

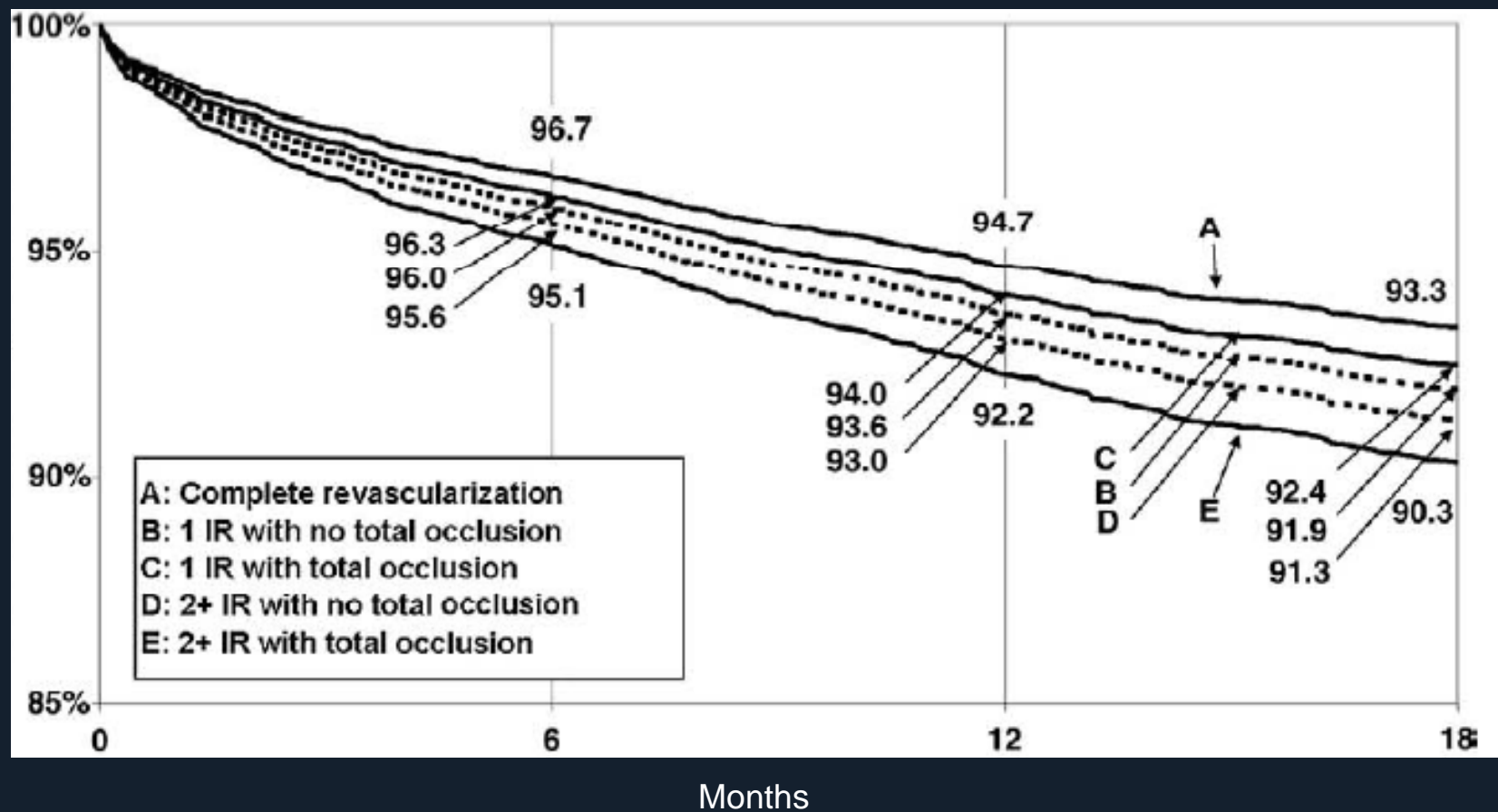
# Impact of Angiographic Complete Revascularization after Drug-Eluting Stent Implantation or Coronary Artery Bypass Surgery for Multivessel Coronary Disease

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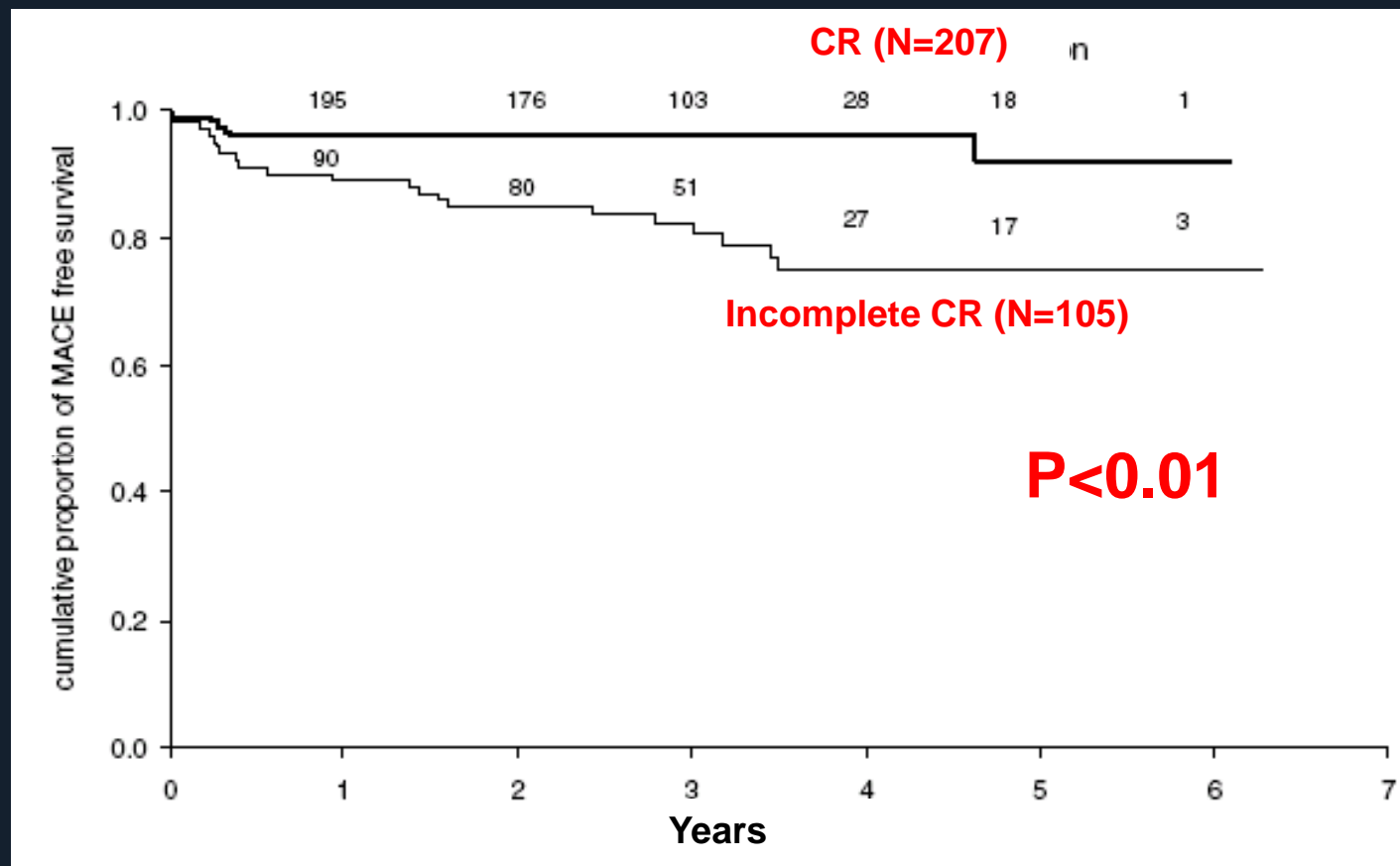
# Impact of Angiographic Complete Revascularization (CR) after DES Implantation

## *MI-free Survival in NY Registry*



# Impact of Angiographic CR after CABG Surgery

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



# But, Impact of CR needs to be further investigated.

- Due to technical complexity, low ejection fraction, or safety concerns regarding the implantation of multiple DES, diseased segments have often been incompletely revascularized in patients undergoing PCI.
- Furthermore, even with CABG, the strategy of incomplete revascularization (IR) has occasionally been adopted to reduce operation-related complications, particularly when minimally invasive or off-pump surgery is attempted.
- Additional studies are needed to assess the outcomes of updated treatments, such as DES, left internal mammary artery (LIMA) grafting, off-pump surgery and current medications.

