FFR and Clinical Outcomes; Evidence Has Never Been Stronger

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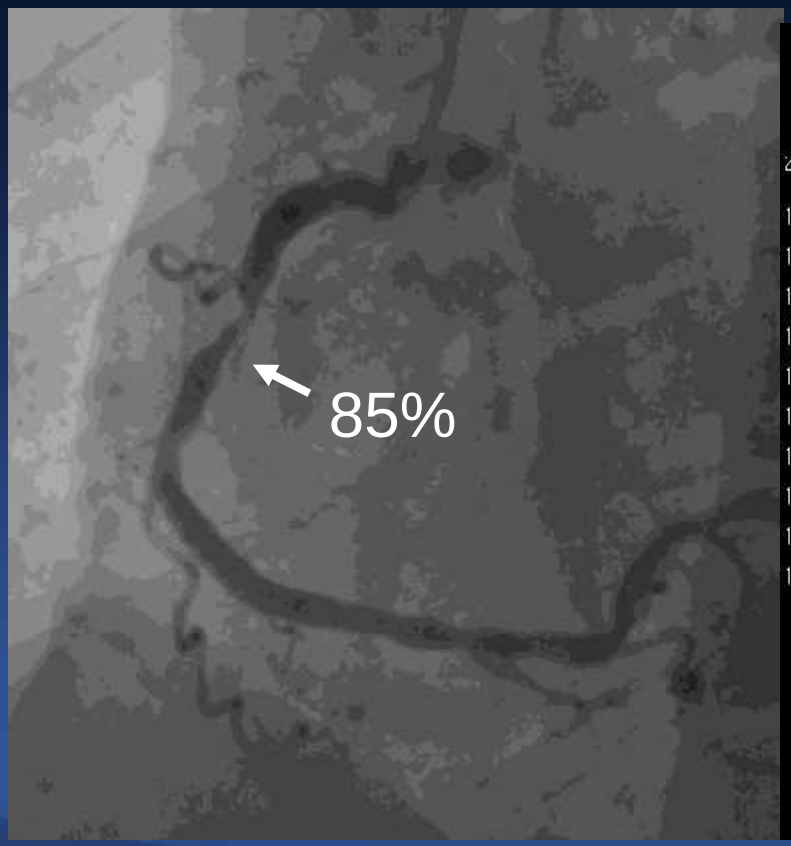
Defer !

