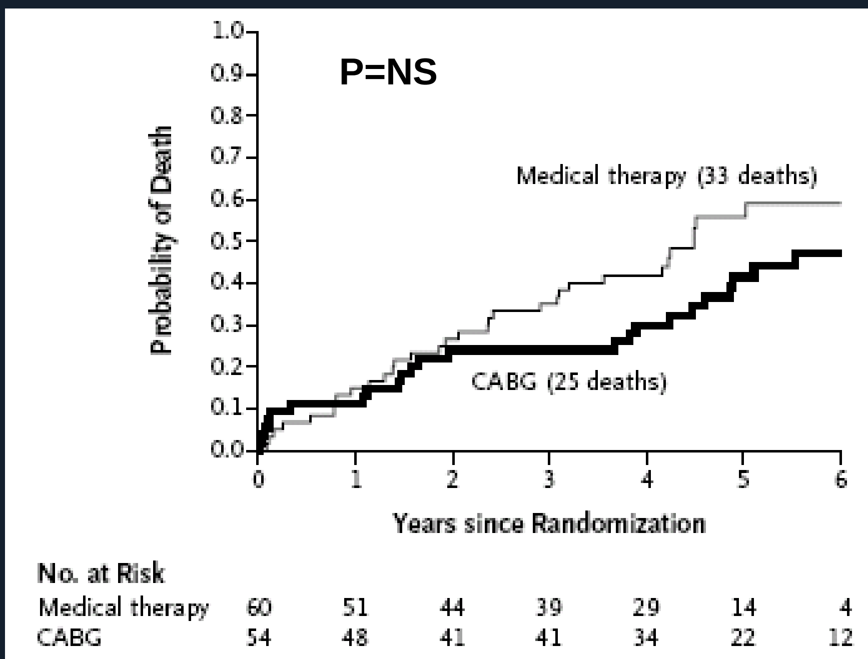
*prematurely terminated

Modest evidence of benefit

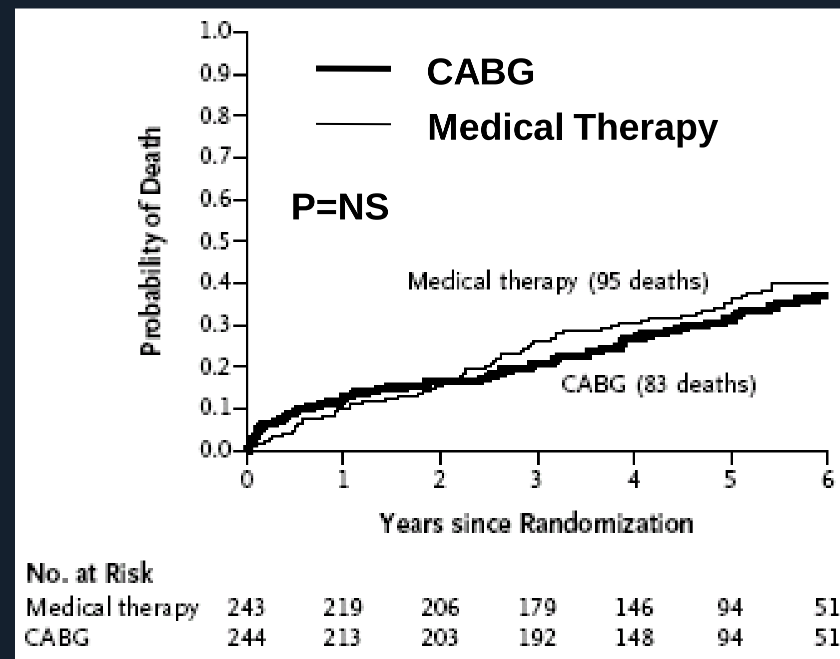
Cleland et al, EHJ. 2011

STITCH
Myocardial Viability and Mortality

Without Myocardial Viability



With Myocardial Viability



Viability assessment does not identify patients with a survival benefit from CABG vs. OMT

Bonow RO et al, NEJM. 2011;364:1617

2011 ACC/AHA/SCAI PCI Guidelines

CAD and LV Dysfunction

	Class I (Benefit >>> risk)	Class II		Class III (Risk / No benefit)
		IIa (benefit >> risk)	IIb (Benefit ≥ risk)	
Level A (Multiple RCTs)				
Level B (Single RCT or non-randomized)		CABG for LVEF = 35-50%	CABG for LVEF < 35% without LM	
Level C (Expert, case studies, or standard care)				

PCI – insufficient data

Levine GN et al, NEJM. 2011;124

2010 ESC/EACTS Revascularization

CAD and LV Dysfunction

	Class I (Benefit >>> risk)	Class II		Class III (Risk / No benefit)
		IIa (benefit >> risk)	IIb (Benefit ≥ risk)	
Level A (Multiple RCTs)				
Level B (Single RCT or non-randomized)	CABG for proximal LAD+2/3 VD	CABG for LVEF=35-50%	CABG for LVEF<35% without LM	No CABG/PCI if no viability
Level C (Expert, case studies, or standard care)			PCI if anatomy suitable and viable myocardium	

Wijns et al, EHJ. 2010;31:2501

Contents

- **Benefit of revascularization for pts. with LV dysfunction**
  - ***Not determined yet, not always beneficial***
- Impact of angiographic CR for stable patients
- Benefit of ischemia-guided revascularization

Contents

- Benefit of revascularization for pts. with LV dysfunction
- **Impact of angiographic CR for stable patients**
- Benefit of ischemia-guided revascularization

Predictors of Mortality in the CASS Registry (CABG Patients)

Predictors of Mortality
CHF Score
LV Wall Motion Score
Number of Assoc Diseases
Age
Number of Prox Vessels Diseased
LVEDP
Unstable Angina
<3 Vessels Bypassed

CR was associated with the greatest improvements in outcome among:

- *Pts with more severe angina*
- *Pts with reduced LV function*

Bell et al, Circulation 1992

NY State PCI Database (2003-2004)
Impact of Incomplete Revascularization

Revascularization was Incomplete in 69%

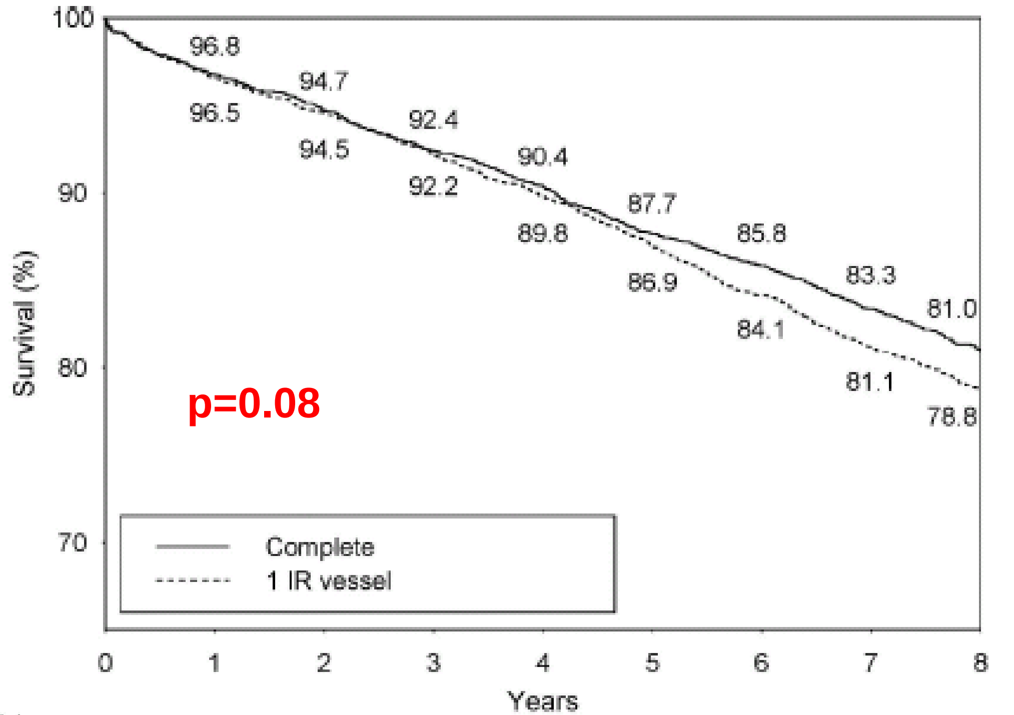
	N	Adjusted HR of IR compared with CR
CR	3499	
IR (All)	7795	1.23 (1.04,1.45)
1 IR with no CTO	3815	1.23 (1.02,1.48)
1 IR vessel is CTO	1725	1.11 (0.87,1.42)
≥2 IR, no CTO	1233	1.18 (0.89,1.56)
≥2 IR, ≥1 CTO	1022	1.44 (1.14,1.82)

Hannan EL et al, *JACC: Cardiovasc Intv 2009*

NY State PCI Database (1999-2000)

Impact of Incomplete Revascularization

Propensity Matching from 13,016 Pts

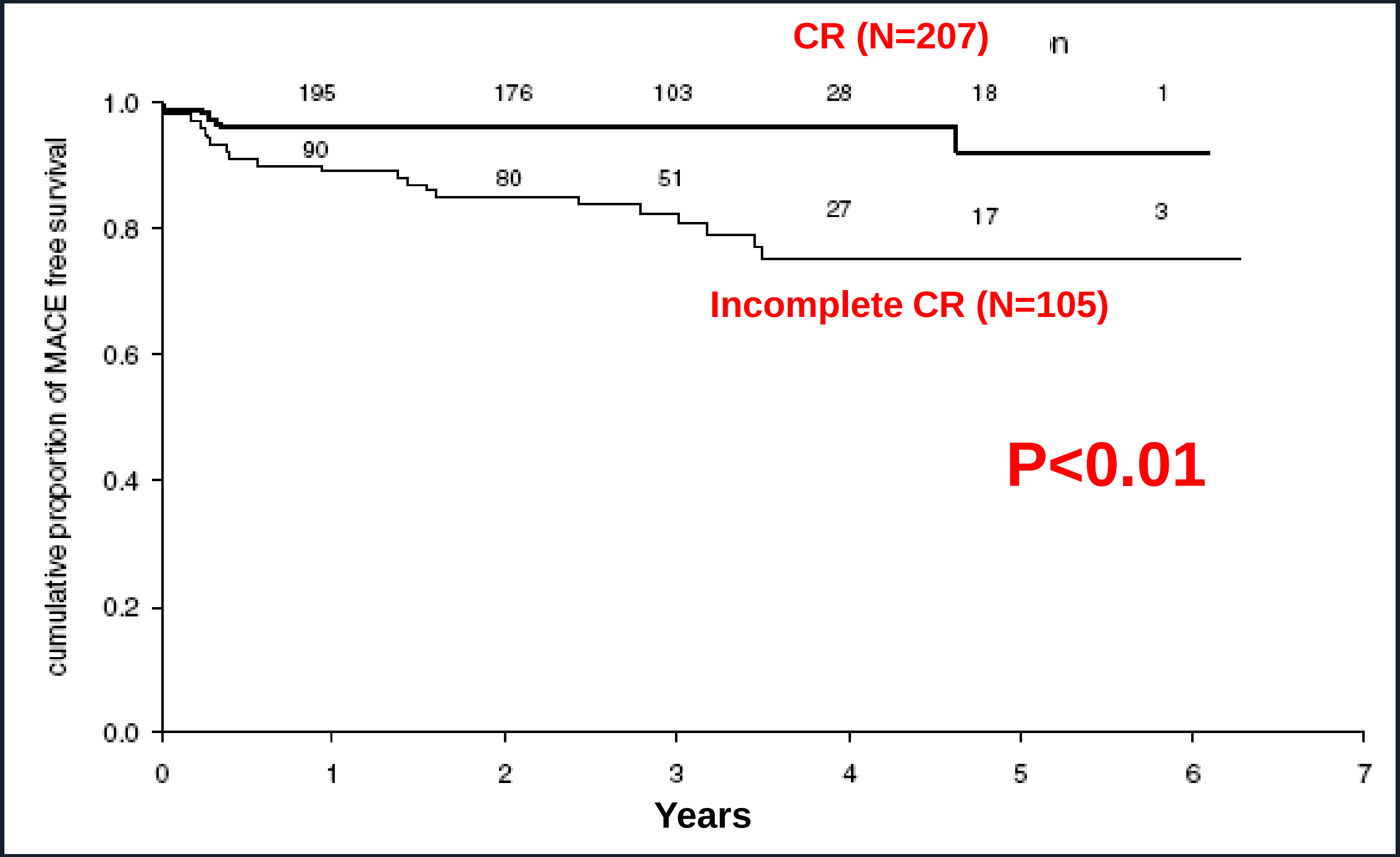


# at Risk	0	1	2	3	4	5	6	7	8
Complete	3,268	3,162	3,096	3,019	2,953	2,865	2,805	2,724	1,296
Incomplete	3,268	3,154	3,090	3,014	2,936	2,841	2,749	2,651	1,248
P-value		0.78	0.99	0.78	0.43	0.40	0.13	0.06	0.08

Wu C et al, *Circ Cardiovasc Interv. 2011;4:413*

Impact of Complete Revascularization after CABG Surgery

Death, UA, MI, Hospitalization, & Repeat revascularization -free Survival



Agostini M et al. J Card Surg 2009;24:650

Debate about this issue of CR
Hardly answer properly because…

- Various definitions about CR
- Different outcomes according to the diverse clinical presentations
- Heterogeneous patient's characteristics
- Mostly observational data, no randomized study

Definitions of CR

- Anatomic:
  - Residual stenosis 50% or 70%
  - Vessel diameter >1.5 mm, >2.5 mm
  - SYNTAX segments