# Purpose

- We, therefore, evaluated the long-term clinical impacts of angiographic CR, as compared with IR, in patients receiving PCI with DES or CABG for multivesel coronary disease (MVD).

# Subjects

- 1914 Patients with MVD in the Asan Medical Center Multivessel Registry who underwent DES (N=1400) implantation or CABG (N=514) between January 2003 and December 2005 were included in this study.
- Patients who underwent prior CABG or concomitant valvular or aortic surgery, and those who had an acute myocardial infarction (MI) within 24 hours before revascularization or presented with cardiogenic shock were excluded.

# Procedures

- The choice of DES type and the use of intravascular ultrasound, glycoprotein IIb/IIIa inhibitor, or other devices to facilitate optimal stenting were at the operator's discretion.
- In CABG, the LIMA primarily attempted to be grafted to the LAD artery.
- On- or off-pump surgery was performed at the operator's discretion.

# Decision of CR

- Factors involved in the decision-making process included patient's presentation and comorbidity, LV EF, objective ischemia evidenced by stress tests, jeopardized myocardium of the diseased segment, presence of viable myocardium, and anatomical complexity.
- PCI was preferred for patients at high surgical risk due to combined morbidity.
- CABG was considered as the primary option of MVD in patients with severe angiographic complexity or low LV EF.



# End Points

- **MACE:** all-cause death, MI, and stroke.
- **MACCE:** MACE plus repeat revascularization.
- **MI:** new pathologic Q waves after index treatment or follow-up MI requiring subsequent hospitalization.
- **Repeat revascularization** included target vessel revascularization.
- **Stroke:** neurologic deficits, was confirmed by a neurologist based on imaging modalities.
- All outcomes of interest were carefully verified and adjudicated by independent clinicians.

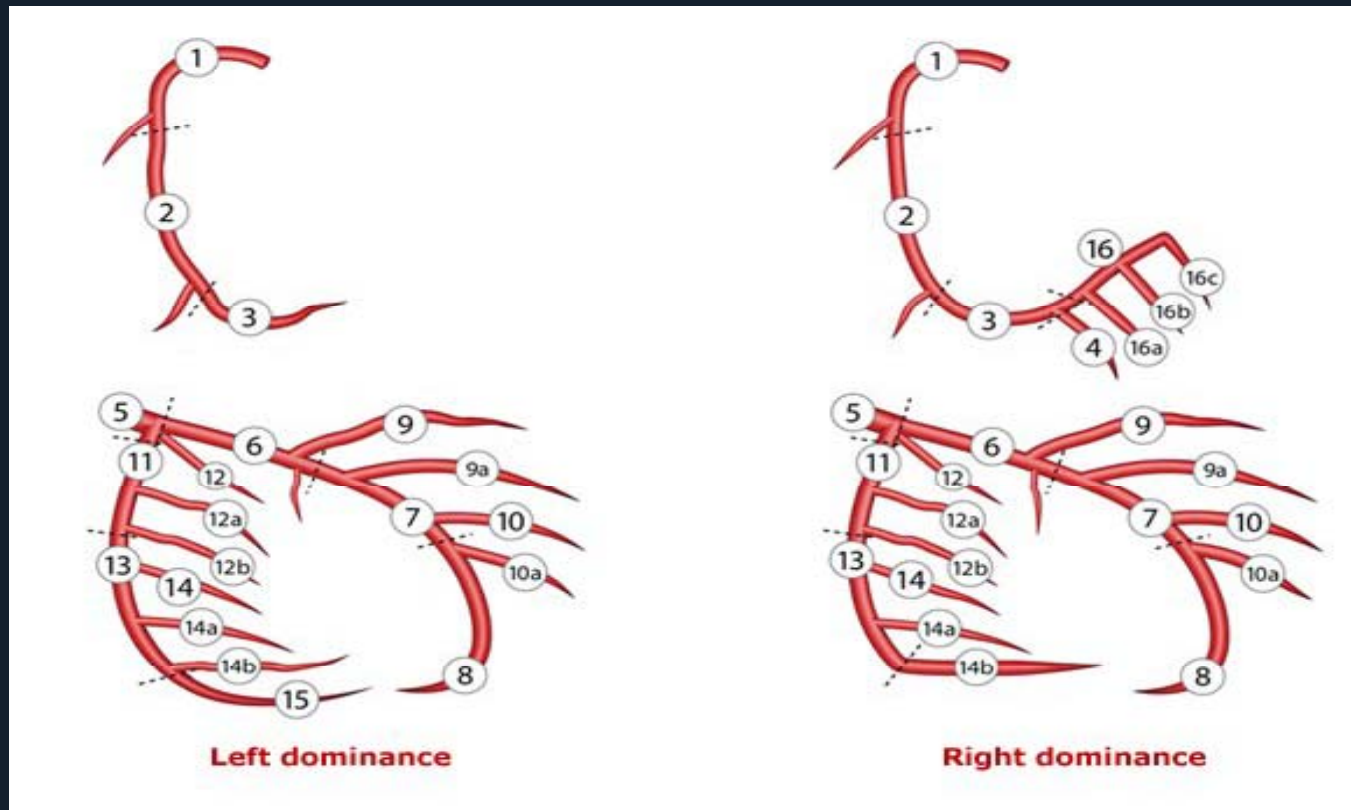
# Angiographic Analysis

- Diseased segments and lesion characteristics were categorized according to the Synergy between PCI with Taxus and Cardiac Surgery (SYNTAX) classification.
- CABG patients were assessed by comparing the diagnostic angiographic analysis with the surgical procedure report.
- CR in PCI patients was assessed by comparing the diagnostic and post-procedural angiograms.

# Definitions of CR

- **Angiographic CR-1**

- Revascularization of all SYNTAX segment ( $\geq 1.5$  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).