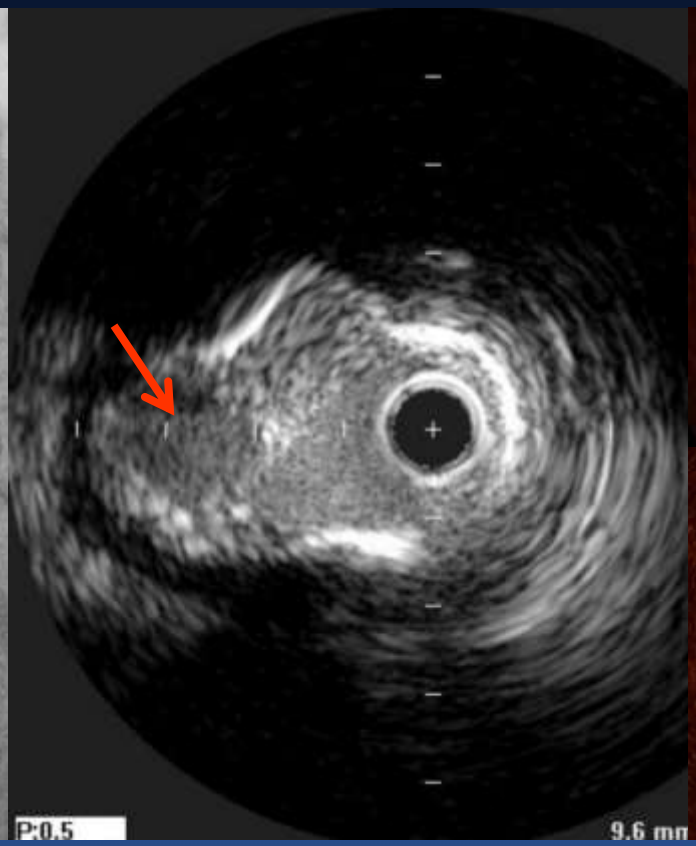
Tight Stenosis

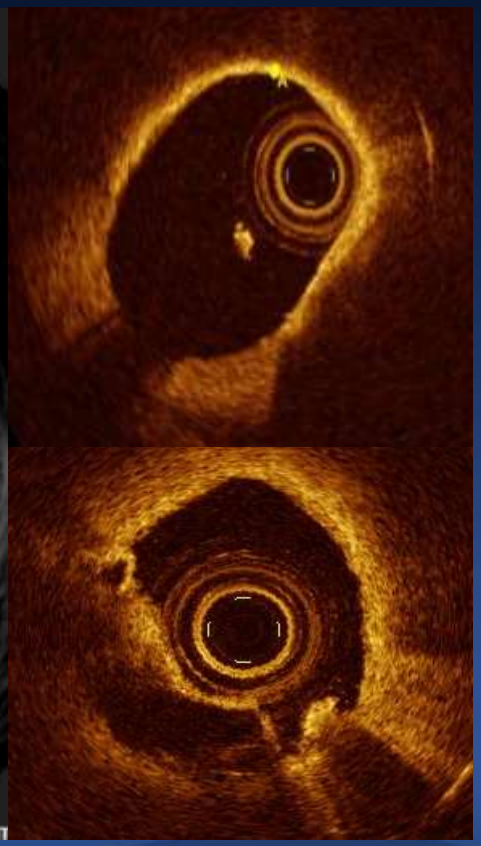
Negative FFR, 0.84



Ruptured Plaque

Rupture and Thrombus

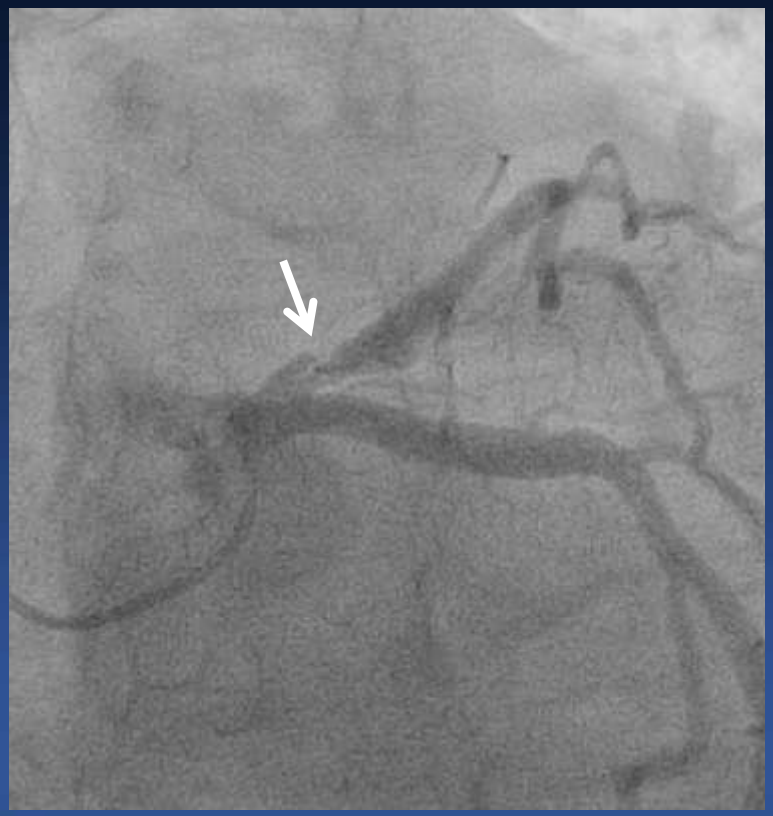




Defer !