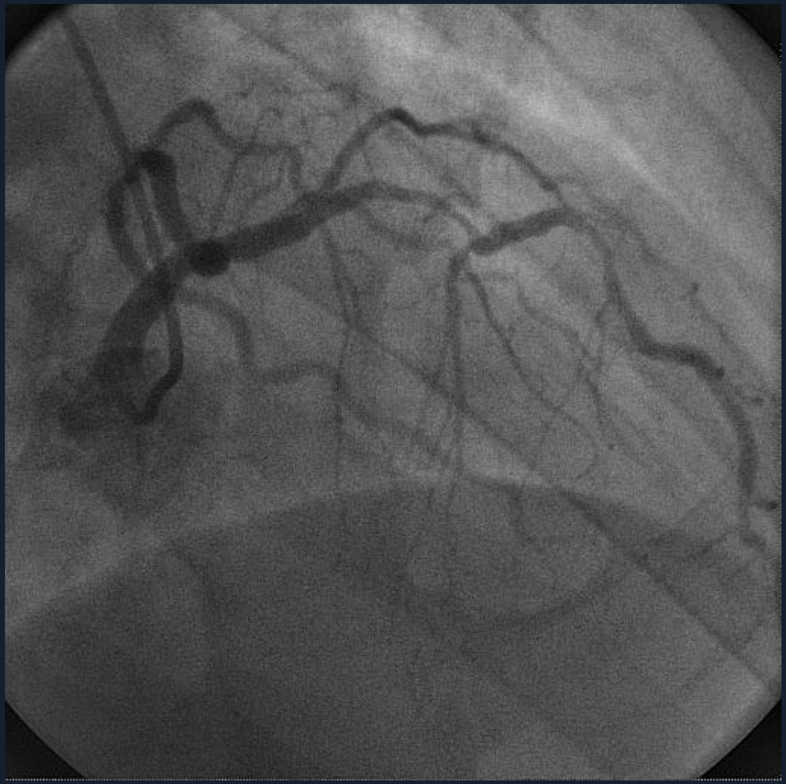
Jeopardy or SYNTAX Score

- Functional / Physiologic
  - Non-invasively assessed viable and ischemic segments
  - FFR <0.75 or <0.8

Extent of Ischemia or Functional SYNTAX Score

Limitation of Observational Data

Lesion Complexity



Limitation of Observational Data

Patient Complexity

Confounders in IR vs. CR Studies

Single-center study of pts undergoing CABG with LIMA-LAD; 3.5 year follow-up

Key Imbalances in Study Groups

	Complete n=7870	Incomplete N=936	p
2VD 3VD	30.9% 69.1%	8.5% 91.5%	<0.001
Emergency Indication	10.2%	6.0%	<0.001
Time on Bypass	83 min	87 min	0.001
Cross-Clamp Time	52 min	56 min	<0.001

Similar Outcomes with Both Strategies

Rastan et al, Circulation. 2009;120[suppl 1]:S70–S77

Impact of Angiographic CR

Interventional Cardiology

Impact of Angiographic Complete Revascularization After Drug-Eluting Stent Implantation or Coronary Artery Bypass Graft Surgery for Multivessel Coronary Artery Disease

Young-Hak Kim, MD, PhD; Duk-Woo Park, MD, PhD; Jong-Young Lee, MD; Won-Jang Kim, MD; Sung-Cheol Yun, PhD; Jung-Min Ahn, MD; Hae Geun Song, MD; Jun-Hyok Oh, MD; Jong Seon Park, MD; Soo-Jin Kang, MD, PhD; Seung-Whan Lee, MD, PhD; Cheol Whan Lee, MD, PhD; Seong-Wook Park, MD, PhD; Seung-Jung Park, MD, PhD

Background—This study sought to evaluate the clinical impact of angiographic complete revascularization (CR) after drug-eluting stent implantation or coronary artery bypass graft surgery for multivessel coronary disease.

Methods and Results—A total of 1914 consecutive patients with multivessel coronary disease undergoing drug-eluting stent implantation (1400 patients) or coronary artery bypass graft surgery (514 patients) were enrolled. Angiographic CR was defined as revascularization in all diseased segments according to the Synergy Between PCI With Taxus and Cardiac Surgery classification. The outcomes of patients undergoing CR were compared with those undergoing incomplete revascularization (IR) after adjustments with the inverse-probability-of-treatment weighting method. Angiographic CR was performed in 917 patients (47.9%) including 573 percutaneous coronary intervention (40.9%) and 344 coronary artery bypass graft (66.9%) patients. CR patients were younger and had more extensive coronary disease than IR patients. Over 5 years, CR patients had comparable incidences of death (8.9% versus 8.9%; adjusted hazard ratio, 1.04; 95% confidence interval, 0.76 to 1.43; P=0.81), the composite of death, myocardial infarction, and stroke (12.1% versus 11.9%; adjusted hazard ratio, 1.04; 95% confidence interval, 0.79 to 1.36; P=0.80), and the composite of death, myocardial infarction, stroke, and repeat revascularization (22.4% versus 24.9%; adjusted hazard ratio, 0.91; 95% confidence interval, 0.75 to 1.10; P=0.32) compared with IR patients. However, 368 patients (19.2%) with multivessel IR had a greater tendency toward higher risk of death, myocardial infarction, stroke, or repeat revascularization (30.3% versus 22.1%; adjusted hazard ratio, 1.27; 95% confidence interval, 0.97 to 1.66; P=0.079) than those without multivessel IR.

Conclusions—Angiographic CR with drug-eluting stent implantation or coronary artery bypass grafting did not improve long-term clinical outcomes in patients with multivessel disease. This finding supports the strategy of ischemia-guided revascularization. (*Circulation*. **2011;123:2373-2381.**)

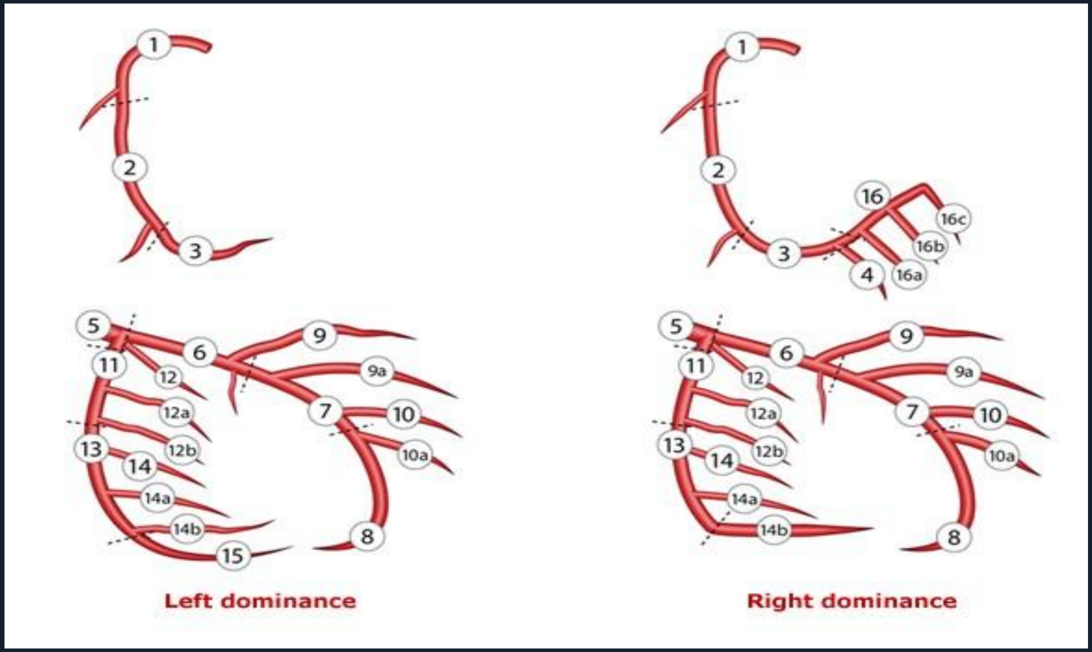
Key Words: bypass surgery ■ coronary disease ■ revascularization ■ stent

Kim YH et al. Circulation. 2011;123:2373

Definitions of CR

1914 pt with MVD in AMC

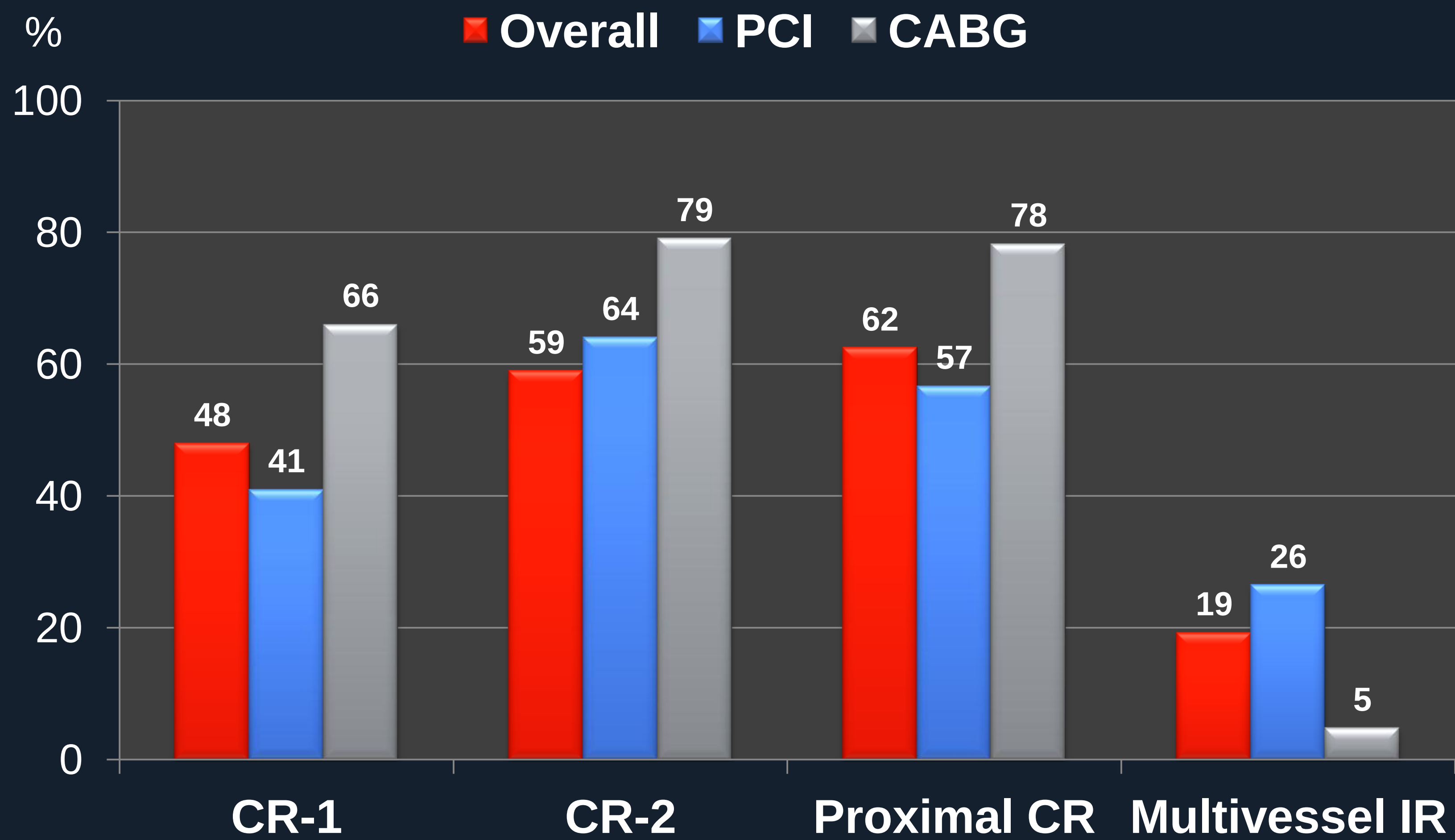
- **Angiographic CR-1**
  - Revascularization of all SYNTAX segment (≥1.5 mm), consisting of RCA (# 1, 2 & 3), PDA (# 4 or 15), PL (# 16), LAD (# 5, 6, 7 & 8), Diag (# 9 or 10), LCX (# 11 &13), OM (# 12 or 14).



Definitions of CR in AMC

- **Angiographic CR-2**
  - Revascularization of all SYNTAX segment (≥ 2.5 mm)
- **Proximal CR**
  - Revascularization of all proximal arterial systems (# 1, 2, 3, 5, 6, 7 & 11)
- **Multivessel IR**
  - IR ≥ 2 diseased vessels
- The LM (# 5) was considered revascularized when the LAD was bypassed in the CABG group or directly treated percutaneously in the PCI group

Prevalence of CR
according to the Definitions



Baseline Characteristics

Variable	PCI CR (N=573)	PCI IR (N=827)	P	CABG CR (N=344)	CABG IR (N=170)	P
Age, years	60.8±10.47	62.7±9.8	<0.001	61.6±8.7	62.2±8.0	0.50
Male	389 (67.9)	586 (70.9)	0.24	253 (73.5)	122 (71.8)	0.67
Diabetes mellitus	172 (30.0)	271 (32.8)	0.28	151 (43.9)	66 (38.8)	0.27
Hypertension	312 (54.5)	486 (58.8)	0.11	211 (61.3)	108 (63.5)	0.63
Current smoker	175 (30.5)	238 (28.8)	0.48	72 (20.9)	34 (20.0)	0.81
Hyperlipidemia	153 (26.7)	189 (22.9)	0.10	164 (47.7)	87 (51.2)	0.46
Prior MI	60 (10.5)	79 (9.6)	0.57	78 (22.7)	47 (27.6)	0.22
Previous CABG	86 (15.0)	159 (19.2)	0.041	57 (16.6)	33 (19.4)	0.43
Previous CHF	7 (1.2)	13 (1.6)	0.59	15 (4.4)	5 (2.9)	0.43