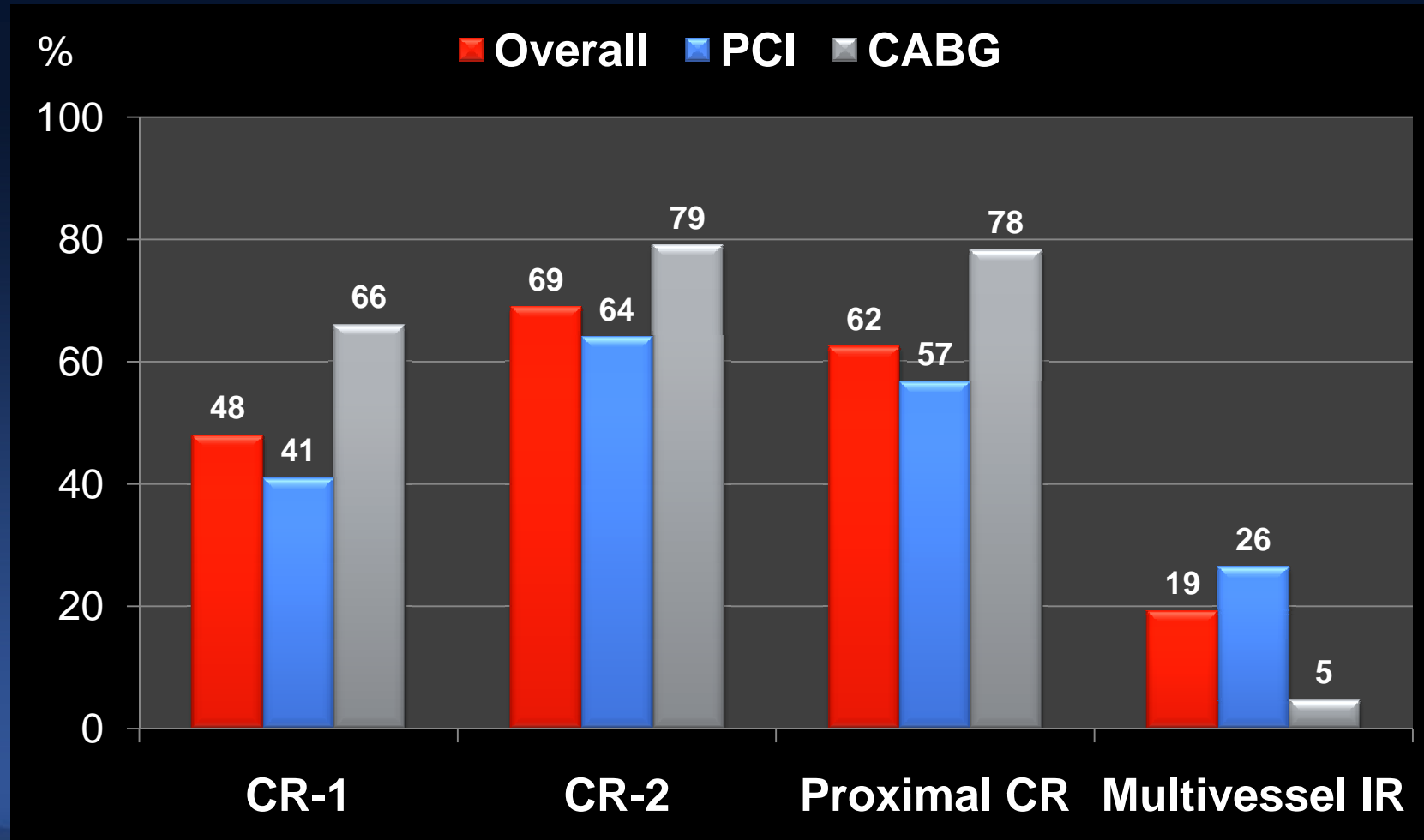
# Definitions of CR

- **Angiographic CR-2**
  - Revascularization of all SYNTAX segment ( $\geq 2.5$  mm)
- **Proximal CR**
  - Revascularization of all **proximal arterial** systems (# 1, 2, 3, 5, 6, 7 & 11)
- **Multivessel IR**
  - **IR  $\geq 2$**  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

# Statistical Analysis

- Adjustment using multivariable Cox proportional-hazards regression and weighted Cox proportional-hazards regression models with inverse-probability-of-treatment weighting (IPTW).
- Interactions between factors associated with CR and treatment strategy were tested by incorporation of formal interaction terms in the multivariable Cox model.

# Prevalence of CR according to the Definitions



# Baseline Characteristics

Variable	PCI			CABG		
	CR (N=573)	IR (N=827)	P	CR (N=344)	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

# Baseline Characteristics

Variable	PCI			CABG		
	CR (N=573)	IR (N=827)	P	CR (N=344)	IR (N=170)	P
COPD	3 (0.5)	12 (1.5)	0.10	7 (2.0)	6 (3.5)	0.37
CVA	25 (4.4)	50 (6.0)	0.17	44 (12.8)	28 (16.5)	0.26
Peripheral Ds	10 (1.7)	20 (2.4)	0.39	29 (8.4)	17 (10.0)	0.56
Renal failure	10 (1.7)	27 (3.3)	<b>0.08</b>	23 (6.7)	15 (8.8)	0.38
Atrial fibrillation	20 (3.5)	24 (2.9)	0.54	9 (2.6)	3 (1.8)	0.76
Clinical presentation			0.57			0.54
Stable angina	275 (48.0)	420 (50.8)		115 (33.4)	58 (34.1)	
Unstable angina	245 (42.8)	338 (40.9)		209 (60.8)	106 (62.4)	
Acute MI	53 (9.2)	69 (8.3)		20 (5.8)	6 (3.5)	



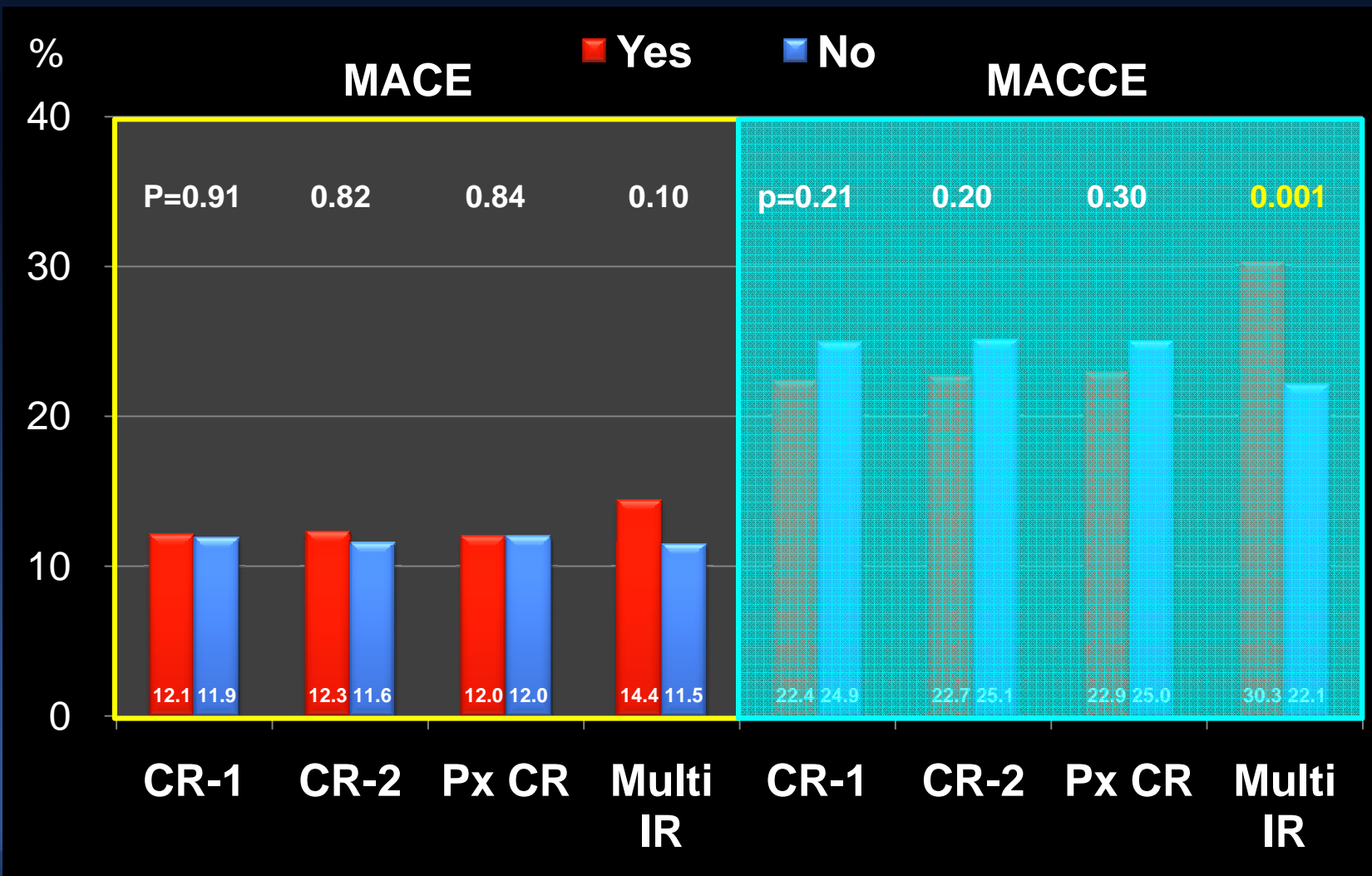
# Angiographic Characteristics

Variable	PCI			CABG		
	CR (N=573)	IR (N=827)	P	CR (N=344)	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