Vulnerable Plaque

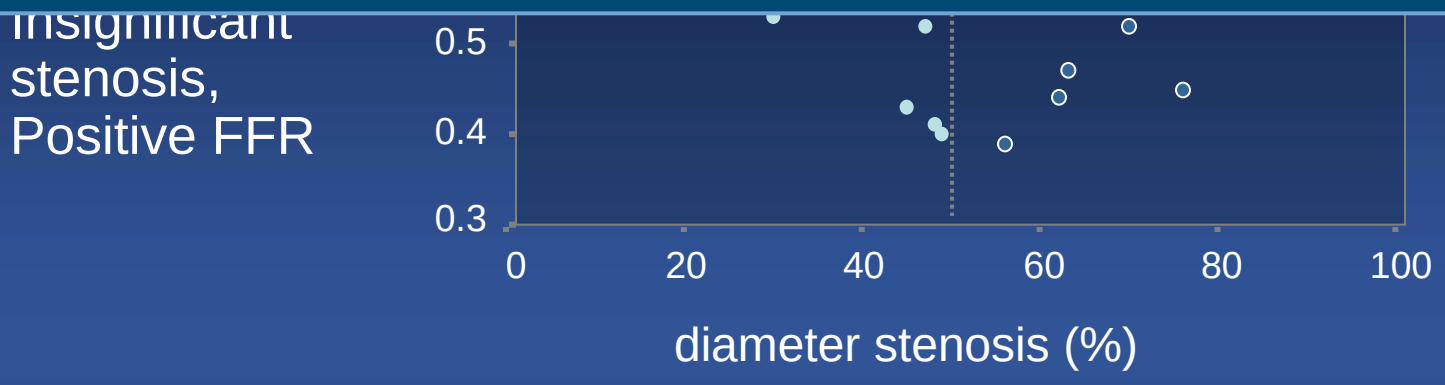
Negative FFR, 0.89



1066 Non-LM lesions, AMC data

We Just Defer !

Even in the Presence of Any Angiographically Proven Coronary Artery Disease.



Park SJ et al, JACC Intv 2012;5:1029 –36

Objective

- To evaluate natural prognosis of deferred or revascularized coronary stenosis after FFR measurement
- To assess the clinical outcome-derived revascularization threshold of FFR in the era of second-generation drug-eluting stent.

The Natural History of FFR-Guided Coronary Intervention Multicenter, Prospective Registry to Evaluate

IRIS FFR Registry

Patients (N=10,000) with ≥1 FFR evaluated Lesions (DS>30% by visual estimation and FFR>0.80)

Clinical Study (N=10,000)