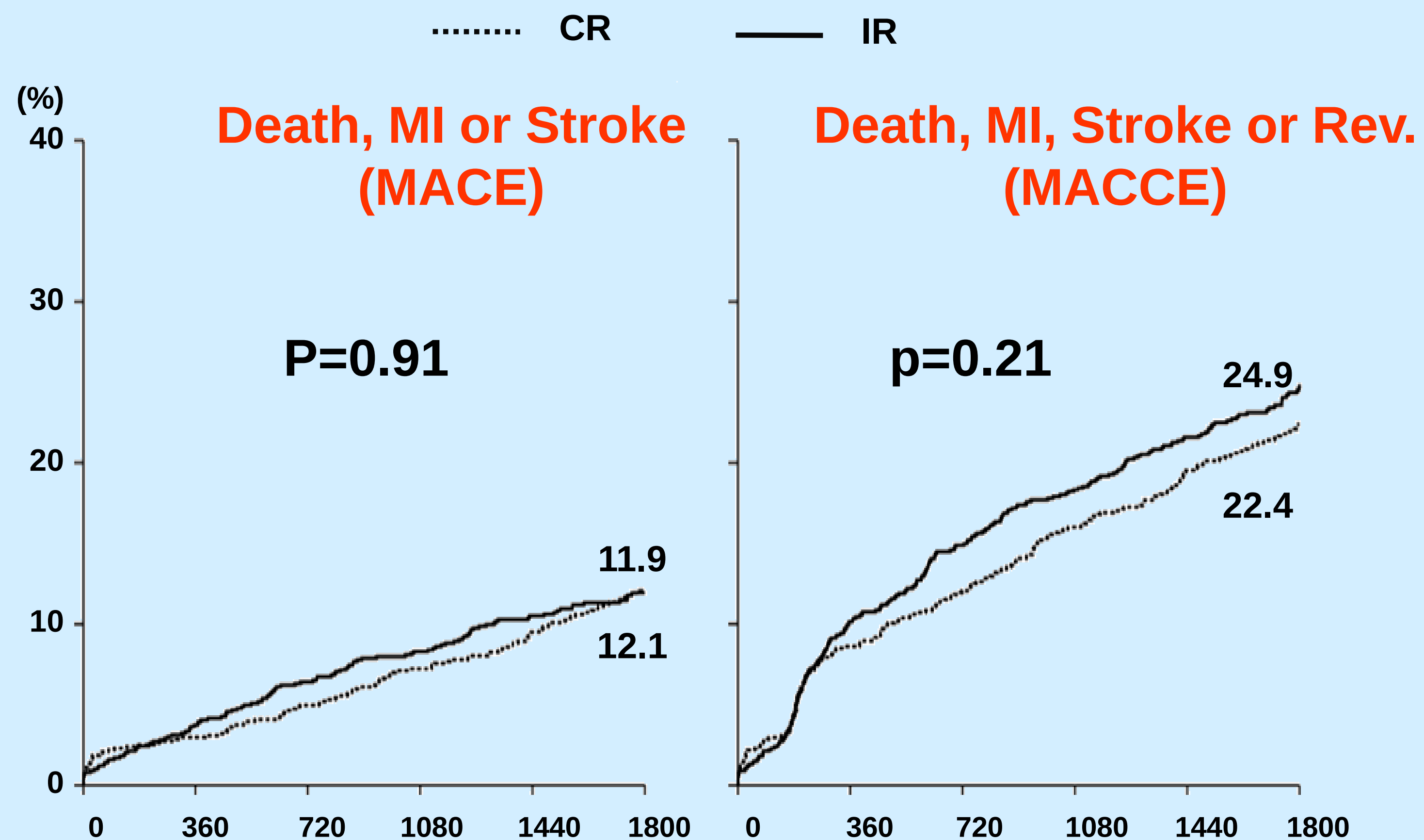
Angiographic Characteristics

Variable	PCI CR (N=573)	PCI IR (N=827)	P	CABG CR (N=344)	CABG IR (N=170)	P
SYNTAX score	15.0±7.1	19.0±7.7	<0.001	29.5±10.5	30.8±10.7	0.20
Angiographic Ds						
LAD	509 (88.8)	770 (93.1)	0.005	340 (98.8)	169 (99.4)	0.53
LCX	294 (51.3)	627 (75.8)	<0.001	270 (78.5)	150 (88.2)	0.007
RCA	332 (57.9)	686 (83.0)	<0.001	290 (84.3)	164 (96.5)	<0.001
LM	104 (18.2)	110 (13.3)	0.013	160 (46.5)	72 (42.4)	0.37
Three-VD	124 (21.6)	446 (53.9)	<0.001	236 (68.6)	143 (84.1)	<0.001
Any CTO	91 (15.9)	202 (24.4)	<0.001	157 (45.6)	79 (46.5)	0.86

Procedures

Variable	PCI CR (N=573)	PCI IR (N=827)	P	CABG CR (N=344)	CABG IR (N=170)	P
CABG procedures						
No. of conduits	–	–	–	3.6±1.0	2.9±1.1	<0.001
No. of a. conduit	–	–	–	1.0±0.1	1.0±0.1	0.58
Internal thoracic a.	–	–	–	266 (77.3)	128 (75.3)	0.61
Off-pump surgery	–	–	–	92 (26.7)	42 (24.7)	0.62
PCI techniques						
No. of total stents	2.5±1.3	2.2±1.2	<0.001	–	–	–
Stents length (mm)	63.6±36.3	55.9±32.3	<0.001	–	–	–
Stent size (mm)	3.2±0.3	3.1±0.3	0.063	–	–	–

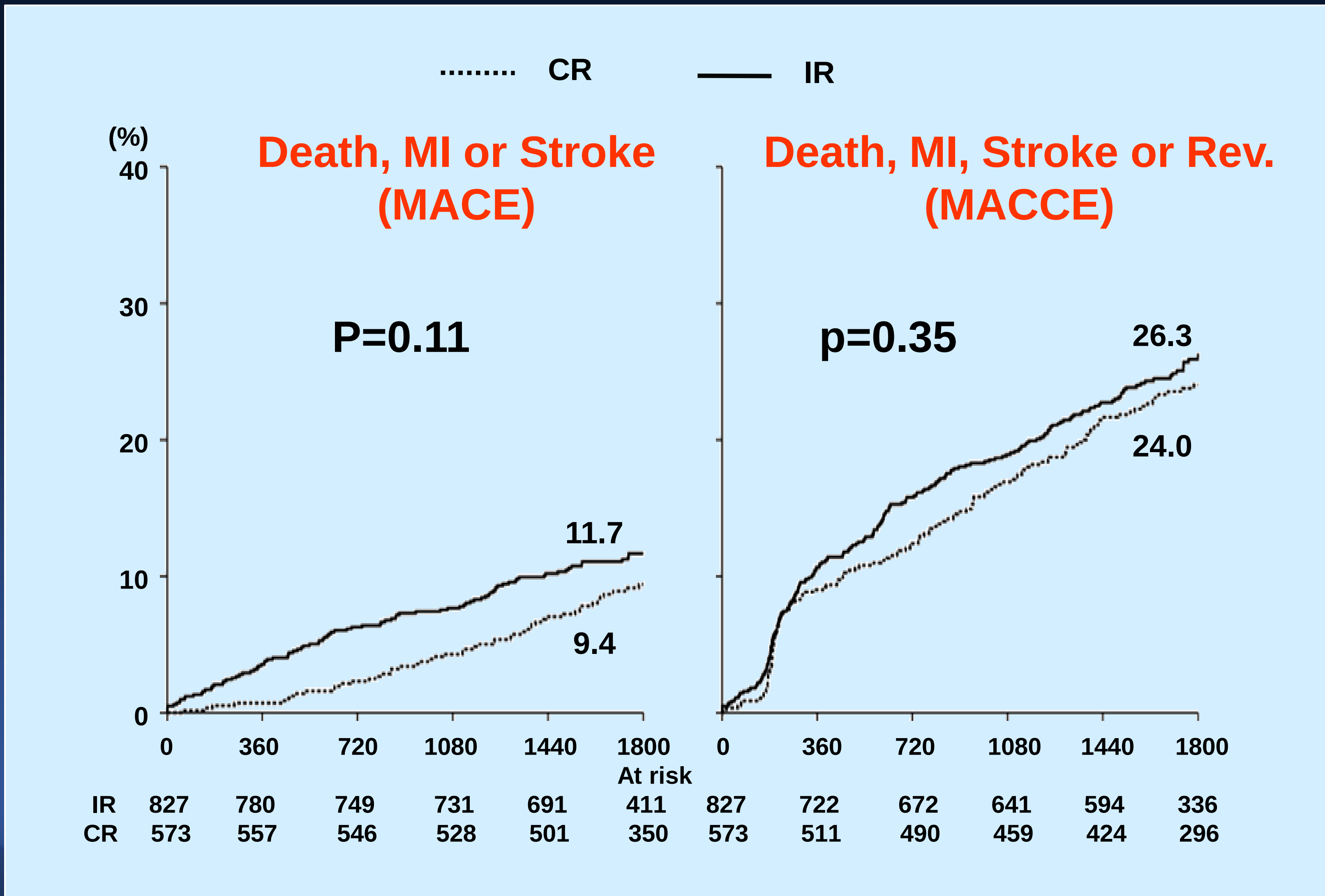
Unadjusted Outcomes in All Pts
By Angiographic CR-1



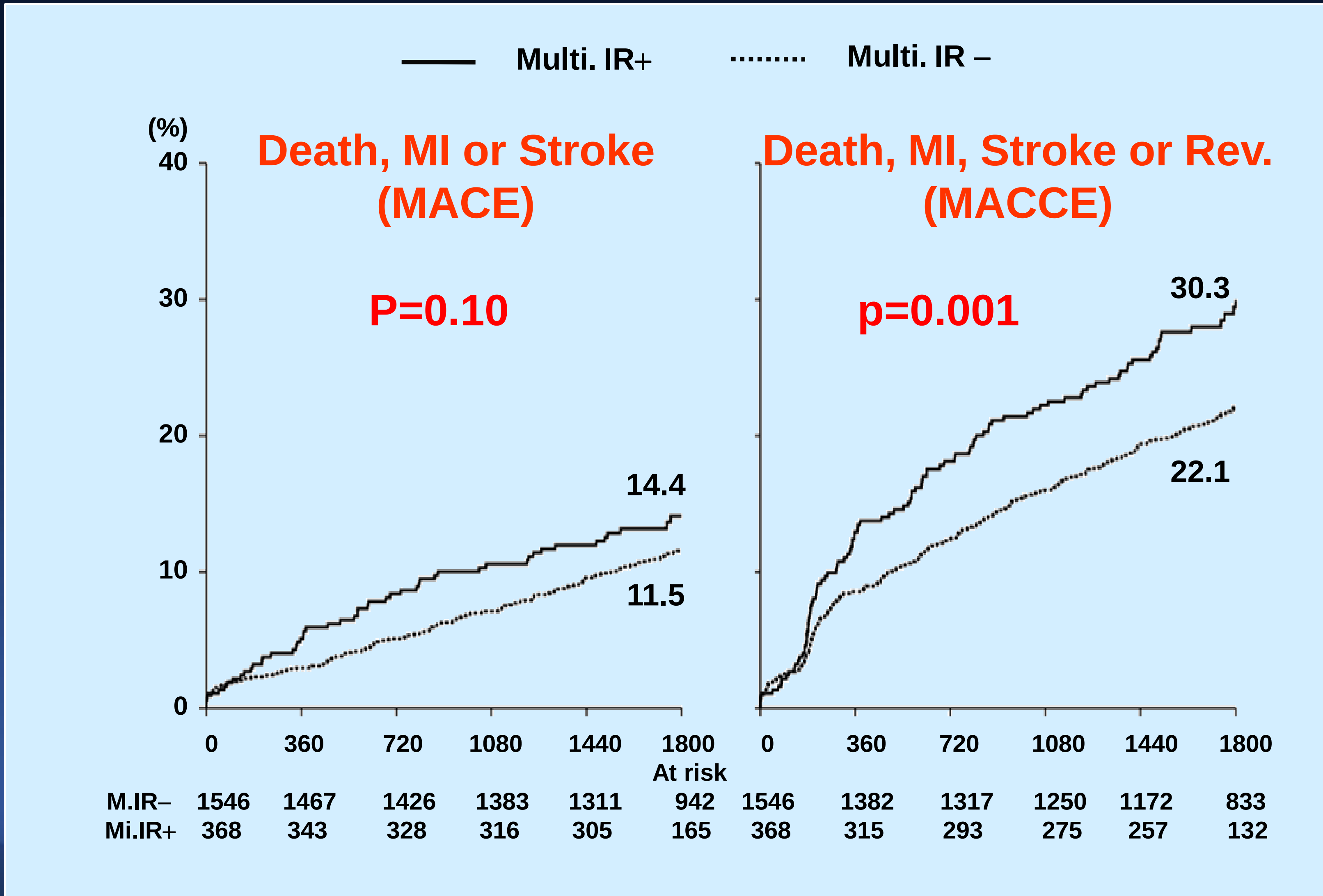
At risk

IR	997	939	904	878	834	526	997	876	821	781	731	444
CR	917	871	850	821	782	581	917	821	787	744	698	520

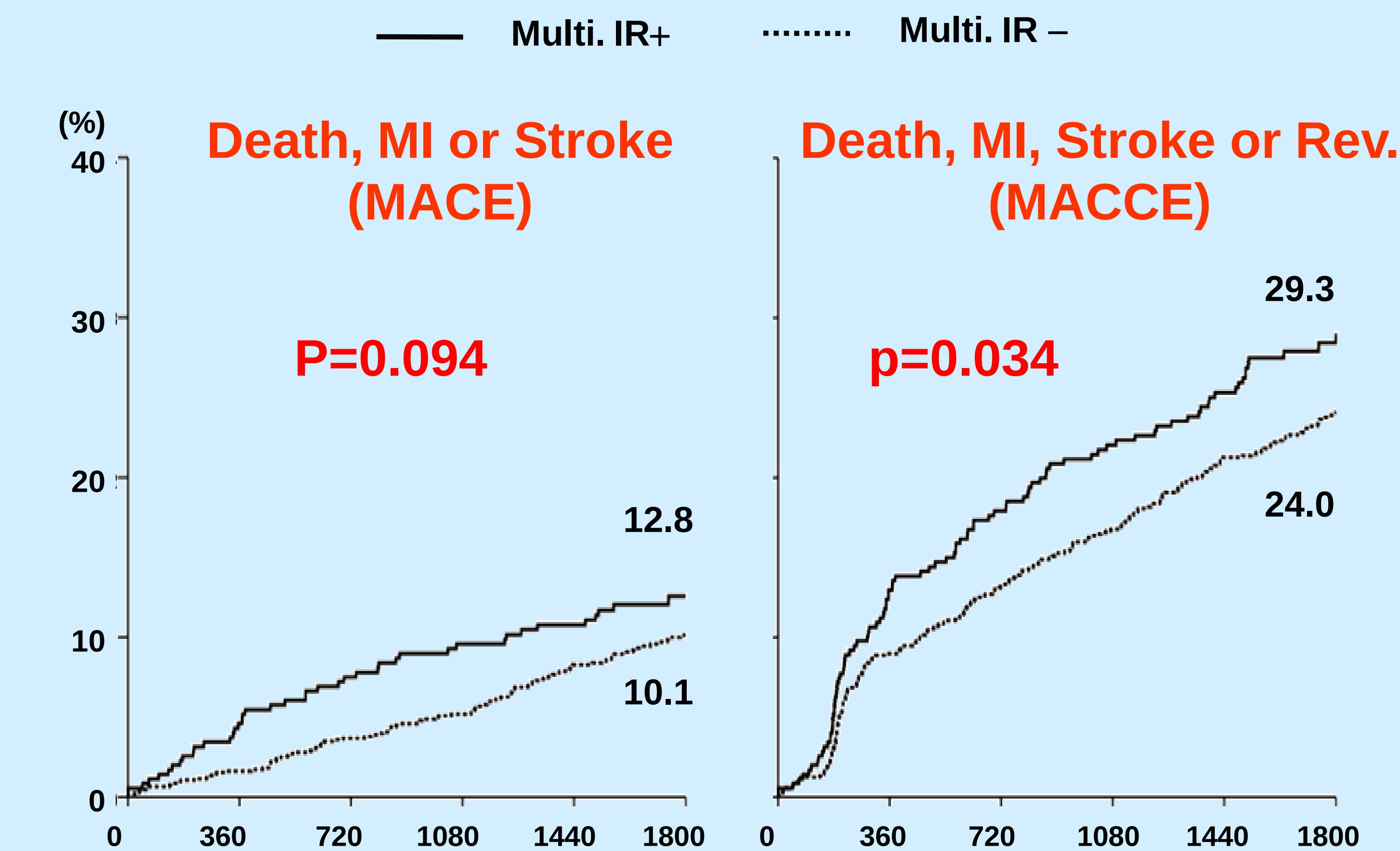
Unadjusted Outcomes in PCI Pts
By Angiographic CR-1



Unadjusted Outcomes in All Pts
By Multivessel IR



Unadjusted Outcomes in PCI Pts
By Multivessel IR



At risk

M.IR–	1056	1015	986	961	903	610	1056	939	888	843	777	513
M.IR+	344	322	309	298	289	151	344	294	274	257	241	119

Adjusted Outcomes of MACE

	Definitions	Multivariate adjustment				IPTW			
		HR	95% CI		p	HR	95% CI		p
			LL	UL			LL	UL	
All	Angiographic CR-1	1.04	0.80	1.36	0.75	1.04	0.79	1.36	0.80
	Angiographic CR-2	1.05	0.80	1.38	0.72	1.09	0.83	1.44	0.53
	Proximal CR	1.04	0.79	1.37	0.80	1.00	0.75	1.32	0.97
	Multivessel IR	1.26	0.92	1.74	0.15	0.97	0.66	1.43	0.89
PCI	Angiographic CR-1	0.82	0.58	1.15	0.25	0.84	0.59	1.20	0.33
	Angiographic CR-2	0.90	0.65	1.25	0.53	0.95	0.68	1.33	0.77
	Proximal CR	0.90	0.65	1.25	0.53	0.95	0.67	1.34	0.76
	Multivessel IR	1.30	0.91	1.87	0.15	1.05	0.70	1.59	0.81

No interaction was found between the treatment type and any definition of CRs.