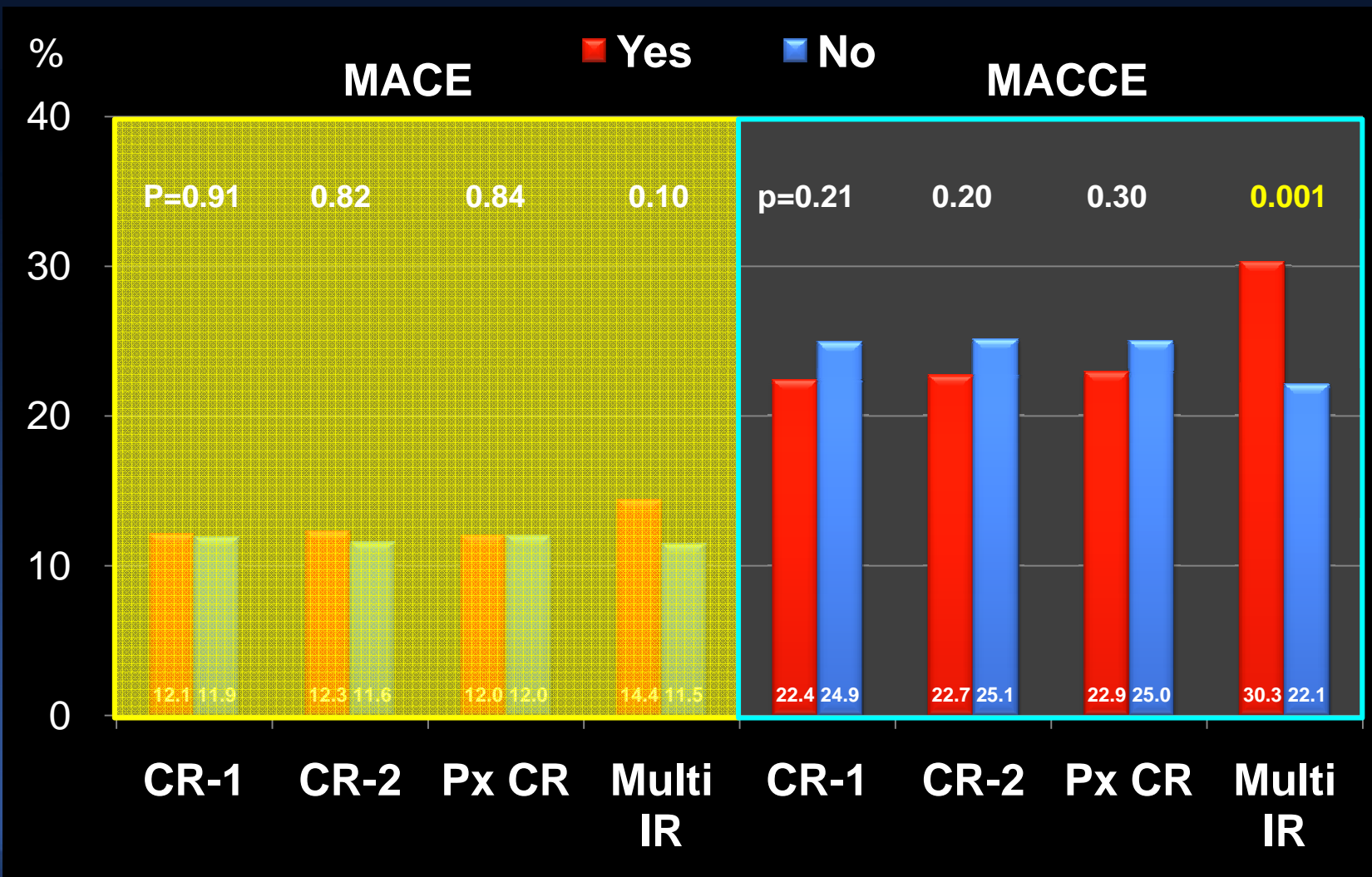
# Procedures

Variable	PCI			CABG		
	CR (N=573)	IR (N=827)	P	CR (N=344)	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	—	—	—

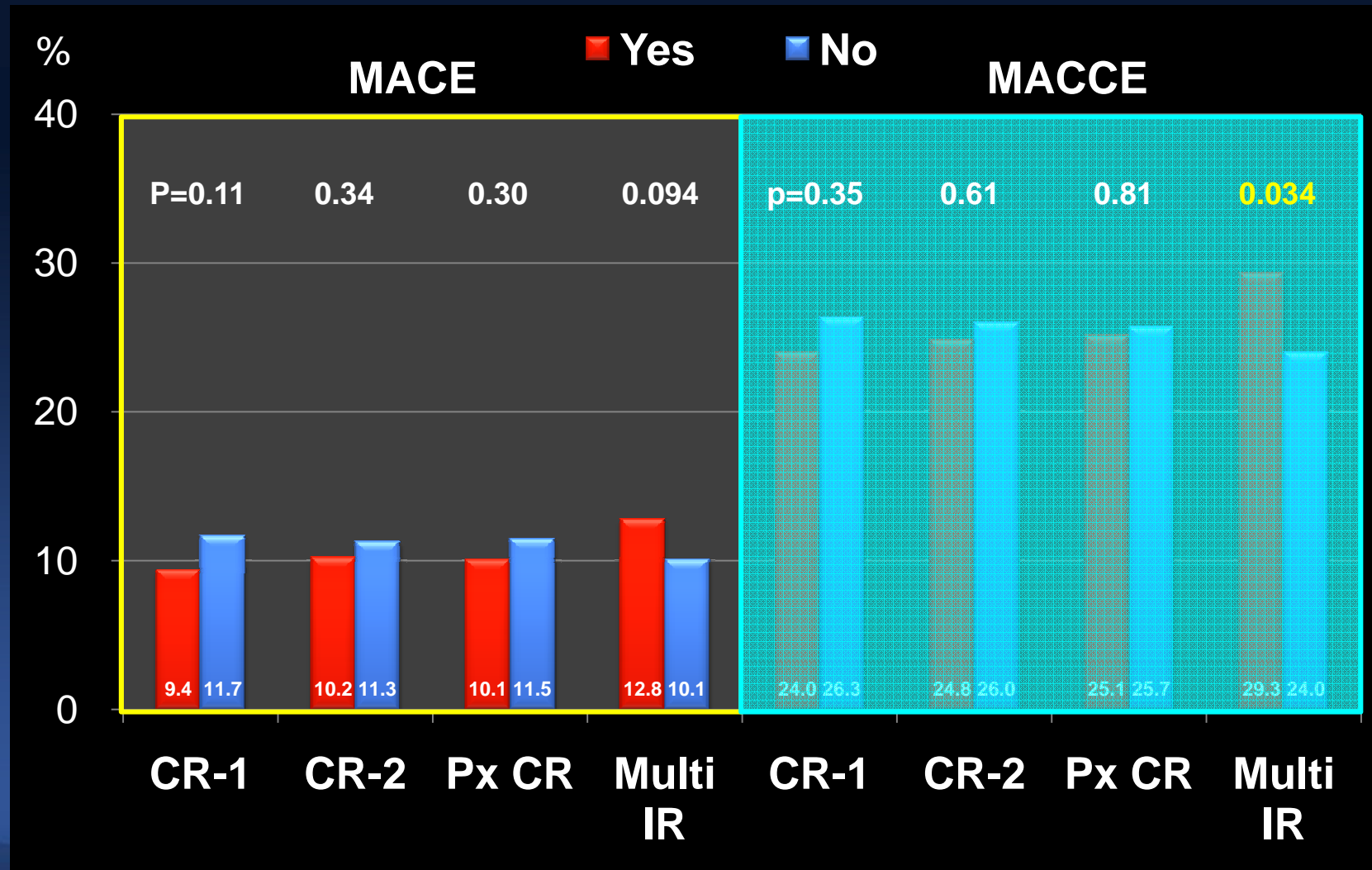
# Cumulative Incidence of Events over 5 Years in All Patients (N=1914)