2 Years Clinical F/U

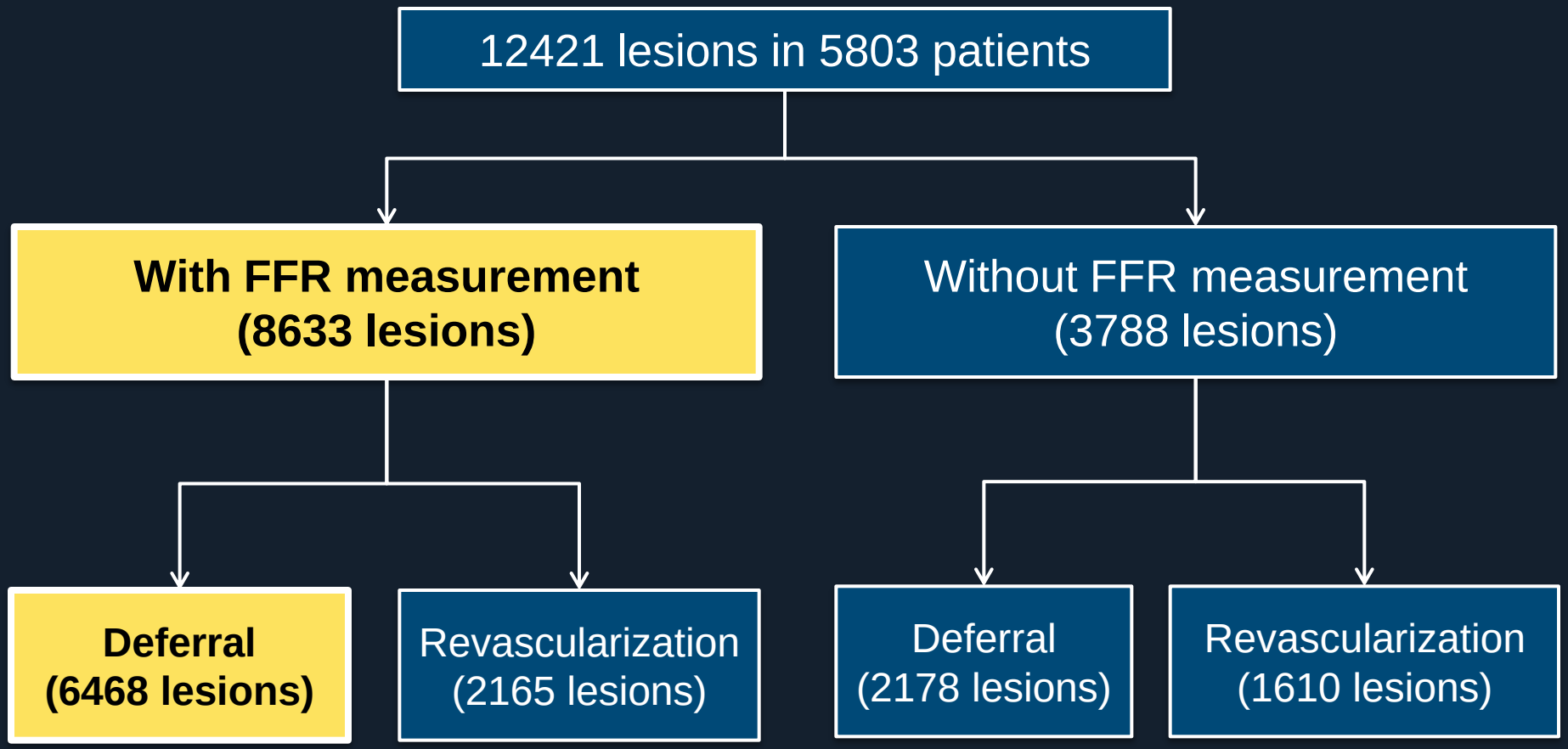
Imaging Study (n=1,200)

2 Years* Imaging F/U (IVUS, VH-IVUS and OCT)

Primary Endpoint : 2 year TVF, Target vessel related Cardiac Death, MI, and Clinical driven TVR

*2-year CAG & Imaging FU will be conducted after Completion of 2 year Clinical FU