Adjusted Outcomes of MACCE

	Definitions	Multivariate adjustment				IPTW			
		HR	95% CI		p	HR	95% CI		p
			LL	UL			LL	UL	
All	Angiographic CR-1	0.90	0.75	1.09	0.29	0.91	0.75	1.10	0.32
	Angiographic CR-2	0.89	0.73	1.07	0.21	0.92	0.76	1.12	0.40
	Proximal CR	0.92	0.76	1.12	0.40	0.90	0.74	1.10	0.30
	Multivessel IR	**1.44**	**1.16**	**1.79**	**0.001**	**1.27**	**0.97**	**1.66**	**0.079**
PCI	Angiographic CR-1	0.95	0.76	1.18	0.62	0.94	0.75	1.18	0.61
	Angiographic CR-2	0.99	0.80	1.22	0.90	1.00	0.81	1.25	0.99
	Proximal CR	1.01	0.82	1.26	0.90	1.04	0.83	1.30	0.73
	Multivessel IR	**1.24**	**0.98**	**1.57**	**0.071**	1.20	0.91	1.58	0.19

No interaction was found between the treatment type and any definition of CRs.

Contents

- Benefit of revascularization for pts. with LV dysfunction

- **Impact of angiographic CR for stable patients**

  - ***Not always better than IR***
- Benefit of ischemia-guided revascularization

Reasonable Incomplete Revascularization

Editorial

Reasonable Incomplete Revascularization

Harold L. Dauerman, MD

Incomplete coronary artery revascularization could increase the risk of death, myocardial infarction, repeat revascularization, and lifestyle-limiting angina. Data to support this hypothesis extend back to the early 1980s, when patients with incomplete surgical revascularization had an absolute 15% reduction in 5-year survival in comparison with patients with complete revascularization.[1,2] This hypothesis should extend to percutaneous coronary intervention (PCI). Two New York State registry analyses demonstrated an increased risk of death associated with incomplete stent-based revascularization, and the Arterial Revascularization Therapies Study (ARTS) trial described a greater need for subsequent bypass surgery after incomplete stent revascularization.[3–5] One study has linked incomplete stent-based revascularization with impaired improvement in left ventricular function, and thus suggests a mechanism for increased mortality risk.[6]

Article see p 2373

Despite the pejorative reputation of incomplete revascularization, the findings of Kim et al[7] from the Asan Medical

more common clinical discussions of stentable and graftable vessels; namely, incomplete revascularization is commonly defined as any nonrevascularized vessel with >1.5-mm diameter and 50% to 100% stenosis.[5,8] Other registry studies have used a more stringent stenosis requirement of >70% severity.[4] The current registry analyzed the frequency of incomplete revascularization in multiple ways, including using the 1.5-mm diameter/50% to 100% definition (overall incidence, 52%) and a 2.5-mm diameter/50% to 100% stenosis definition (overall incidence, 41%). Other registry definitions provide estimates of stent-based incomplete revascularization as high as 69% of patients with multivessel disease.[4]

Incomplete revascularization occurs more frequently in PCI patients, but it is not rare in CABG populations—in the current study, incomplete revascularization occurred in 33% of CABG patients in comparison with 59% of PCI patients ($P<0.001$). Although the practice of incomplete revascularization by traditional definition is common, it is also variable. In the New York State registry study, incomplete revascularization with drug-eluting stents ranged from 45% to 89% of

Circulation. 2011;123:2337

What is a reasonable incomplete revascularization ?

Reasonable Incomplete Revascularization

Anatomy Guided

- Very small vessels
- Only 1-vessel IR
- Jailed asymptomatic side branch
- Not culprit artery (thrombus)

Function Guided

- Non-viable myocardium
- < 5% residual ischemic area expected
- Small ischemic area

Physiology Guided

- FFR > 0.80

Dauerman HL. Circulation. 2011;123:2337

Function (Ischemia)-Guided Revascularization

Reasonable Incomplete Revascularization

Anatomy Guided

- Very small vessels
- Only 1-vessel IR
- Jailed asymptomatic side branch
- Not culprit artery (thrombus)

Function Guided

- Non-viable myocardium
- < 5% residual ischemic area expected
- Small ischemic area

Physiology Guided

- FFR > 0.80

Dauerman HL. Circulation. 2011;123:2337

Impact of Angiographic Complete Revascularization After Drug-Eluting Stent Implantation or Coronary Artery Bypass G[...] Surgery for Multivessel Coronary Artery Disease

Summary: The current guideline recommends complete reva
ization (CR) with the use of percutaneous coronary interve
coronary artery bypass grafting for stable patients with mul
coronary disease because of its favorable long-term pr
compared with the strategy of incomplete revascularization
ever, in daily practice, CR is not always attempted bec
hemodynamic instability, low ejection fraction, complex m
ogy, absence of objective ischemia, or preference for a mi
invasive procedure. In this regard, our study sought to investi
benefit of CR with detailed angiographic analyses accordin
Synergy Between PCI With Taxus and Cardiac Surgery classifica-
tion for patients with multivessel disease undergoing percutaneous
coronary intervention with drug-elut
bypass grafting. The major finding
according to the varying definitio
outcomes. Although the mechanism i
ation between CR and clinical progn
the limitation of angiography to det
fact, recent clinical studies using fract
invasive modality to determine obj
epicardial coronary artery, demonstrat
intermediate angiographic stenosis an
Therefore, the strategy of angiograp
sary procedures and subsequently fai
Given this result and others with the u
functional evaluations, an ischemia
performed in treating patients with m

Conclusions: Angiographic CR with
or coronary artery bypass grafting did
outcomes in patients with multivessel
the strategy of ischemia-guided revas

Editor's Comment: In current clinica
whether or not a complete revascu
angiographic findings alone, will lead
when there is incomplete angiographi
showed that after 5 years, regardle
revascularized by percutaneous coro
artery bypass graft surgery, there w
survival or clinical outcomes betwee
incomplete angiographic revasculari
veal that clinical decision-making reg
revascularization should not rely on a
should include a functional assessme
optimal revascularization strategy.[9]

Circulation: Cardiovascular Interventions Topic Review

Circulation: Cardiovascular Interventions Editors' Picks

Most Important Papers in Coronary Stenting

The Editors

The following are highlights from the new series, *Circulation: Cardiovascular Interventions* Topic Review. This series will summarize the most important manuscripts, as selected by the editors, that have published in the *Circulation* portfolio. The objective of this new series is to provide a concise review of significant papers that are relevant to interventional cardiology. The studies included in this article represent the most noteworthy research in the area of coronary stent placement. (*Circ Cardiovasc Interv*. 2011;4:e24–e30.)

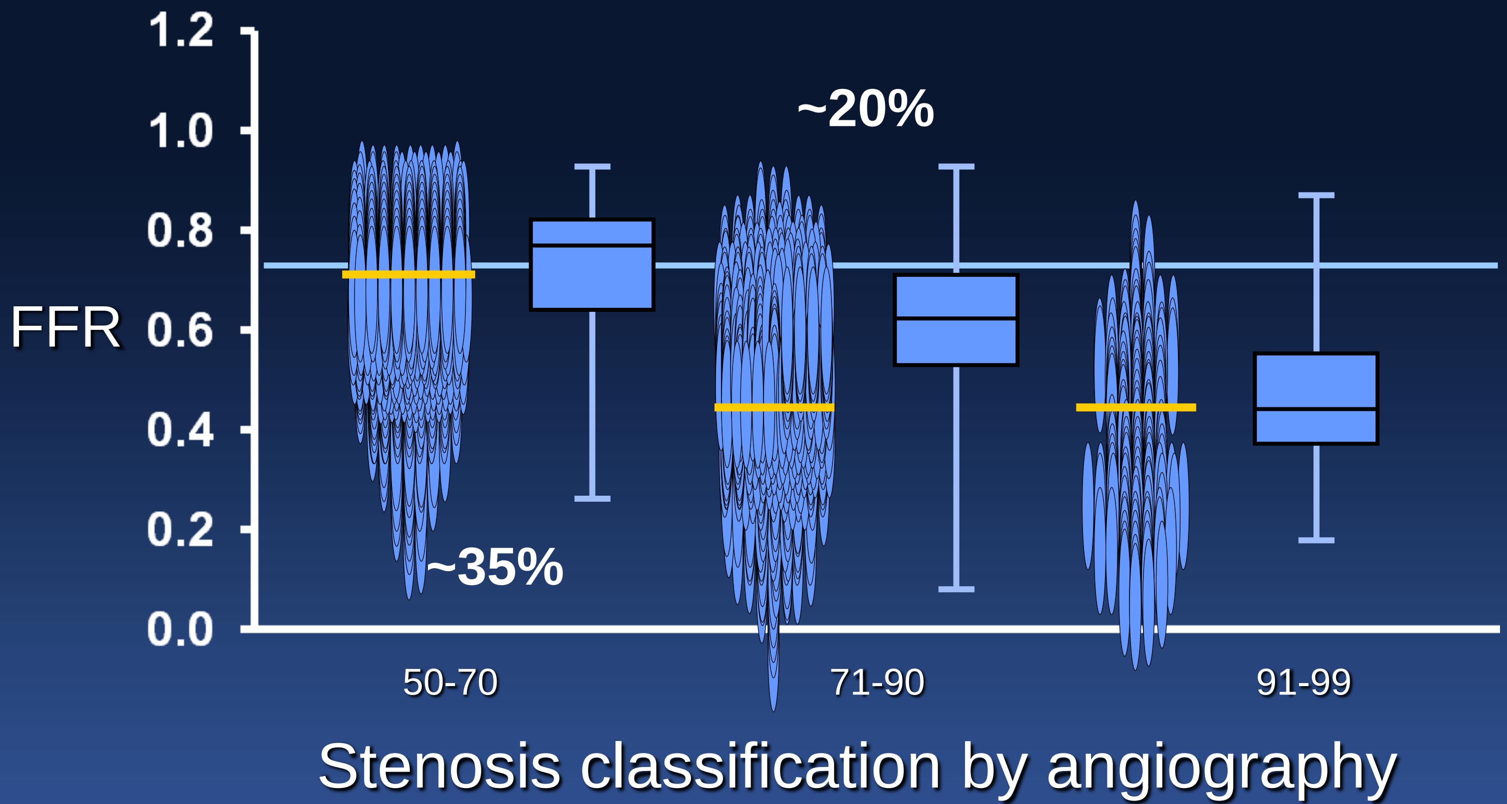
Editor's Comment: In current clinical practice, it remains unclear whether or not a complete revascularization strategy, based on angiographic findings alone, will lead to similar clinical outcomes as when there is incomplete angiographic revascularization. This study showed that after 5 years, regardless of whether patients were revascularized by percutaneous coronary intervention or coronary artery bypass graft surgery, there was no significant difference in survival or clinical outcomes between patients with complete and incomplete angiographic revascularization. These observations reveal that clinical decision-making regarding complete or incomplete revascularization should not rely on angiographic findings alone and should include a functional assessment of ischemia to determine the optimal revascularization strategy.[9]

Circ Cardiovasc Interv. 2011;4:e24

Contents

- Benefit of revascularization for pts. with LV dysfunction
- Impact of angiographic CR for stable patients
- **Benefit of ischemia-guided revascularization**