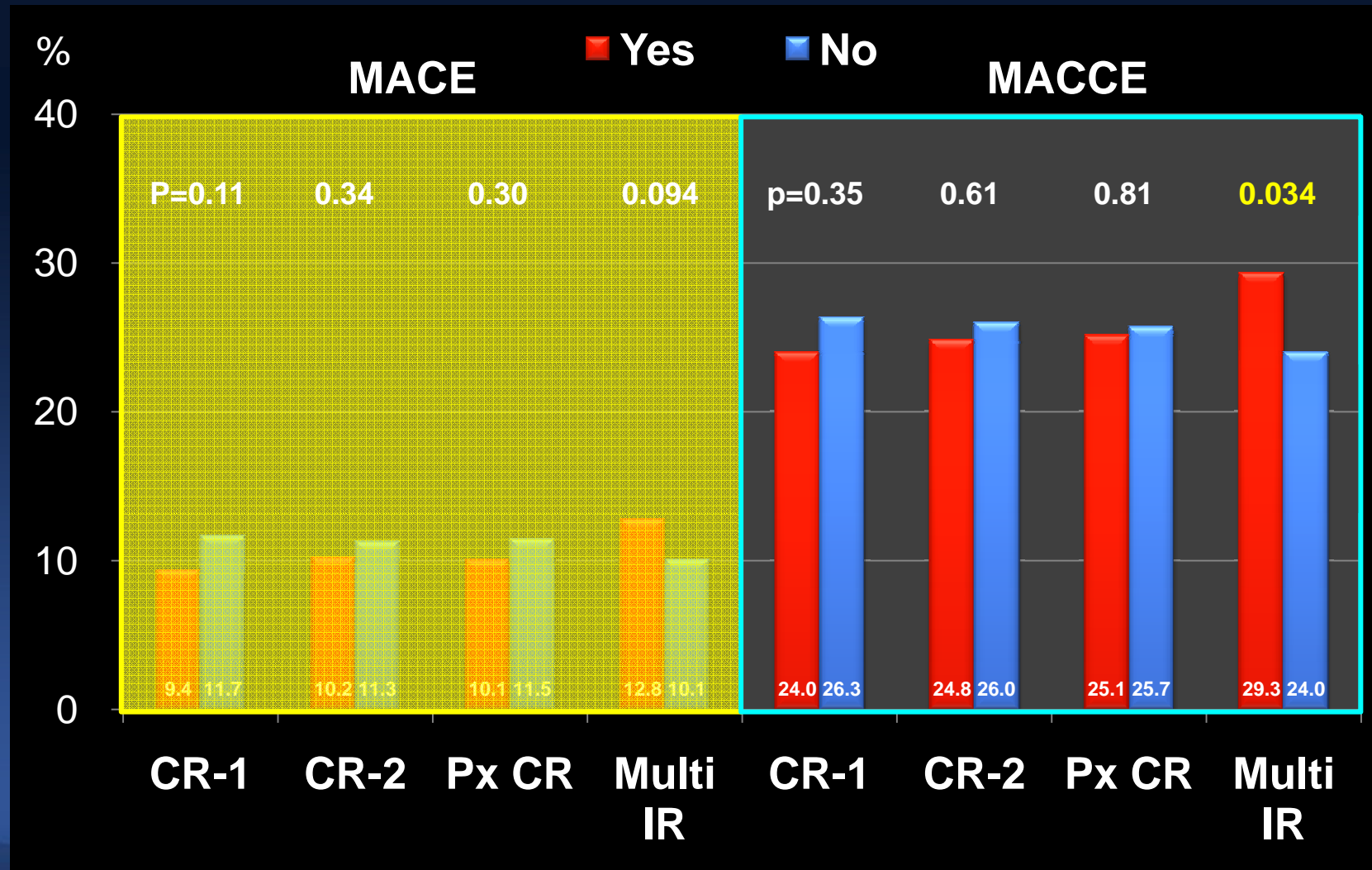
# Cumulative Incidence of Events over 5 Years in All Patients (N=1914)



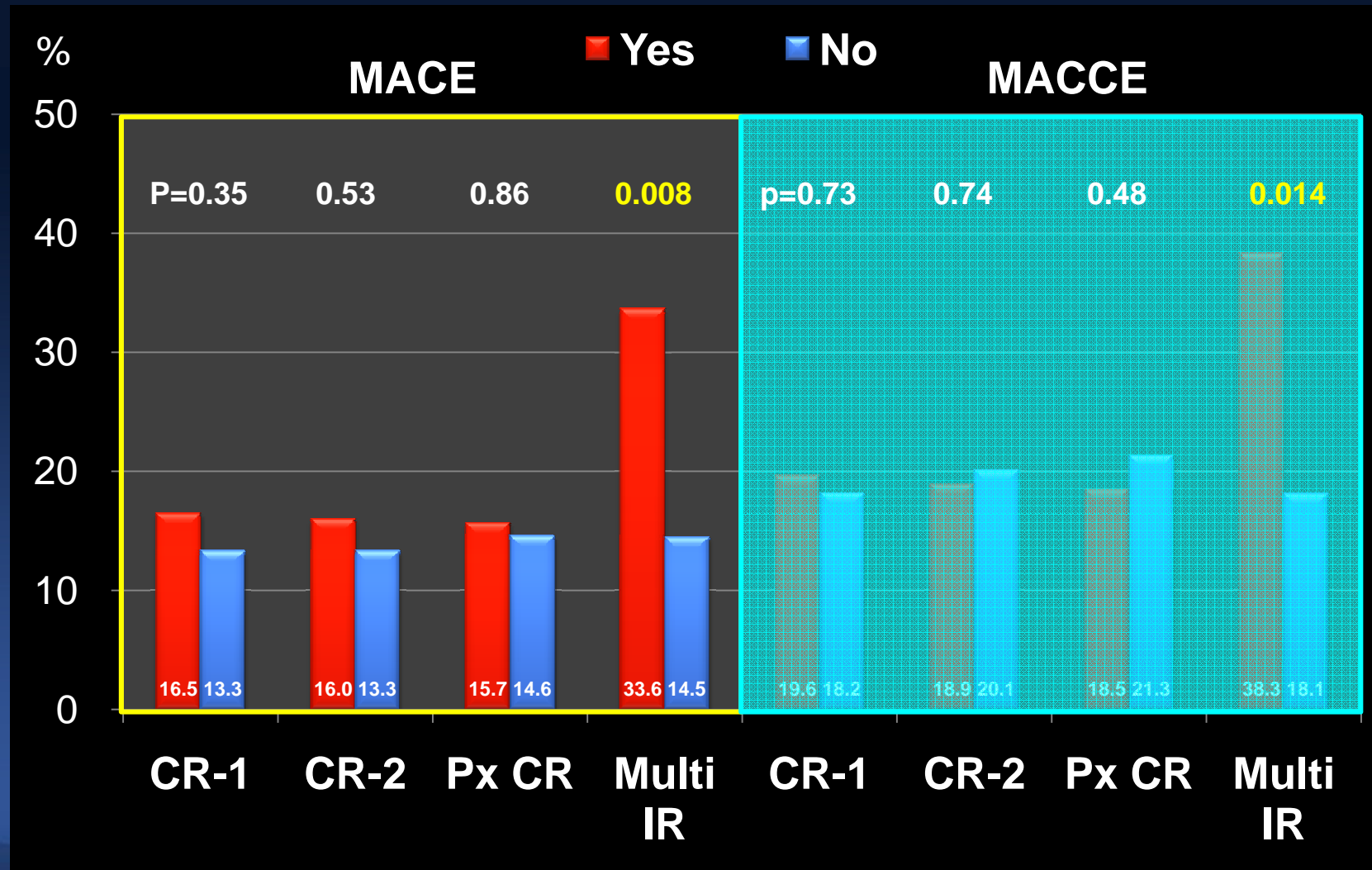
# Cumulative Incidence of Events over 5 Years in PCI Patients (N=1400)