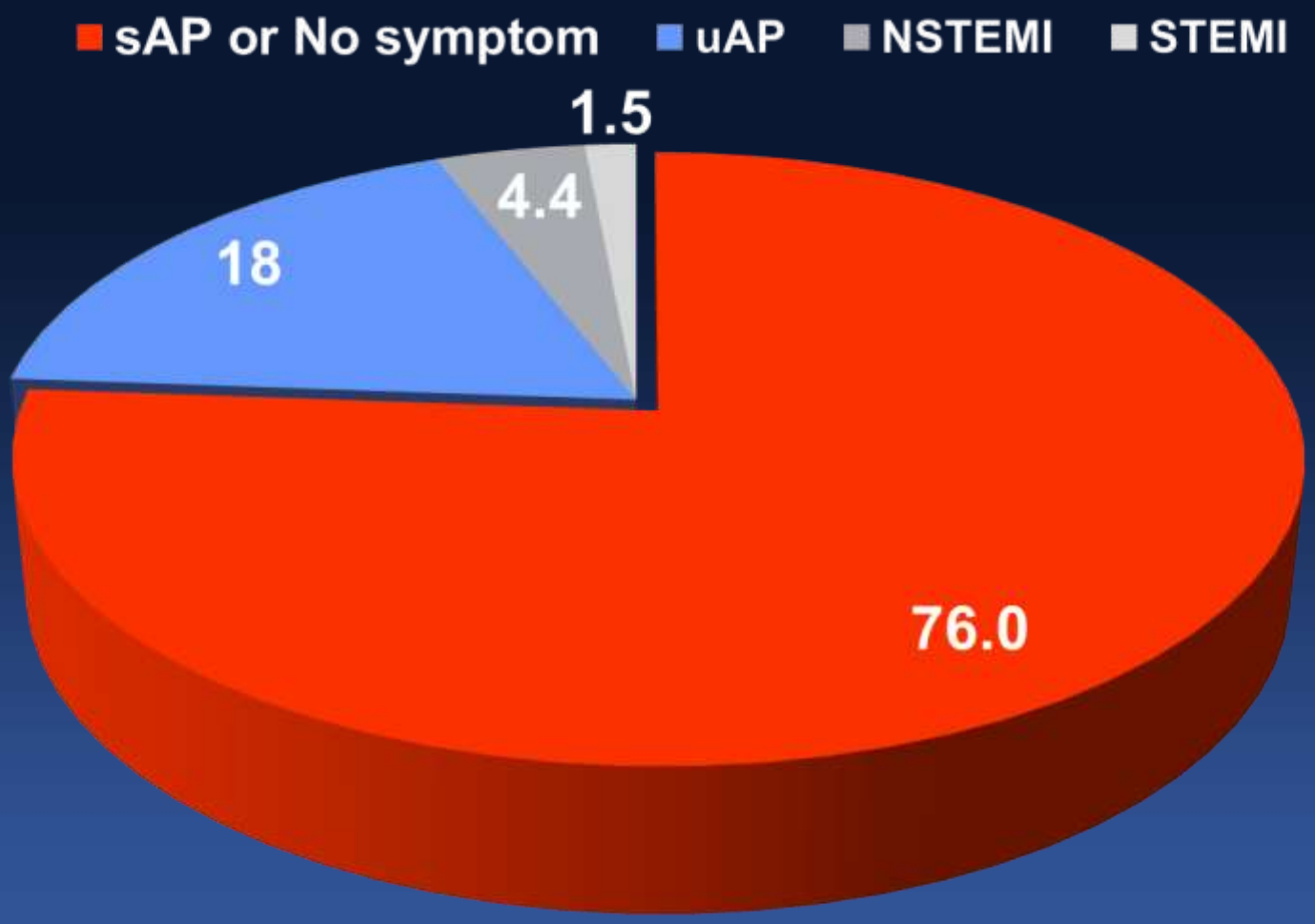
IRIS FFR Registry (2009.8-2015.8)



Patient Characteristics

Variables	N=5803
Age	63.9±9.7
Sex (men)	4151 (71.5%)
Diabetes	1795 (30.9%)
Hypertension	3665 (63.2%)
Current smoker	1392 (24.0%)
Hyperlipidemia	3481 (60.0%)
Previous myocardial infarction	377 (6.5%)
Previous PCI	1133 (19.5%)
Previous stroke	340 (5.9%)
Chronic renal failure	116 (2.0%)
Chronic lung disease	125 (2.2%)
Peripheral artery disease	139 (2.4%)
Family history	595 (10.3%)