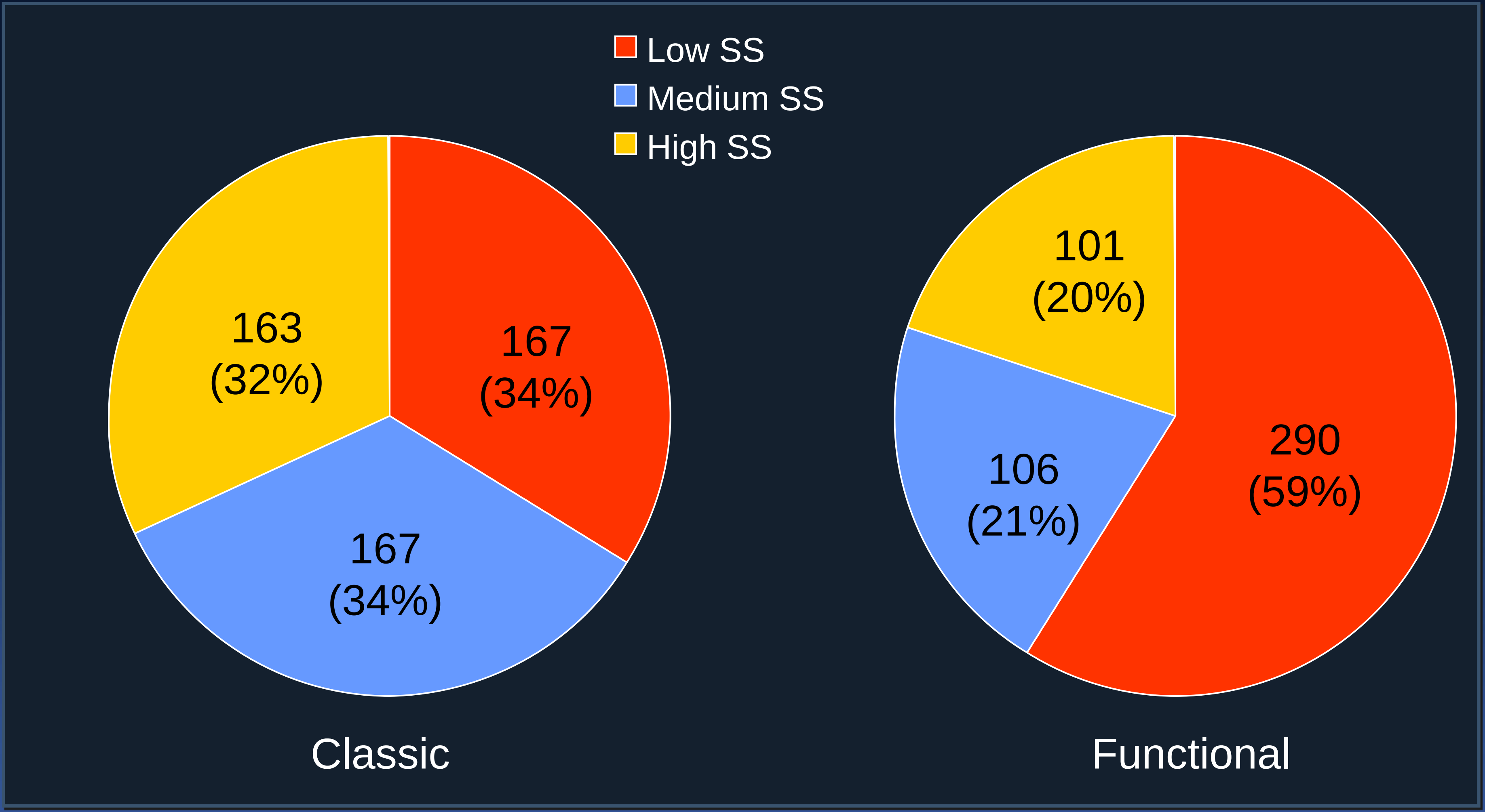
Angiographic vs. Functional Severity of Coronary Stenosis



Of 509 pts with angiographically-defined MVD, 46% had “functional MVD”

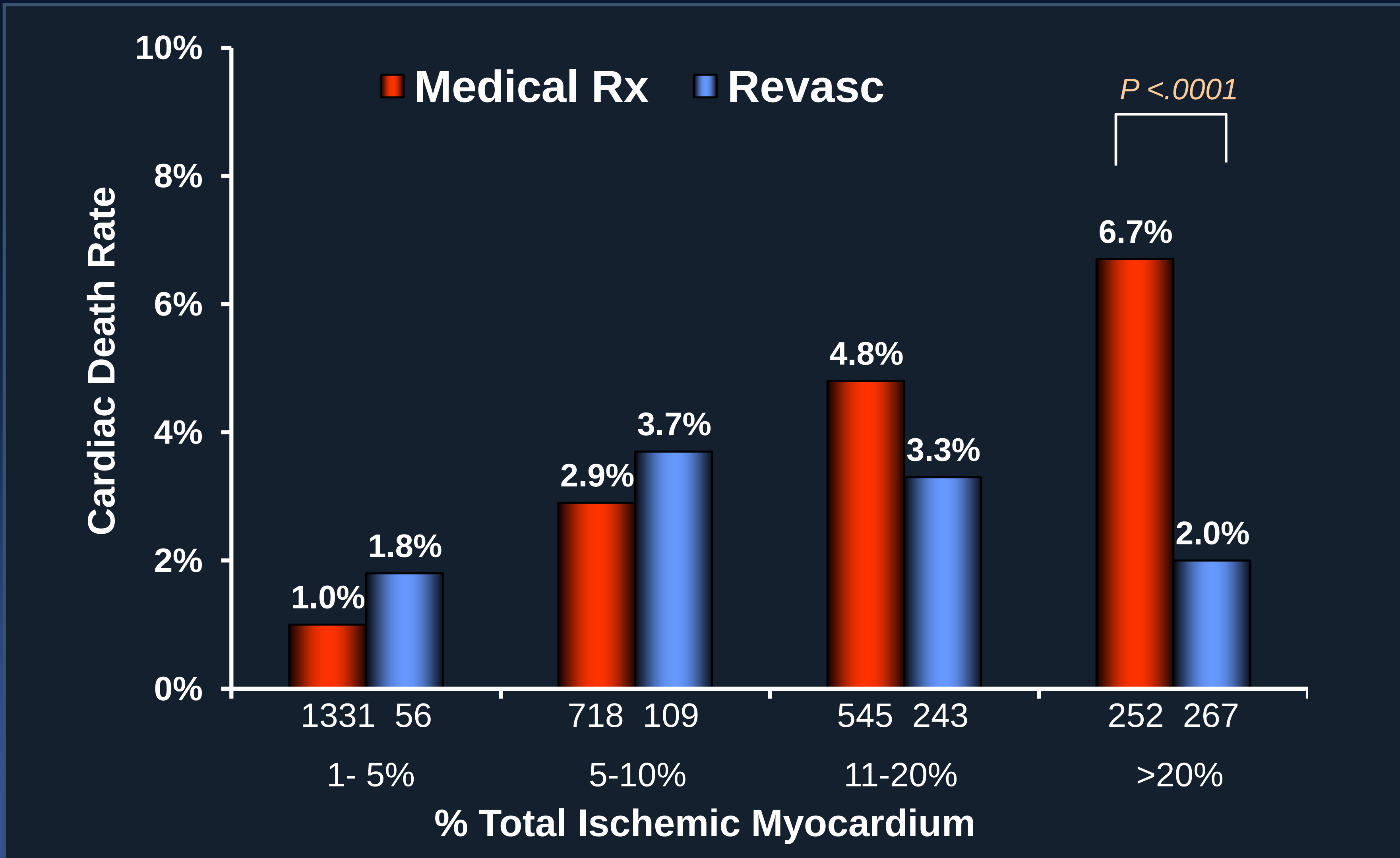
Tonino et al, *JACC* 2010;55:2816-21

Functional SYNTAX Score in FAME



Nam et al, JACC 2011;58:1211-18

Ischemic Gradient vs. Revascularization



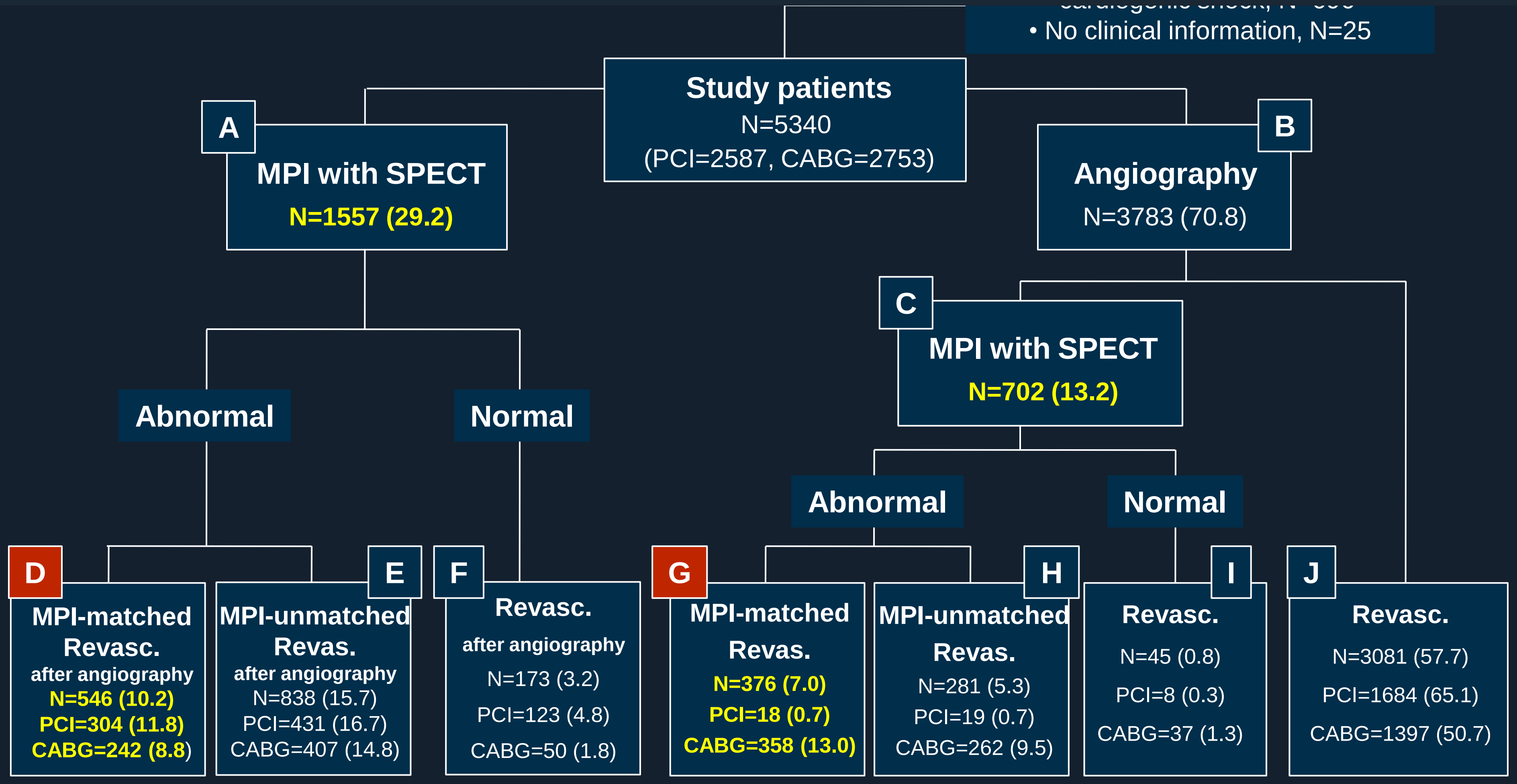
Hachamovitch et al Circulation. 2003; 107:2900

Definition of IR in AMC

- **Ischemia-guided (IG) revascularization**
  - Revascularization a LAD and/or non-LAD artery matched with the perfusion abnormalities of MPI during the index hospitalization or within 30 days after the index procedure.

- **Non-IG revascularization**
  - Revascularization of a non-ischemic LAD or non-LAD artery, non-revascularization of the ischemic artery, or revascularization without MPI

922 (17.3%) underwent IG revascularization, including 322 (12.4%) in the PCI and 600 (21.8%) in the CABG (*P*<.001) patients.



Baseline Characteristics

	PCI			CABG		
Variable	**IG**	**Non-IG**	***P***	**IG**	**Non-IG**	***P***
	N=322	**N=2265**		**N=600**	**N=2153**	
Age, median, y	62	64	0.35	63	64	0.006
Male	226 (70.2)	1550 (68.4)	0.53	456 (76.0)	1571 (73.0)	0.04
BMI, median, kg/m^2	25.2	25.0	0.060	24.8	24.5	0.051
Diabetes mellitus	120 (37.3)	727 (32.1)	0.064	191 (31.8)	772 (35.9)	0.068
Hypertension	205 (63.7)	1339 (59.1)	0.12	226 (37.7)	1114 (51.7)	<0.001
Current smoker	116 (36.0)	848 (37.4)	0.62	87 (14.5)	487 (22.6)	<0.001
Hyperlipidemia	114 (35.4)	750 (33.1)	0.42	182 (30.3)	665 (30.9)	0.80
Prior MI	9 (2.8)	76 (3.4)	0.60	85 (14.2)	259 (12.0)	0.16
Previous PCI	70 (21.7)	395 (17.4)	0.060	59 (9.8)	273 (12.7)	0.058
Previous CHF	3 (0.9)	16 (0.7)	0.72	26 (4.3)	99 (4.6)	0.78

Baseline Characteristics

	PCI			CABG		
	IG	Non-IG	*P*	IG	Non-IG	*P*
	N=322	N=2265		N=600	N=2153	
COPD	4 (1.2)	10 (0.4)	0.086	13 (2.2)	44 (2.0)	0.85
Cerebrovascular disease	23 (7.1)	144 (6.4)	0.59	55 (9.2)	272 (12.6)	0.020
Peripheral Ds	2 (0.6)	40 (1.8)	0.13	30 (5.0)	120 (5.6)	0.58
Renal failure	9 (2.8)	67 (3.0)	0.87	33 (5.5)	139 (6.5)	0.39
Atrial fibrillation	10 (3.1)	49 (2.2)	0.29	20 (3.3)	89 (4.1)	0.37
LV EF, median, %	60	60	0.29	58		
Clinical presentation			0.006			<0.001
Stable angina	207 (64.3)	1244 (54.9)		302 (50.3)	1495 (69.4)	
Unstable angina	114 (35.4)	1004 (44.3)		298 (49.7)	655 (30.4)	
Acute NSTEMI	1 (0.3)	17 (0.8)		0	3 (0.1)	

Angiographic Characteristics

	PCI			CABG		
	IG	Non-IG	*P*	IG	Non-IG	*P*
	N=310	N=1713		N=268	N=1061	
SYNTAX score, median	15.5	17.0	0.30	24.5	23.0	0.016
Angiographic stenosis						
LAD artery	260 (83.9)	1555 (90.8)	<0.001	214 (79.9)	854 (80.5)	0.81
Left circumflex artery	202 (65.2)	1106 (64.6)	0.84	160 (59.7)	679 (64.0)	0.19
Right coronary artery	229 (73.9)	1252 (73.1)	0.78	190 (70.9)	746 (70.3)	0.85
Left main	34 (11.0)	261 (15.2)	0.050	95 (35.4)	327 (30.8)	0.15
Three-vessel disease	127 (41.0)	714 (41.7)	0.82	147 (54.9)	604 (56.9)	0.54
Any total occlusion	61 (19.7)	247 (14.4)	0.018	98 (36.6)	283 (26.7)	0.001