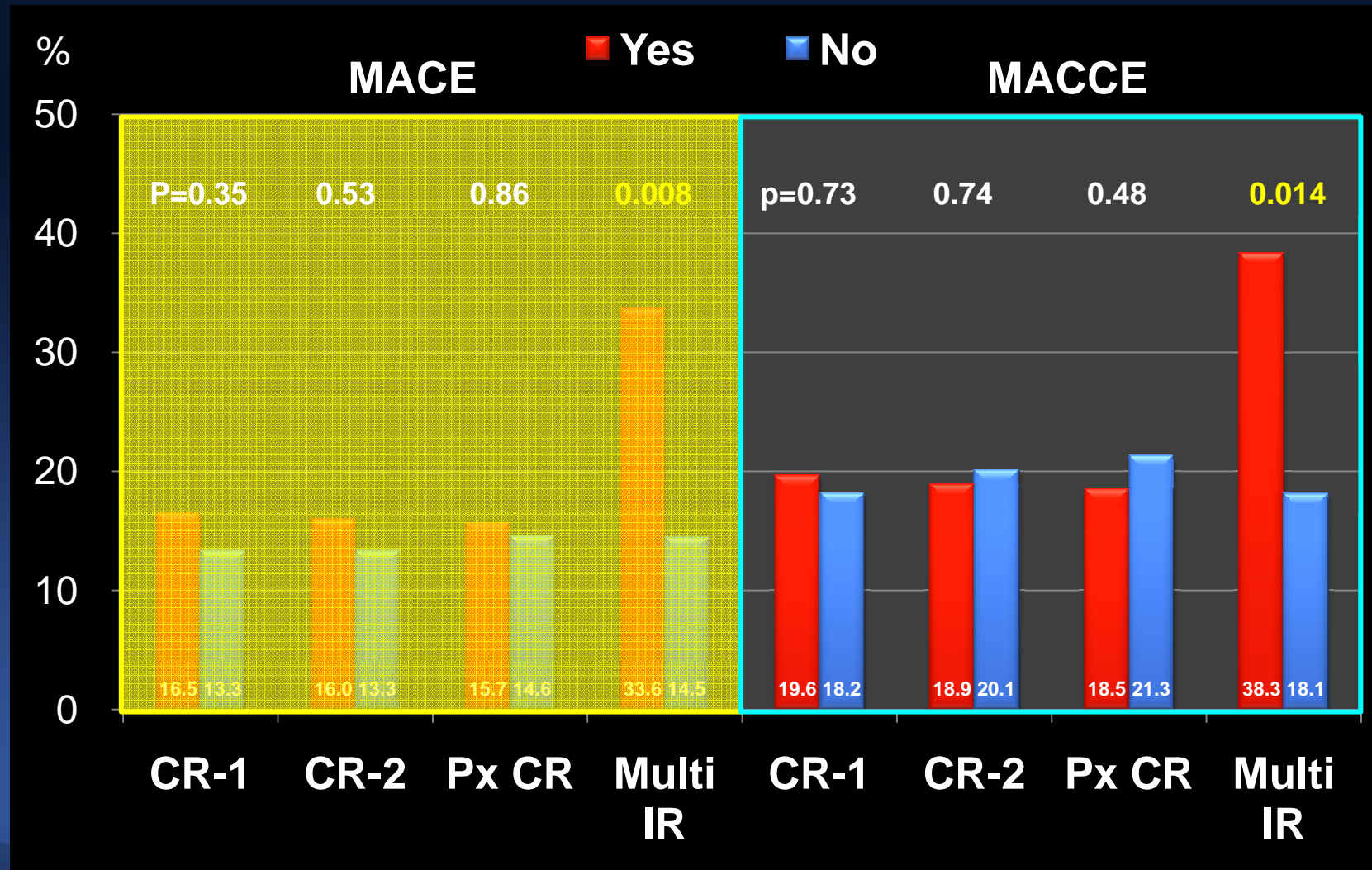
# Cumulative Incidence of Events over 5 Years in PCI Patients (N=1400)