Clinical Presentation



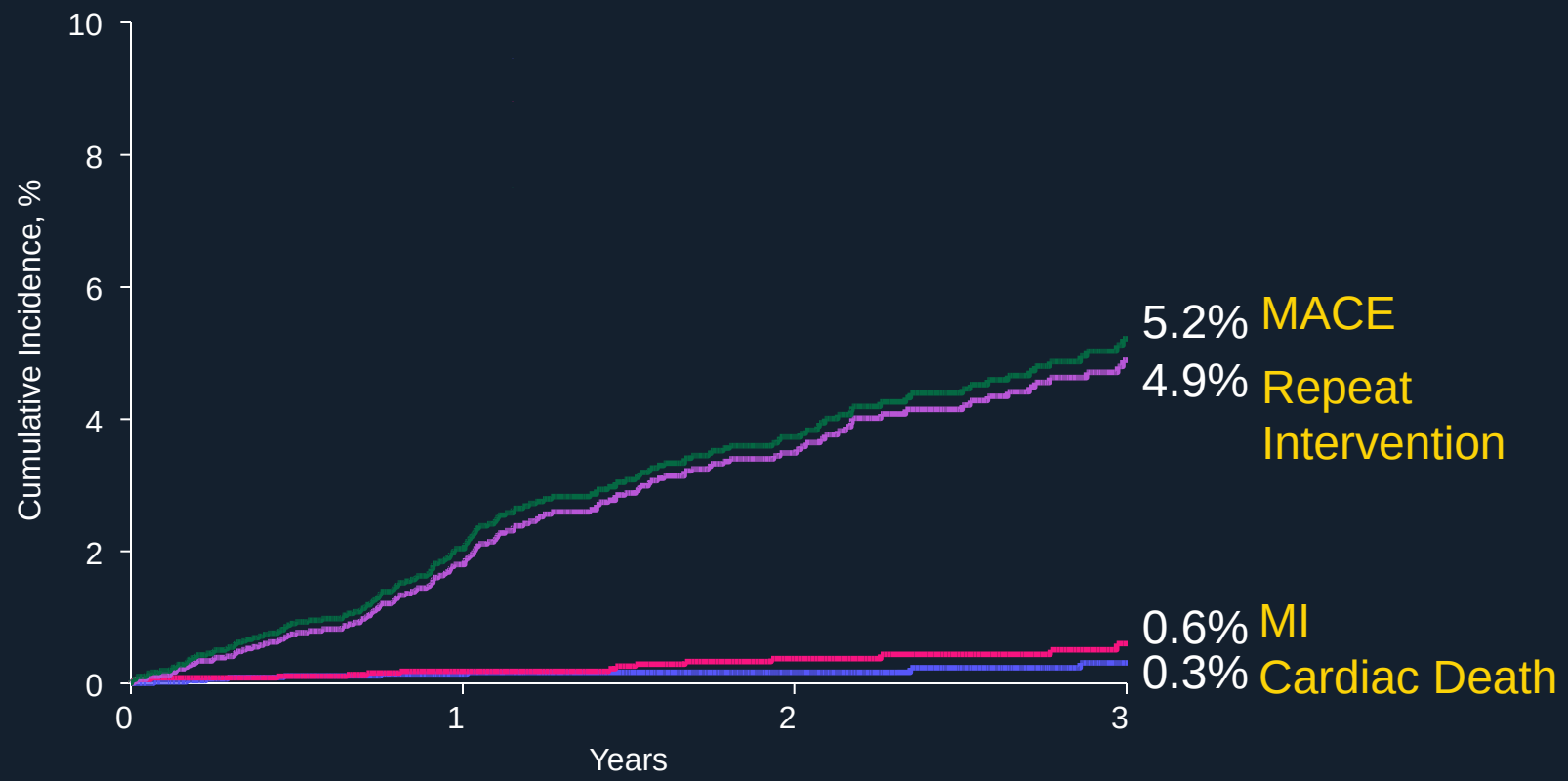
Lesion Characteristics

Variables	N=8633
Lesion territory	
Left main	345 (4.1%)
Left anterior descending artery	4372 (50.6%)
Left circumflex artery	2070 (24.0%)
Right coronary artery	1407 (16.3%)
ACC/AHA B2C lesion	4819 (55.8%)
Long lesion (>20mm)	3680 (42.6%)
Moderate to severe calcification	269 (3.1%)
Diameter stenosis	
30-50%	2659 (30.7%)
50-70%	4057 (47.0%)
70-99%	1854 (21.5%)