Procedures

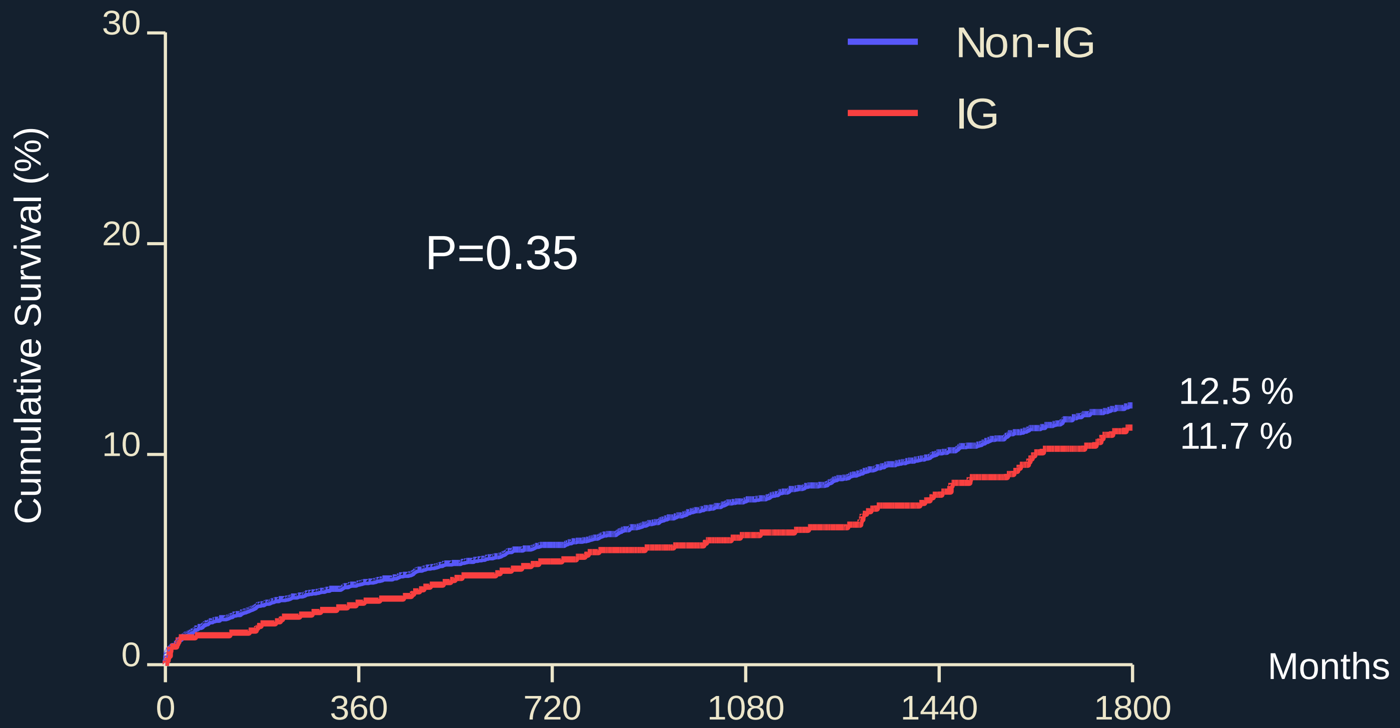
	PCI			CABG		
	IG	Non-IG	*P*	IG	Non-IG	*P*
	N=322	N=2265		N=600	N=2153	
Treadmill test	113 (35.1)	431 (19.0)	<0.001	99 (16.5)	251 (11.7)	0.002
Treated vessel						
LAD or left main artery	205 (63.7)	1768 (78.1)	<0.001	589 (98.2)	2091 (97.1)	0.16
Left circumflex artery	113 (35.1)	940 (41.5)	0.029	477 (79.5)	1680 (78.0)	0.44
Right coronary artery	138 (42.9)	1172 (51.7)	0.003	439 (73.2)	1427 (66.3)	0.001
Conduits, median	–	–	–	3.0 (3.0, 4.0)	3.0 (2.0, 4.0)	<0.001
Arterial conduit, median	–	–	–	3.0 (2.0, 3.0)	2.0 (1.0, 3.0)	<0.001
Internal thoracic artery	–	–	–	510 (85.0)	1867 (86.7)	0.28
Off-pump surgery	–	–	–	370 (61.7)	1243 (57.7)	0.084
Total stents, median	2.0 (1.0, 3.0)	2.0 (2.0, 3.0)	<0.001	–	–	–

SPECT Perfusion Abnormality

	PCI			CABG		
	IG	Non-IG	*P*	IG	Non-IG	*P*
	N=322	N=581		N=600	N=756	
Perfusion defect sites						
LAD	205 (63.7)	246 (42.3)	<0.001	589 (98.2)	299 (39.6)	<0.001
Non-LAD	199 (61.8)	236 (40.6)	<0.001	556 (92.7)	363 (48.0)	<0.001
Reversibility						
Any fixed defect	32 (9.9)	56 (9.6)	0.88	88 (14.7)	90 (11.9)	0.14
Any reversible defect	301 (93.5)	362 (62.3)	<0.001	572 (95.3)	564 (74.6)	<0.001
Area of perfusion defect ≥ medium	306 (95.0)	397 (68.3)	<0.001	600 (100)	625 (82.7)	<0.001

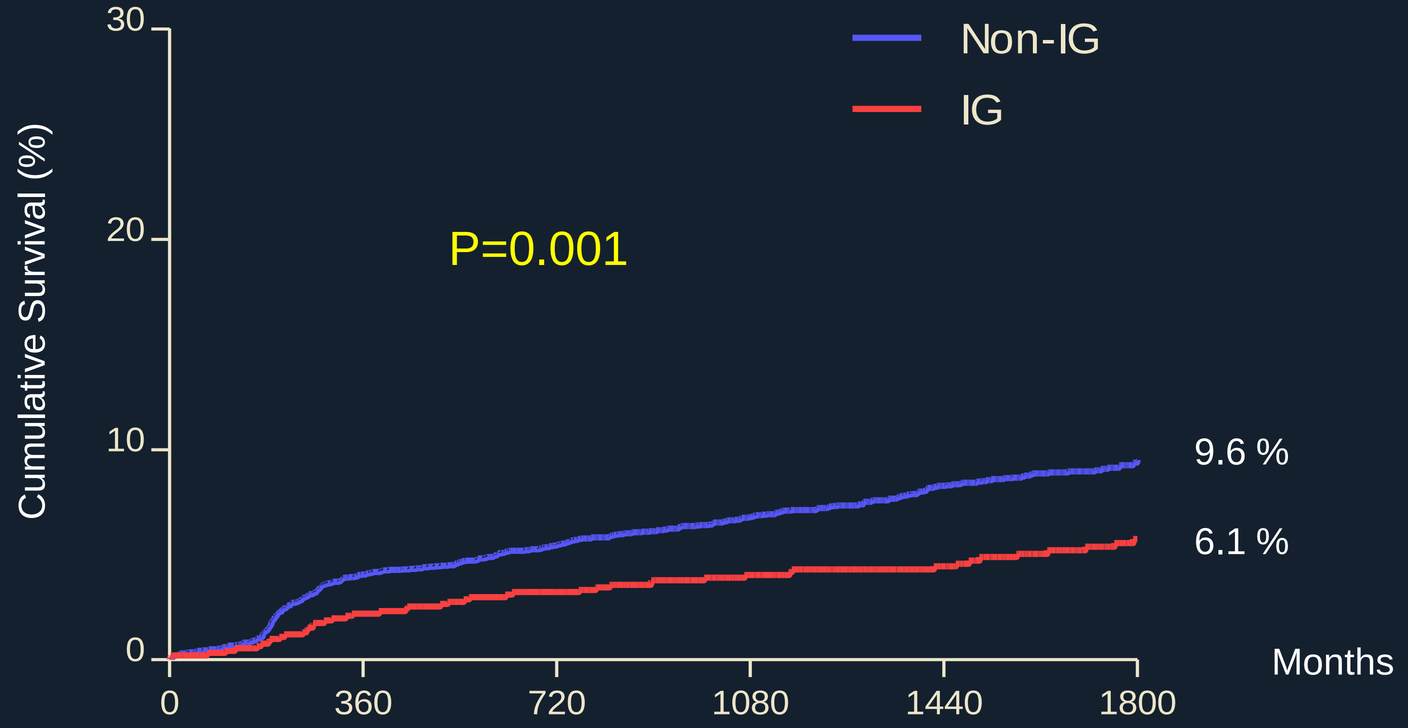
All Patients

Death, MI, or Stroke for 5 Years



At risk			
IG-	4418	3330	1548
IG+	922	780	494

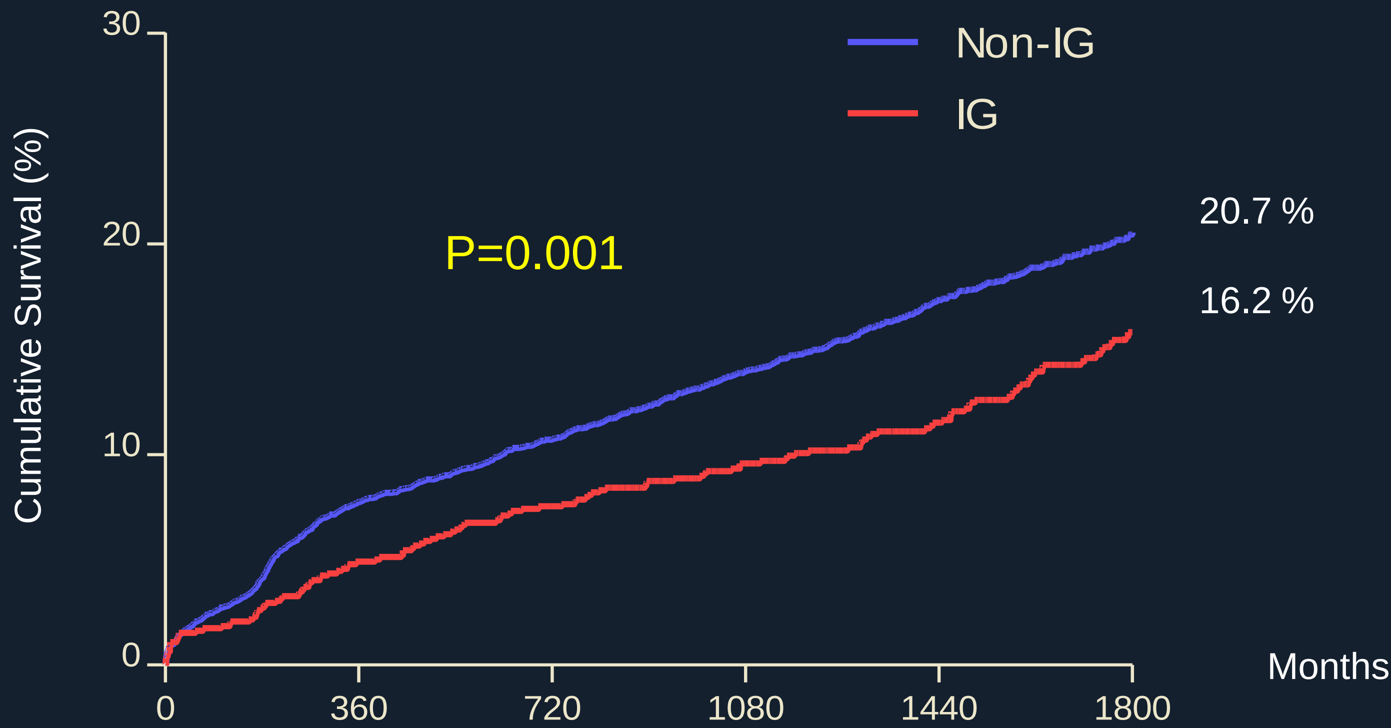
All Patients
Repeat Revascularization for 5 Years