# Cumulative Incidence of Events over 5 Years in CABG Patients (N=514)

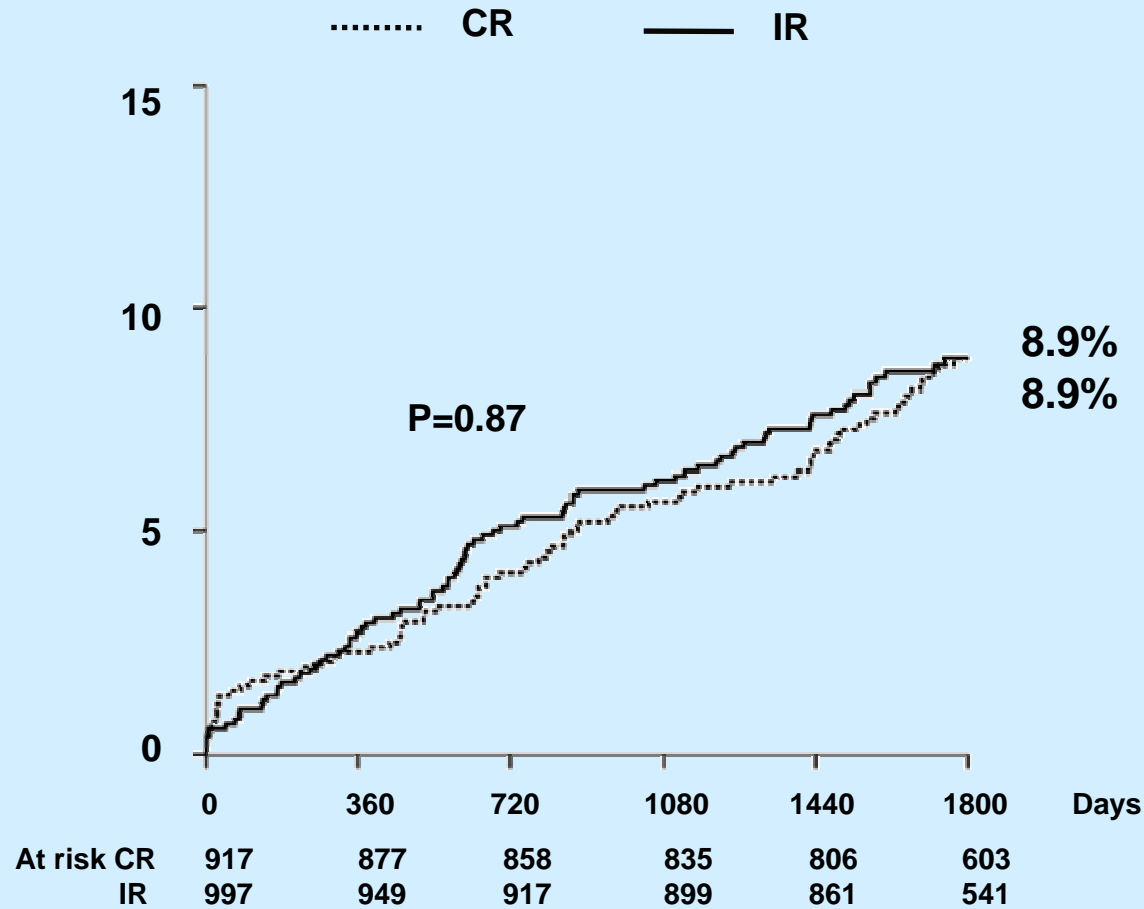


# Cumulative Incidence of Events over 5 Years in CABG Patients (N=514)

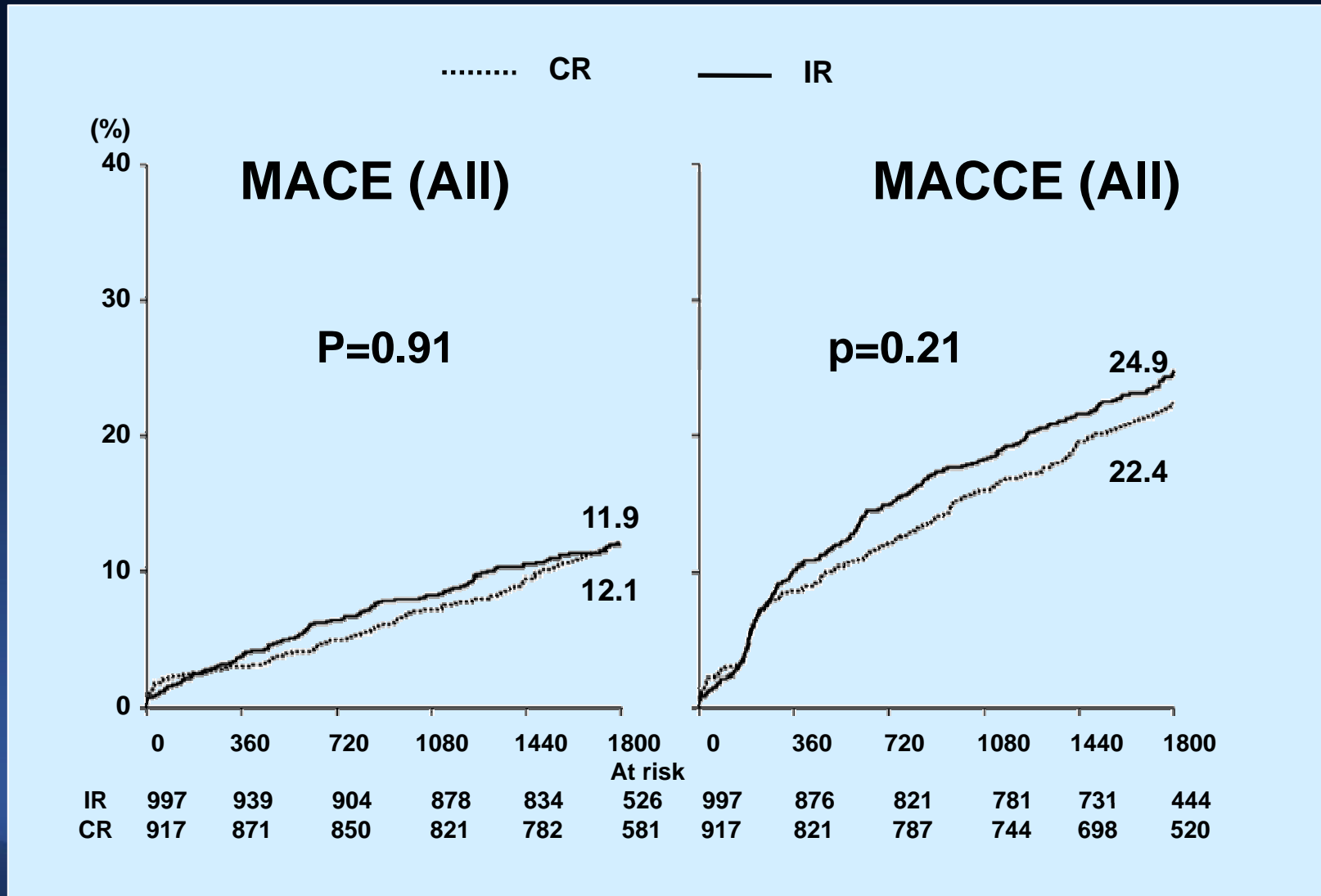




# Unadjusted Mortality By Angiographic CR-1

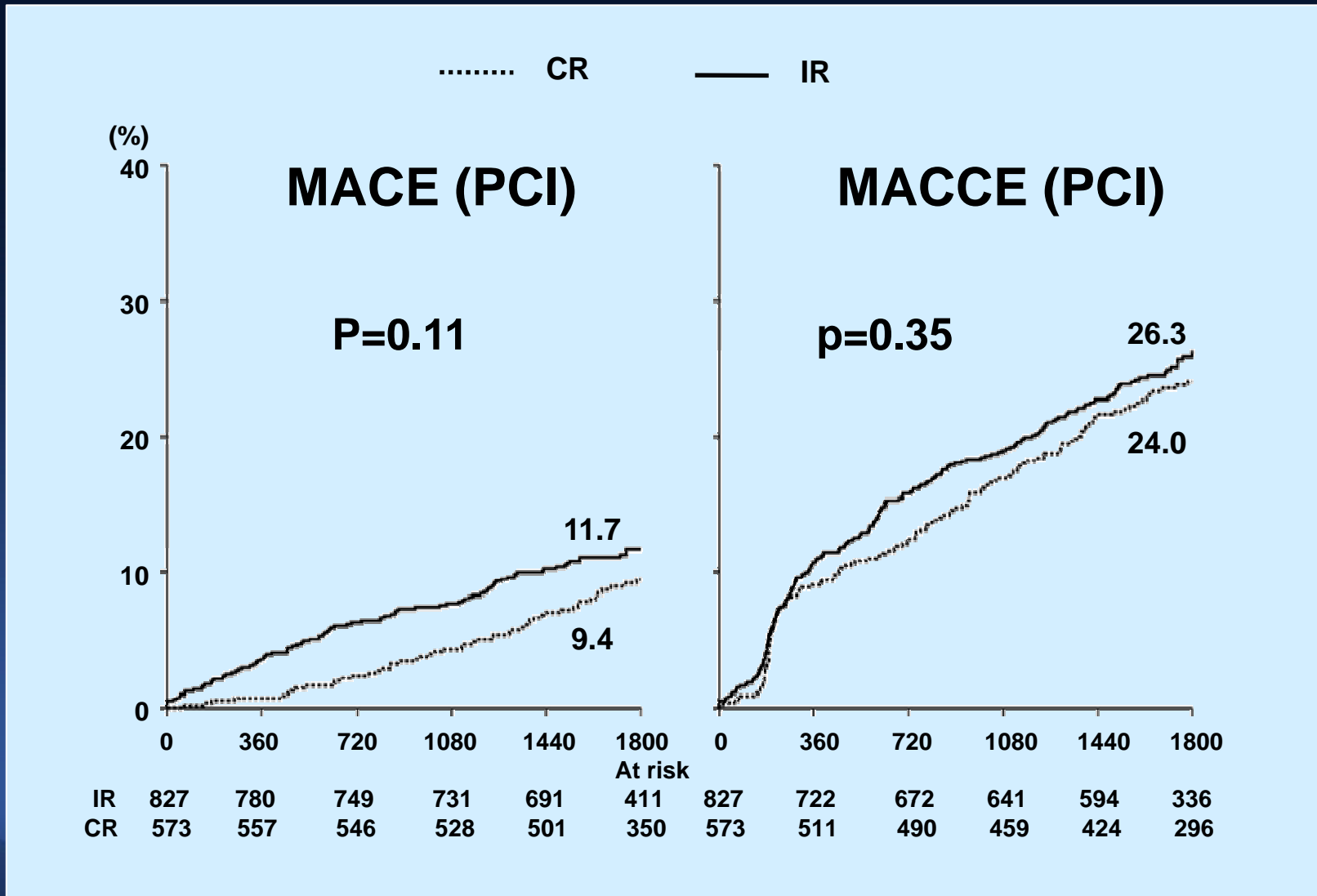


# Unadjusted Outcomes in All Patients By Angiographic CR-1

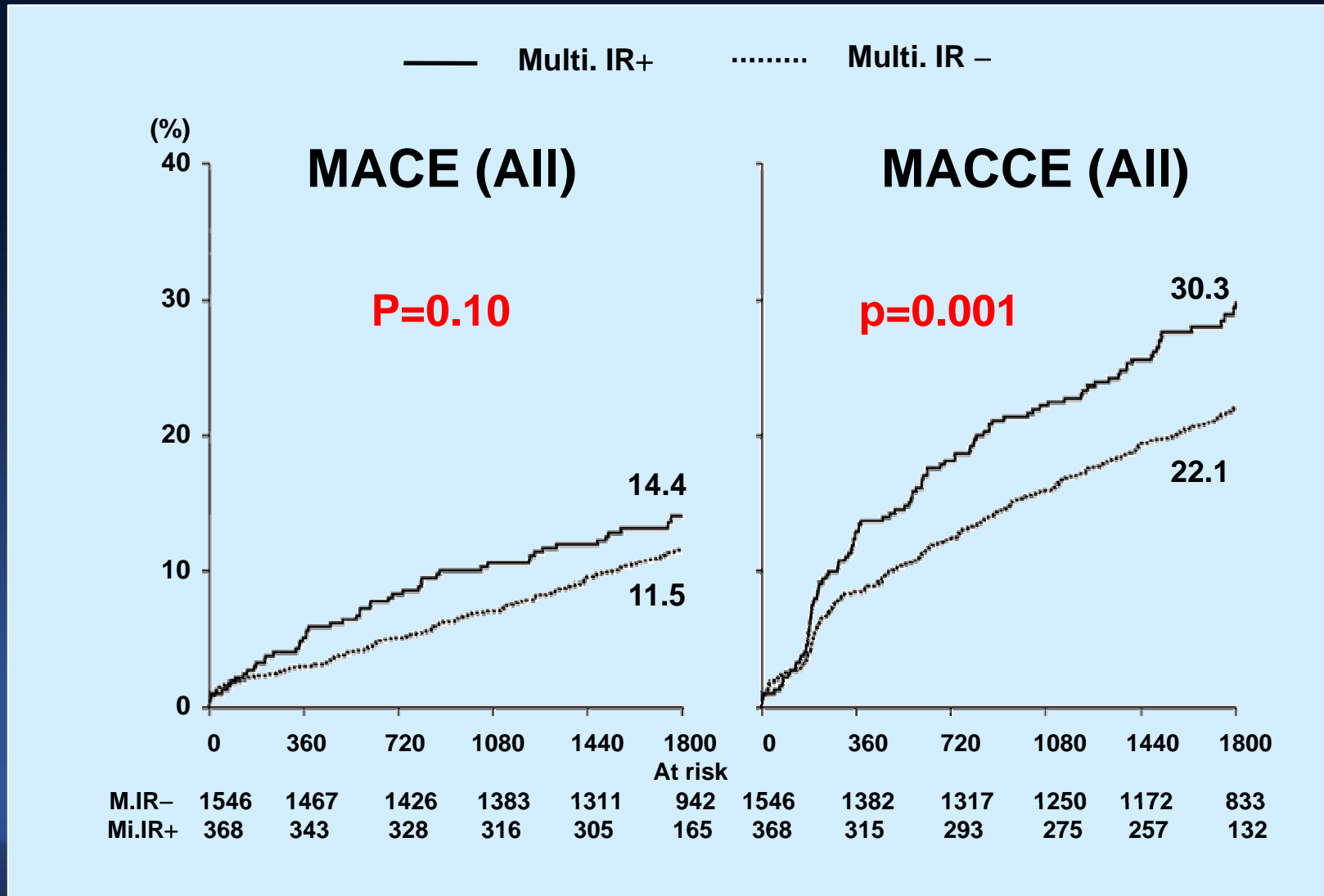


# Unadjusted Outcomes in PCI

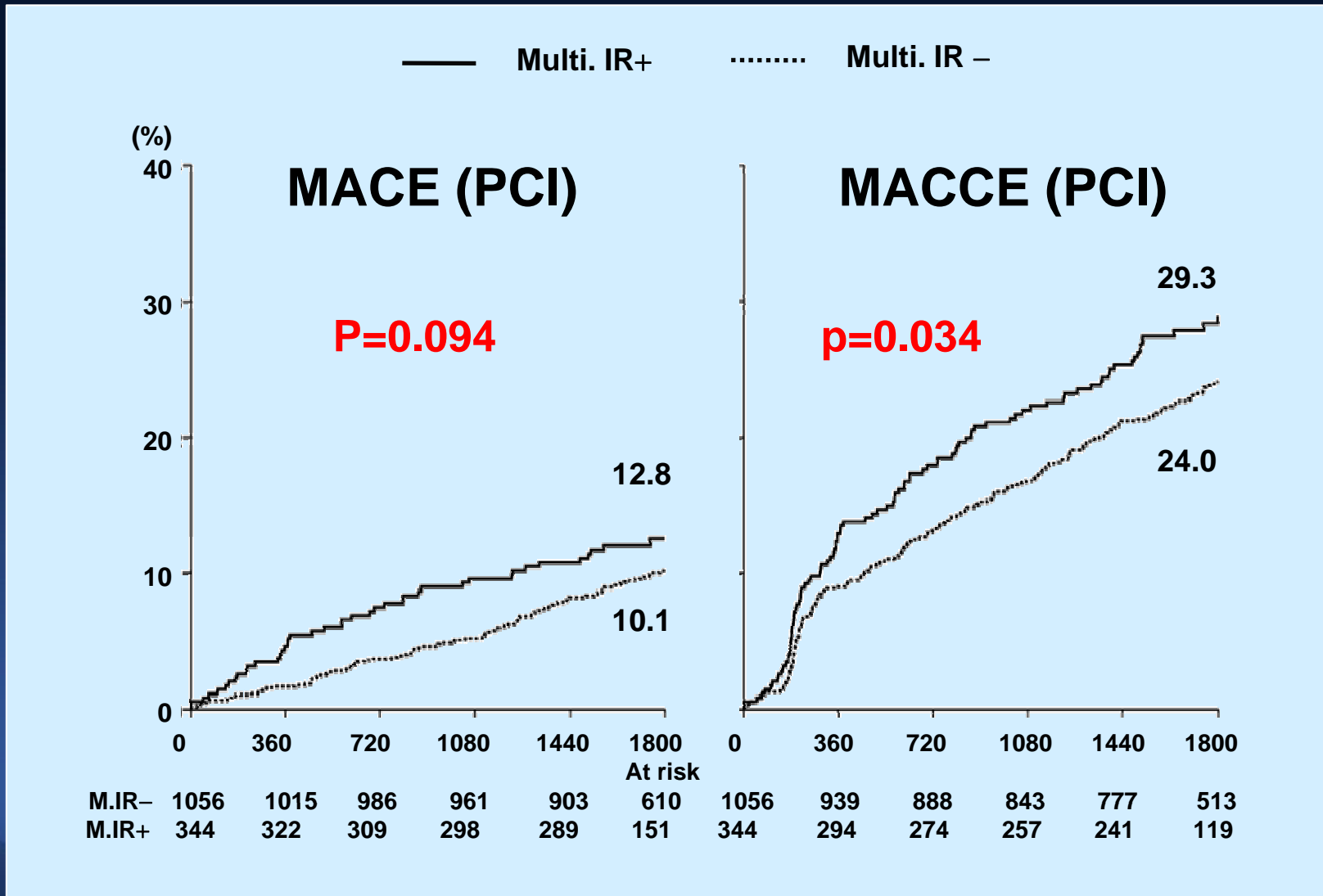
## By Angiographic CR-1



# Unadjusted Outcomes in All Patients By Multivessel IR



# Unadjusted Outcomes in PCI By Multivessel IR



# 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
	<b>Multivessel IR</b>	<b>1.44</b>	<b>1.16</b>	<b>1.79</b>	<b>0.001</b>	<b>1.27</b>	<b>0.97</b>	<b>1.66</b>	<b>0.079</b>
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
	<b>Multivessel IR</b>	<b>1.24</b>	<b>0.98</b>	<b>1.57</b>	<b>0.071</b>	1.20	0.91	1.58	0.19

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

# Conclusions

- Anatomical CR for all angiographic stenoses did not improve the long-term clinical outcomes after either PCI or CABG in patients with MVD.
- However, in patients with extensive coronary artery disease, multivessel IR may be associated with unfavorable long-term clinical outcomes.
- Therefore, the risks and benefits of revascularization treatment may be balanced by an ischemia-guided revascularization strategy.