FFR

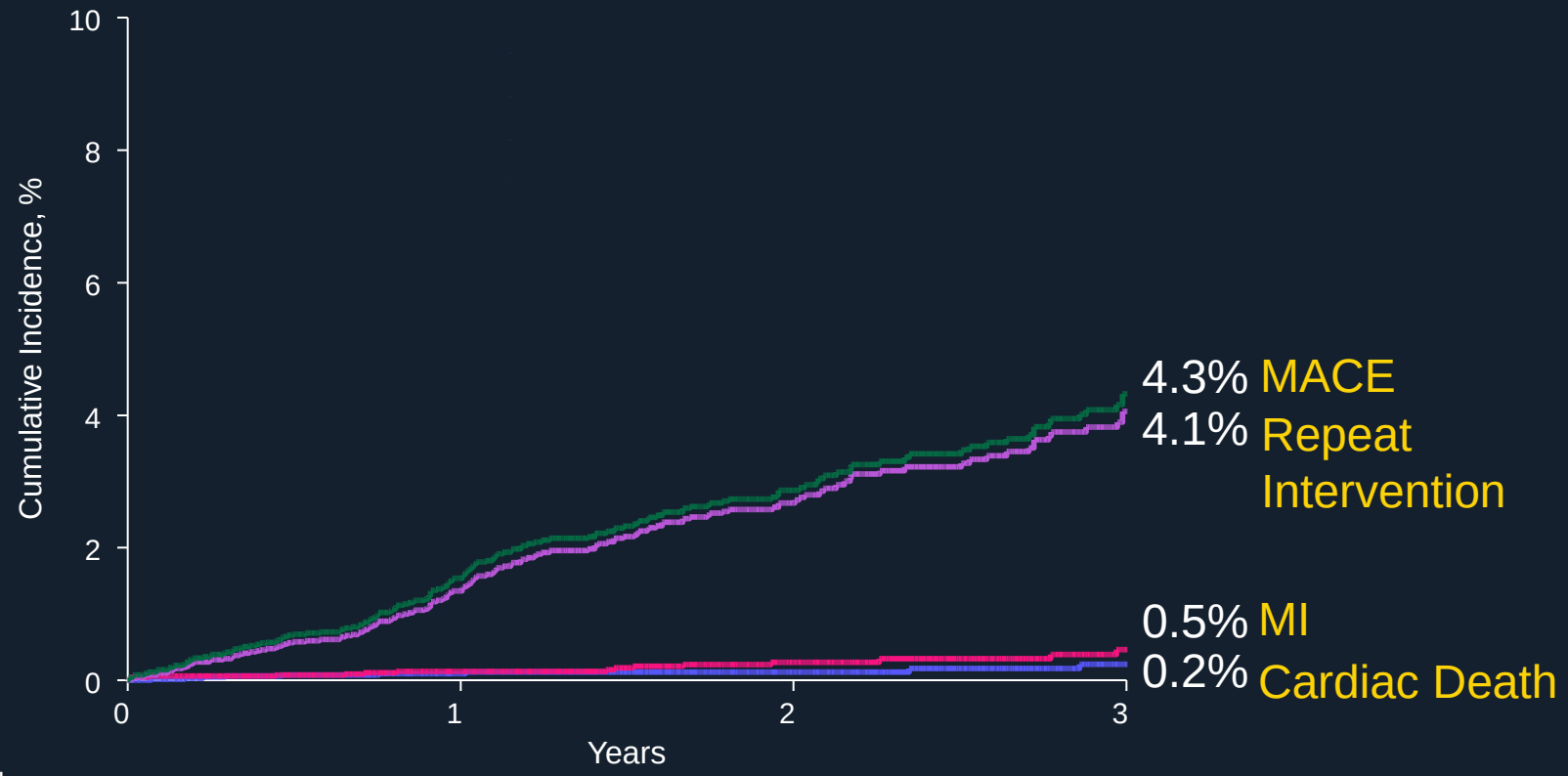
Variables	8633 lesions
Fractional flow reserve	
Mean	0.83±0.11
Median	0.85 (0.77, 0.91)
<0.75	1903 (22.1%)
0.75-0.80	1001 (11.6%)
>0.80	5729 (66.3%)
Route of adenosine	
Intravenous	7881 (91.3%)
Intracoronary	752 (8.7%)
Hyperemic Agent	
Adenonsine	8393 (97.2%)
Others	240 (2.8%)

Deferred Lesion Outcome at 3 Year (per Patient)