At risk

IG-	4418	3145	1420
IG+	922	763	487

All Patients
MACCE for 5 Years

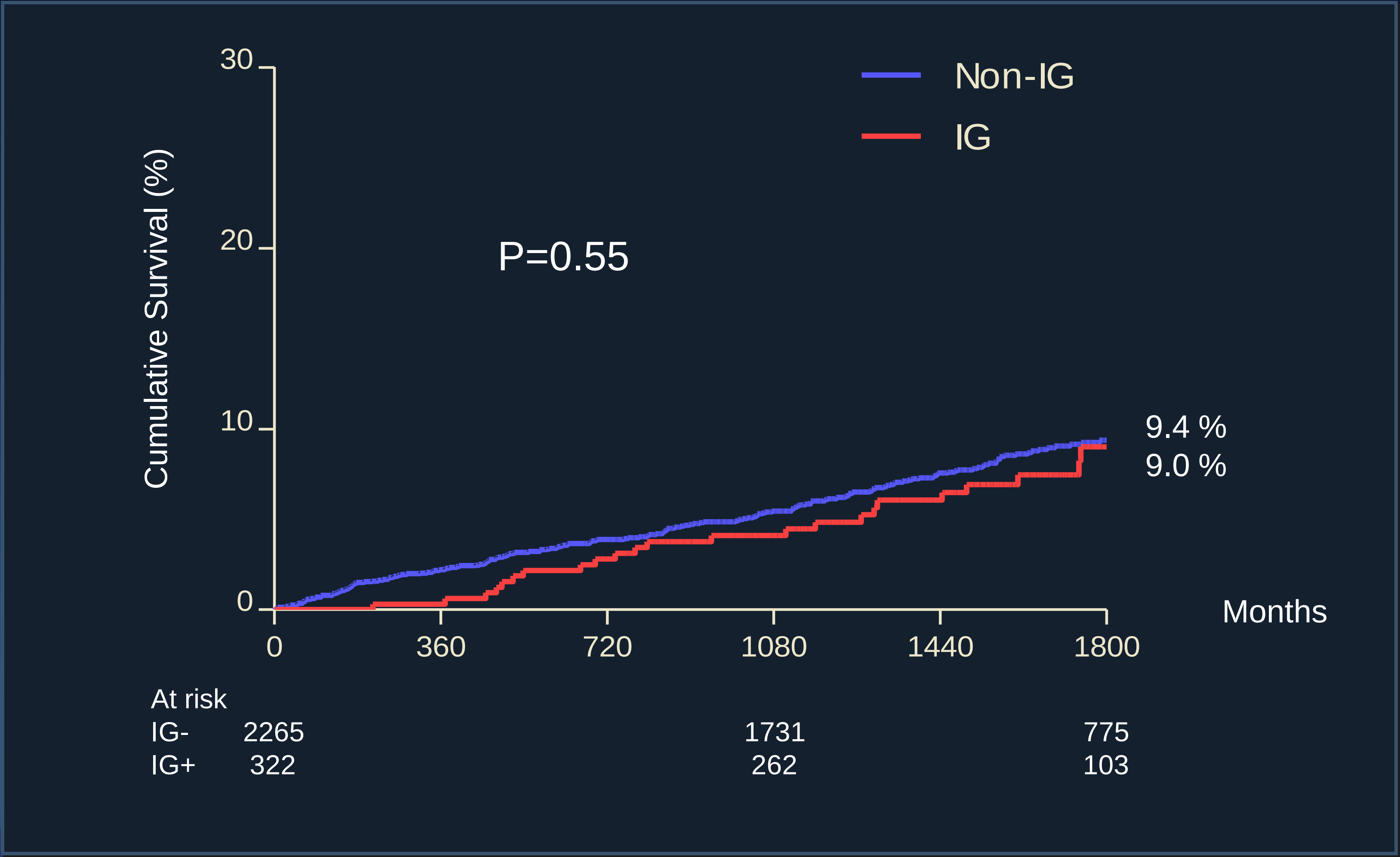


At risk			
IG-	4418	3088	1375
IG+	922	750	469

MACCE including death, MI, stroke or repeat revascularization

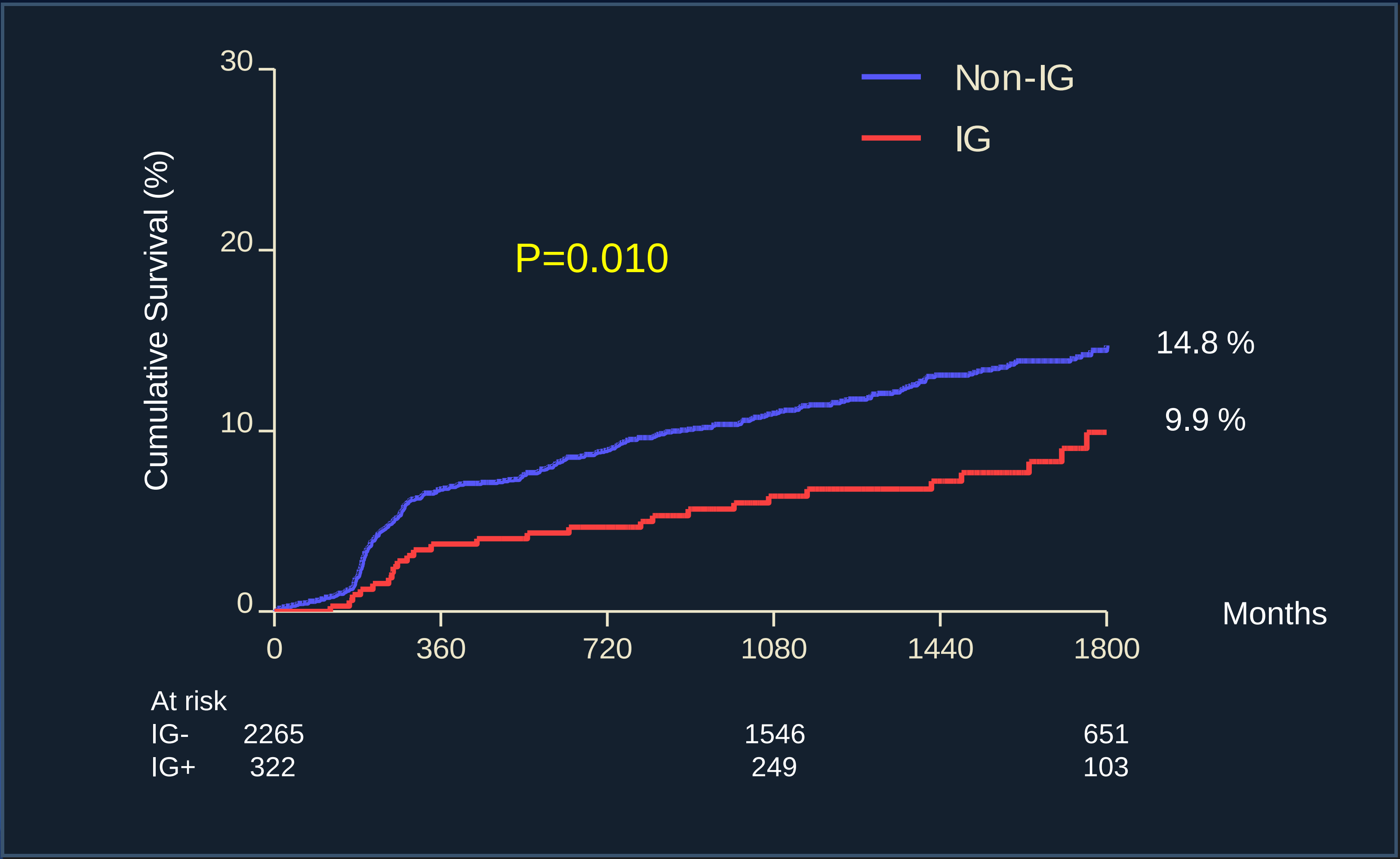
PCI Patients

Death, MI, or Stroke for 5 Years

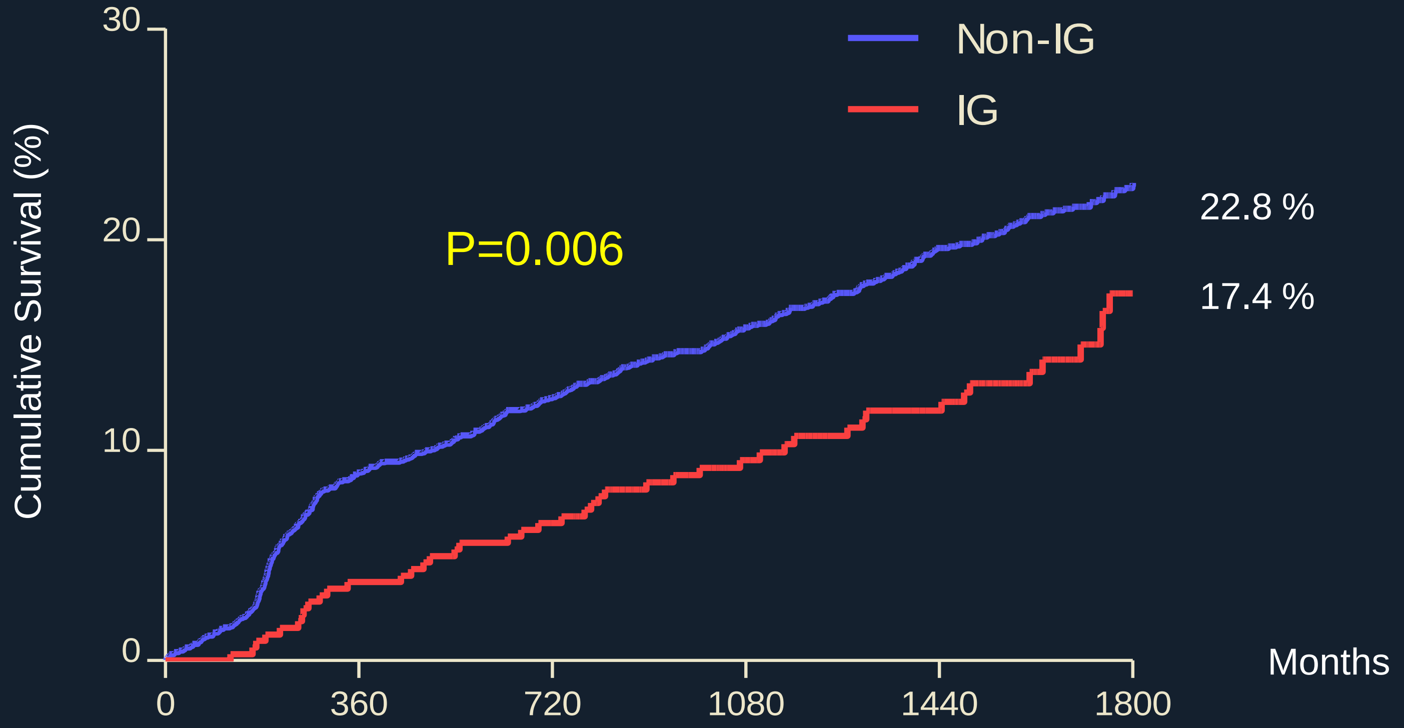


PCI Patients

Repeat Revascularization for 5 Years



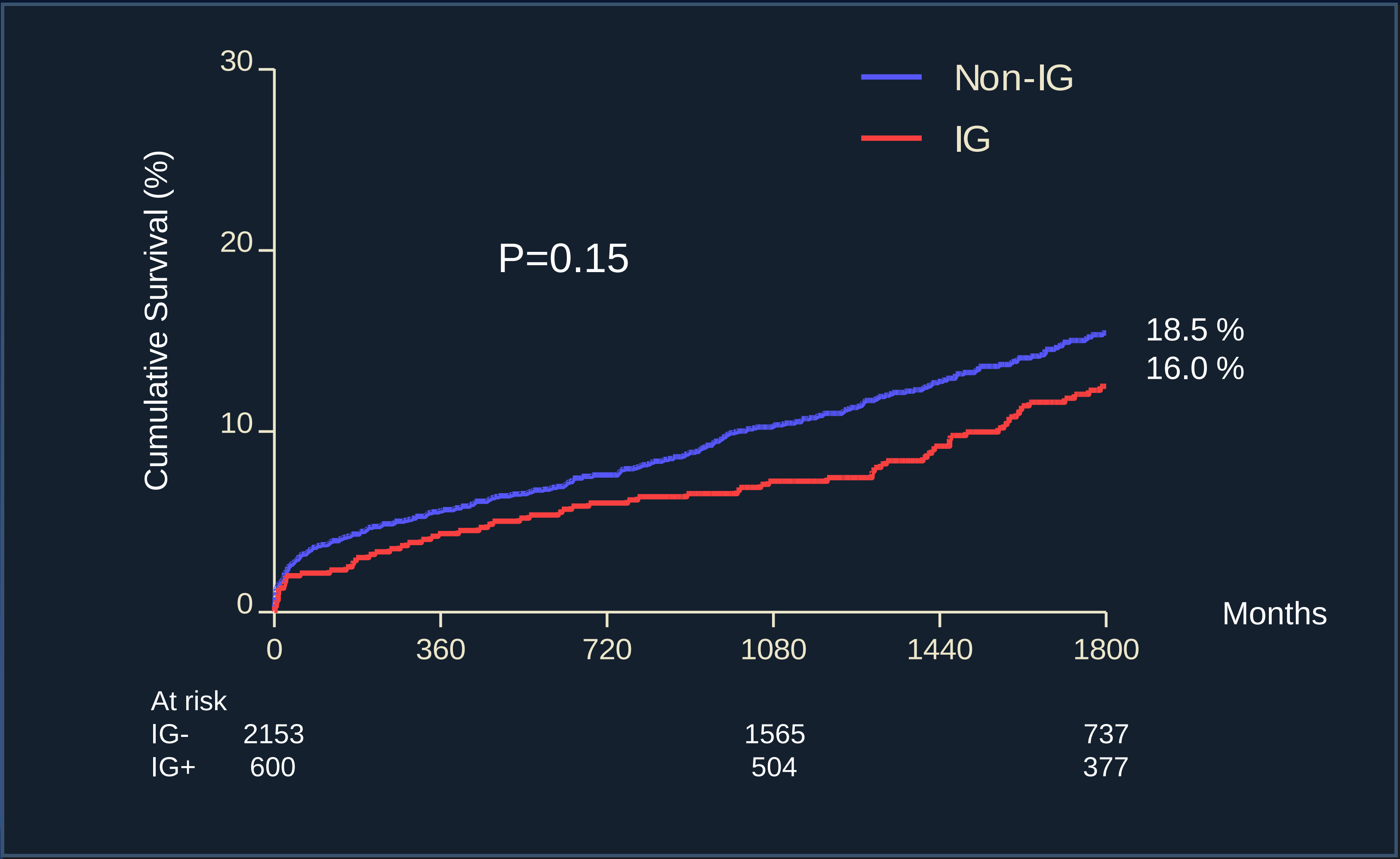
PCI Patients
MACCE for 5 Years



At risk			
IG-	2265	1523	638
IG+	322	246	92

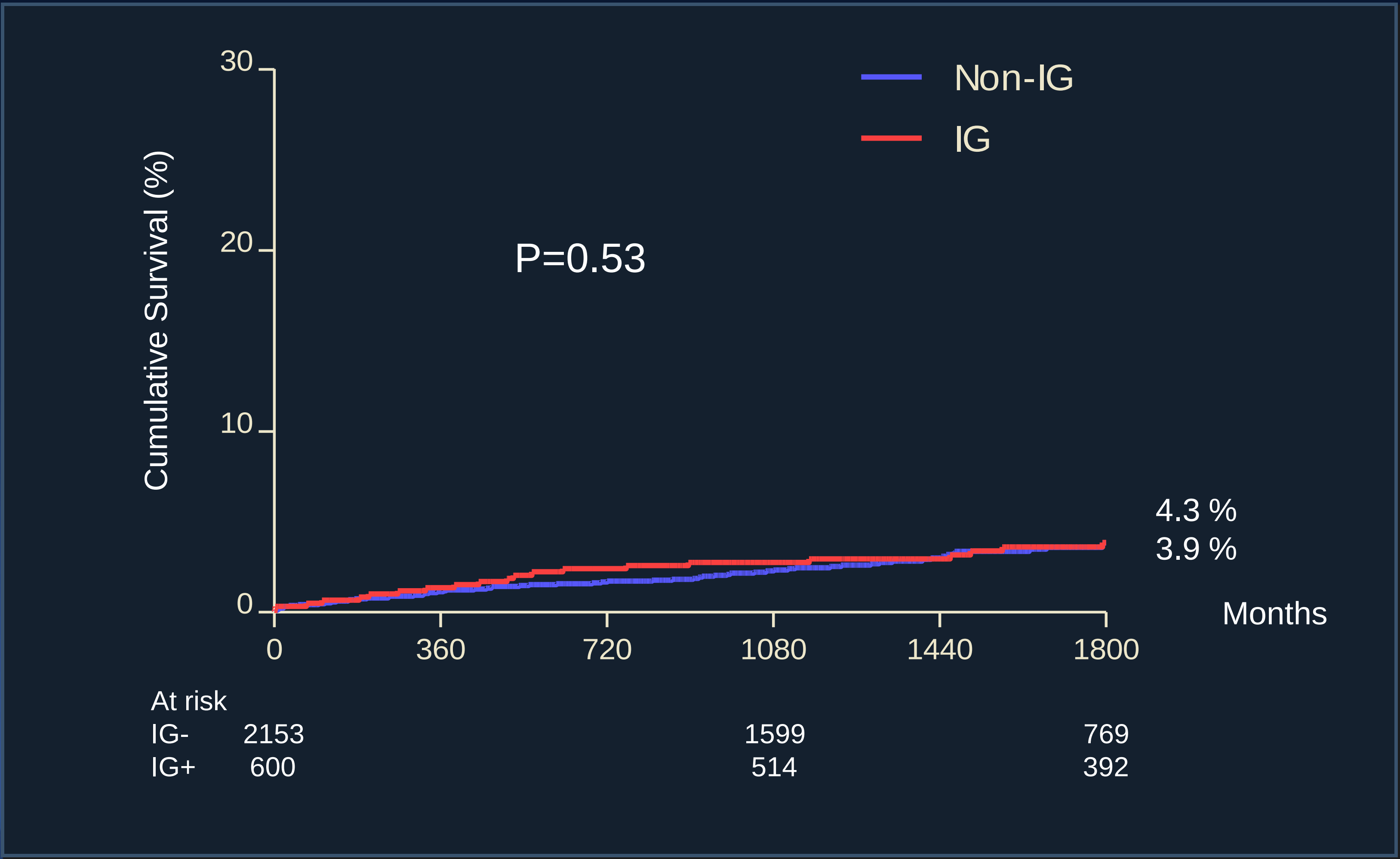
CABG Patients

Death, MI, or Stroke for 5 Years

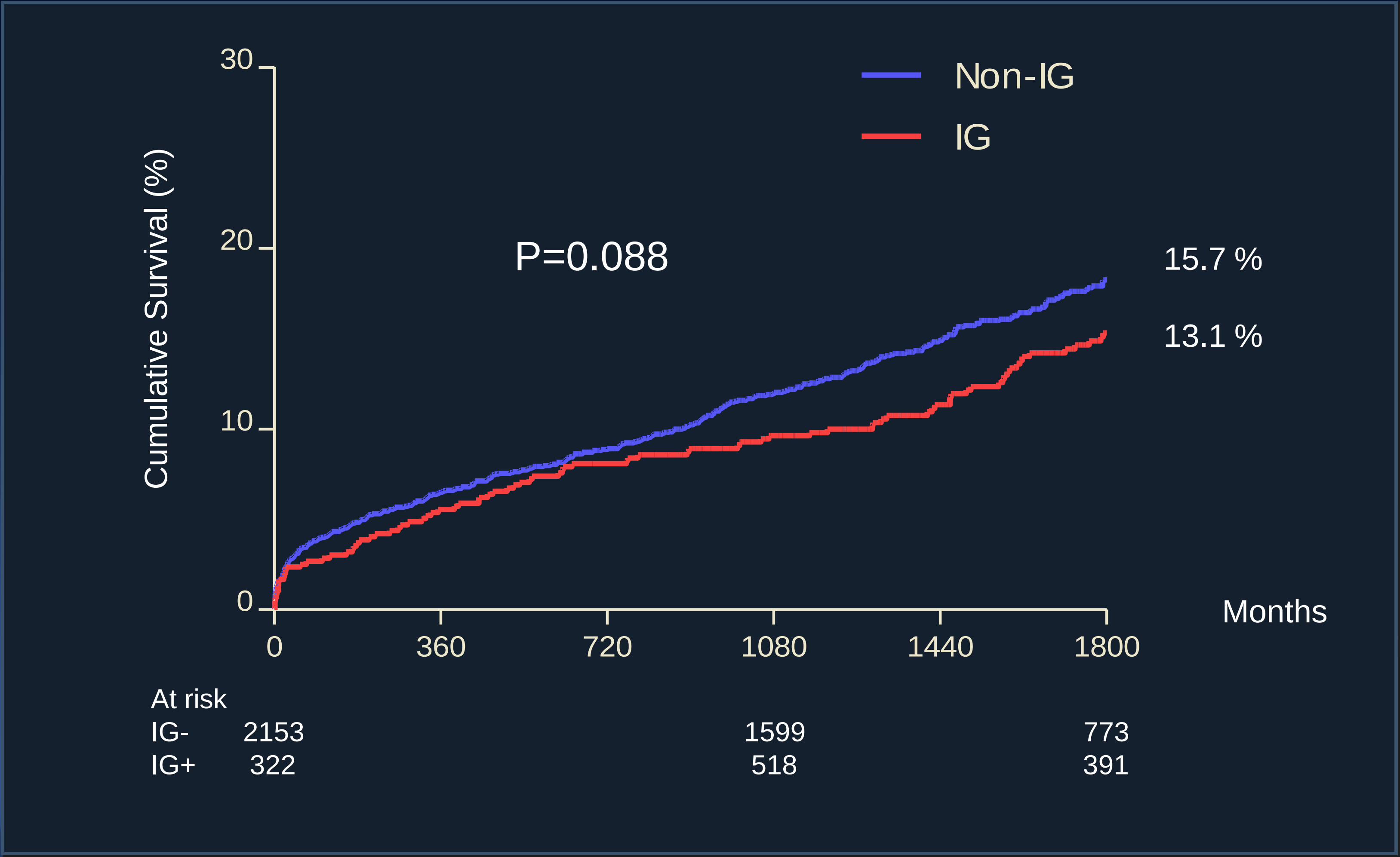


CABG Patients

Repeat Revascularization for 5 Years



CABG Patients
MACCE for 5 Years

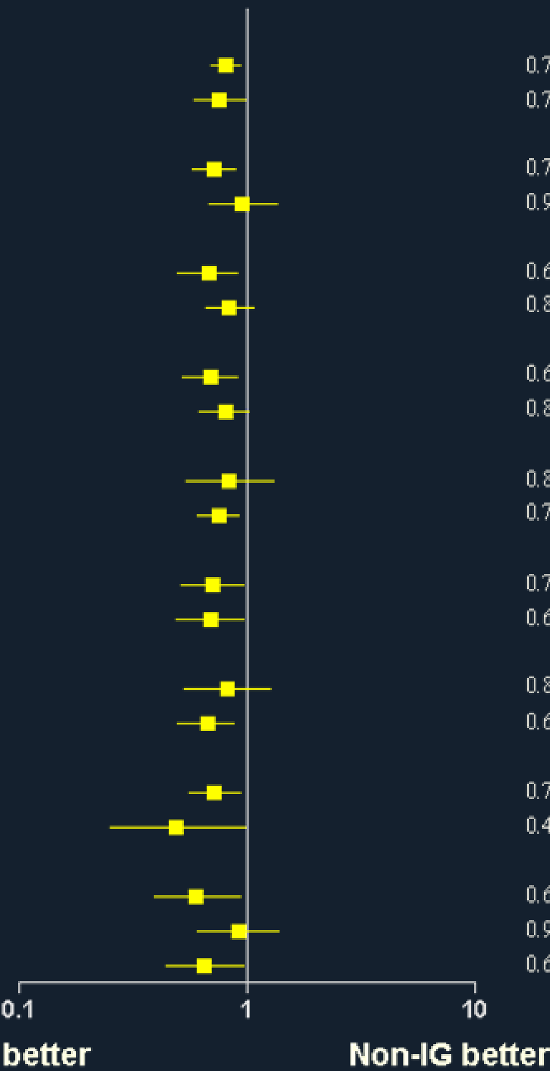


Adjusted Hazards using IPTW

		HR	95% CI		*P*	Interaction *P*
			Lower	Upper		
Death, MI, stroke	All	0.84	0.66	1.06	0.13	0.96
	PCI	0.83	0.53	1.29	0.41	
	CABG	0.82	0.61	1.10	0.18	
Repeat revascularization	All	0.66	0.49	0.90	0.009	0.044
	PCI	0.53	0.35	0.80	0.003	
	CABG	1.16	0.70	1.94	0.57	
MACCE	All	0.73	0.60	0.88	0.001	0.18
	PCI	0.59	0.43	0.81	0.001	
	CABG	0.87	0.67	1.14	0.32	

5-Year MACCE in Subgroups

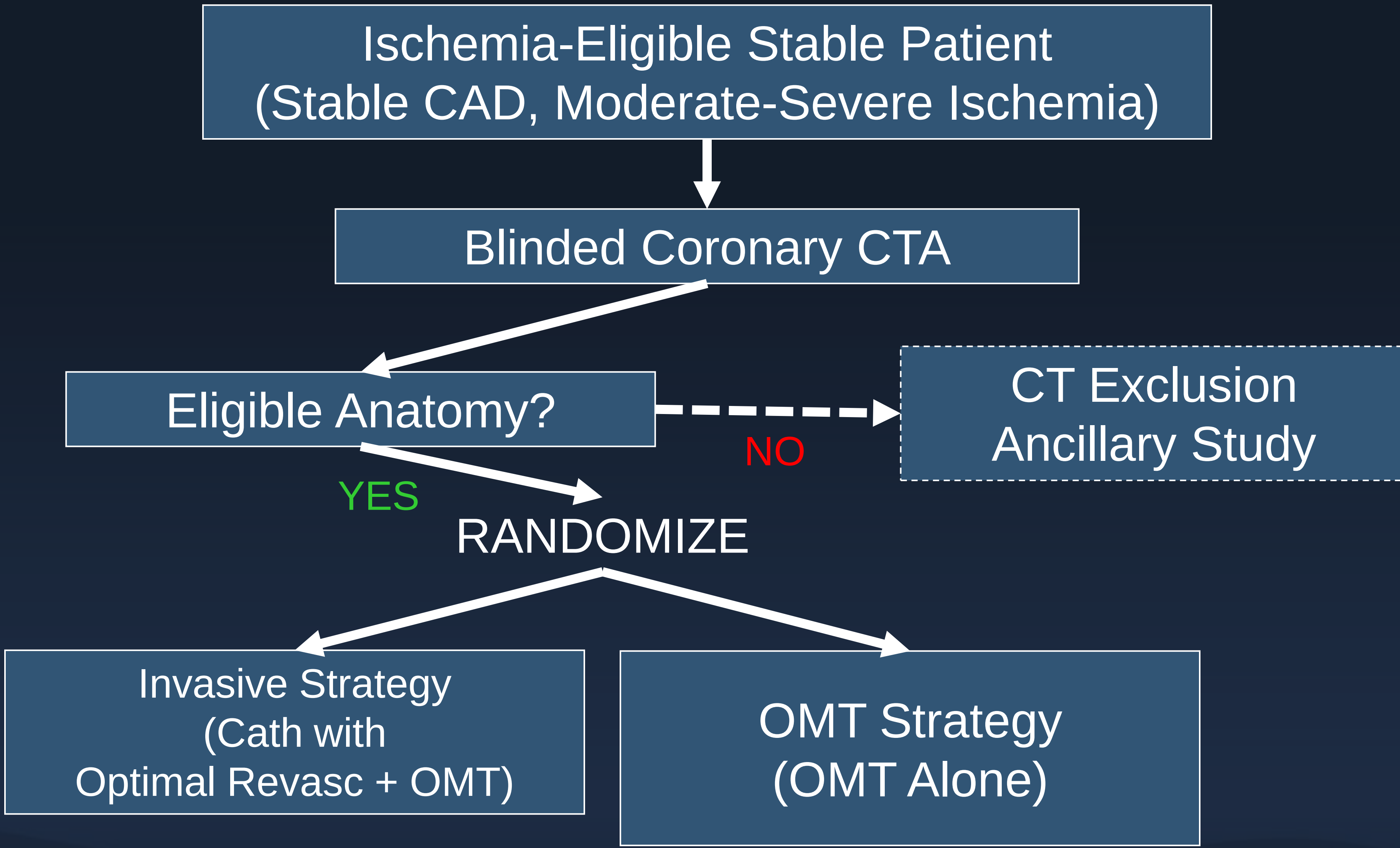
Subgroup	MACCE IG	MACCE Non-IG	Adjusted HR (95% CI)	*P* value	*P* value for Interaction
	no./total no. (%)				
Age					0.756
≥65 yr	66/533 (13.4)	361/2380 (17.3)	0.76 (0.59, 0.98)	0.035	
<65 yr	69/389 (20.4)	429/2038 (24.8)	0.79 (0.61, 1.03)	0.087	
Sex					0.184
Male	96/682 (15.7)	570/3121 (21.5)	0.72 (0.58, 0.89)	0.003	
Female	39/240 (17.7)	220/1297 (18.9)	0.96 (0.68, 1.36)	0.818	
Diabetes mellitus					0.222
Yes	51/311 (19.4)	329/1499 (25.5)	0.68 (0.50, 0.91)	0.010	
No	84/611 (14.4)	461/2919 (18.3)	0.84 (0.66, 1.07)	0.152	
Acute coronary syndrome					0.707
Yes	63/413 (15.9)	344/1679 (22.1)	0.69 (0.52, 0.91)	0.008	
No	72/509 (16.5)	446/2739 (19.6)	0.80 (0.62, 1.02)	0.076	
Prior angioplasty					0.466
Yes	17/94 (19.5)	53/335 (18.6)	0.84 (0.54, 1.30)	0.434	
No	118/828 (15.9)	737/4083 (20.9)	0.75 (0.61, 0.92)	0.006	
Three vessel disease*					0.934
Yes	43/274 (18.8)	269/1318 (23.0)	0.70 (0.51, 0.97)	0.033	
No	38/304 (14.8)	244/1456 (19.4)	0.69 (0.49, 0.97)	0.034	
Any total occlusion*					0.409
Yes	27/159 (20.1)	103/530 (22.2)	0.82 (0.53, 1.26)	0.363	
No	54/419 (15.5)	410/2244 (20.8)	0.67 (0.50, 0.88)	0.005	
LAD stenosis*					0.558
Yes	70/474 (17.7)	456/2409 (21.3)	0.72 (0.56, 0.93)	0.011	
No	11/104 (11.7)	57/365 (20.2)	0.49 (0.25, 0.98)	0.044	
SYNTAX score*					0.354
Low (≤ 14)	24/208 (14.3)	170/979 (20.7)	0.60 (0.39. 0.93)	0.022	
Intermediate (14-24)	28/167 (20.9)	172/958 (20.1)	0.92 (0.61, 1.37)	0.677	
High (≥ 24)	29/203 (16.2)	171/837 (22.9)	0.65 (0.44, 0.97)	0.033	



Contents

- Benefit of revascularization for pts. with LV dysfunction
- Impact of angiographic CR for stable patients
- **Benefit of ischemia-guided revascularization**
  - ***Probably the standard approach for CAD with or without LV dysfunction***

ISCHEMIA Trial Proposed Design



J. Hochman, TCT 2010

Conclusions

- Benefit of revascularization for pts. with LV dysfunction
  - Not determined yet, not always beneficial
- Impact of angiographic CR for stable patients
  - Not always better than IR
- Benefit of ischemia-guided revascularization
  - Probably the standard approach for CAD with or without LV dysfunction
- *Further randomized studies are required to assess the benefit of ischemia-guided revascularization with a consideration of LV viability for stable CAD with decreased LV function.*