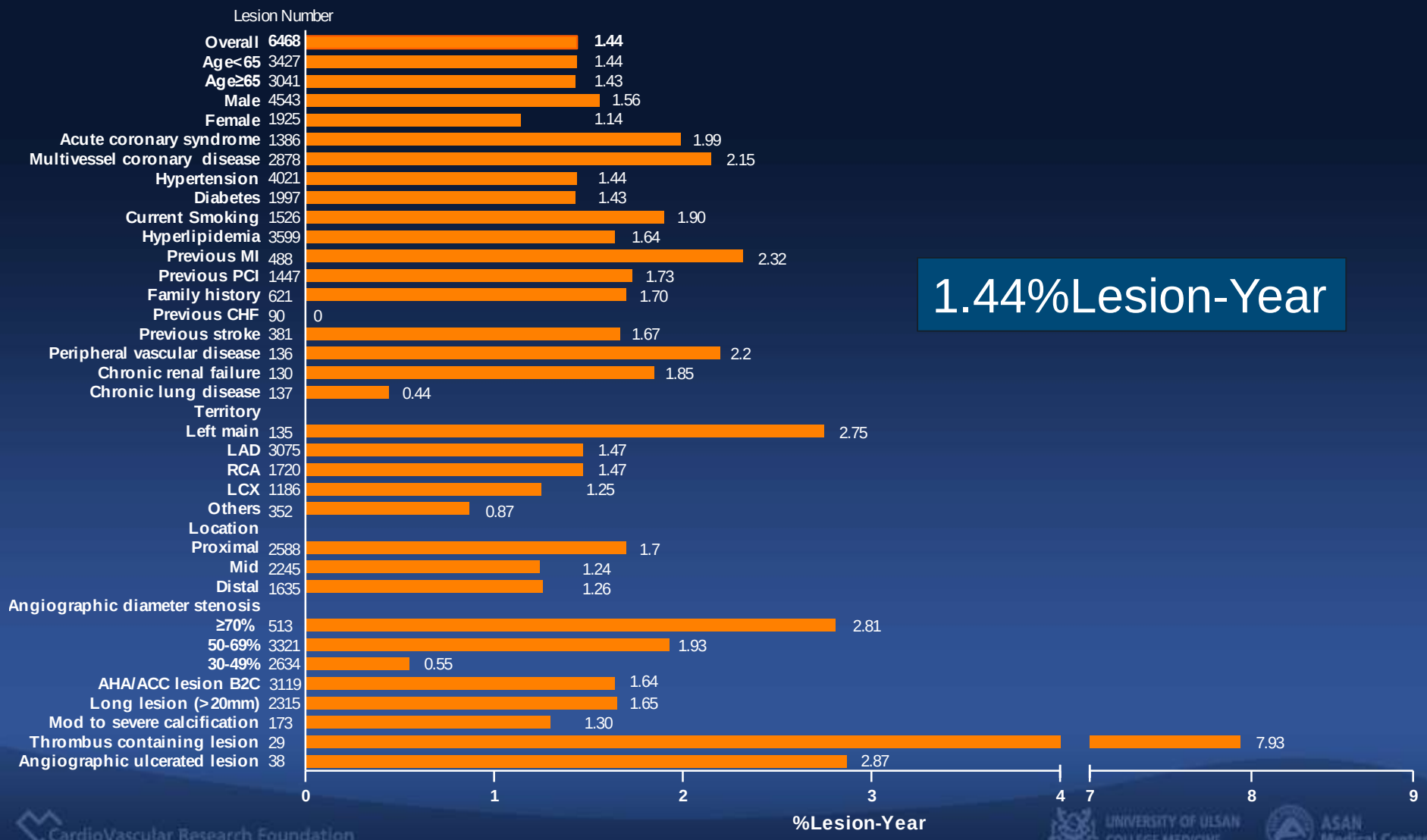
Cardiac Death	4608	3393	2069	1036
Myocardial Infarction	4608	3445	2107	1059
Repeat Intervention	4608	3337	1998	987
MACE	4608	3333	1996	987

Deferred Lesion Outcome at 3 Year (per Lesion)



Cardiac Death	6468	4745	2675	1229
Myocardial Infarction	6468	4740	2669	1225
Repeat Intervention	6468	4685	2599	1174
MACE	6468	4681	2597	1174

Incidence Rate of Deferred Lesion Failure



1.44%Lesion-Year

CardioVascular Research Foundation

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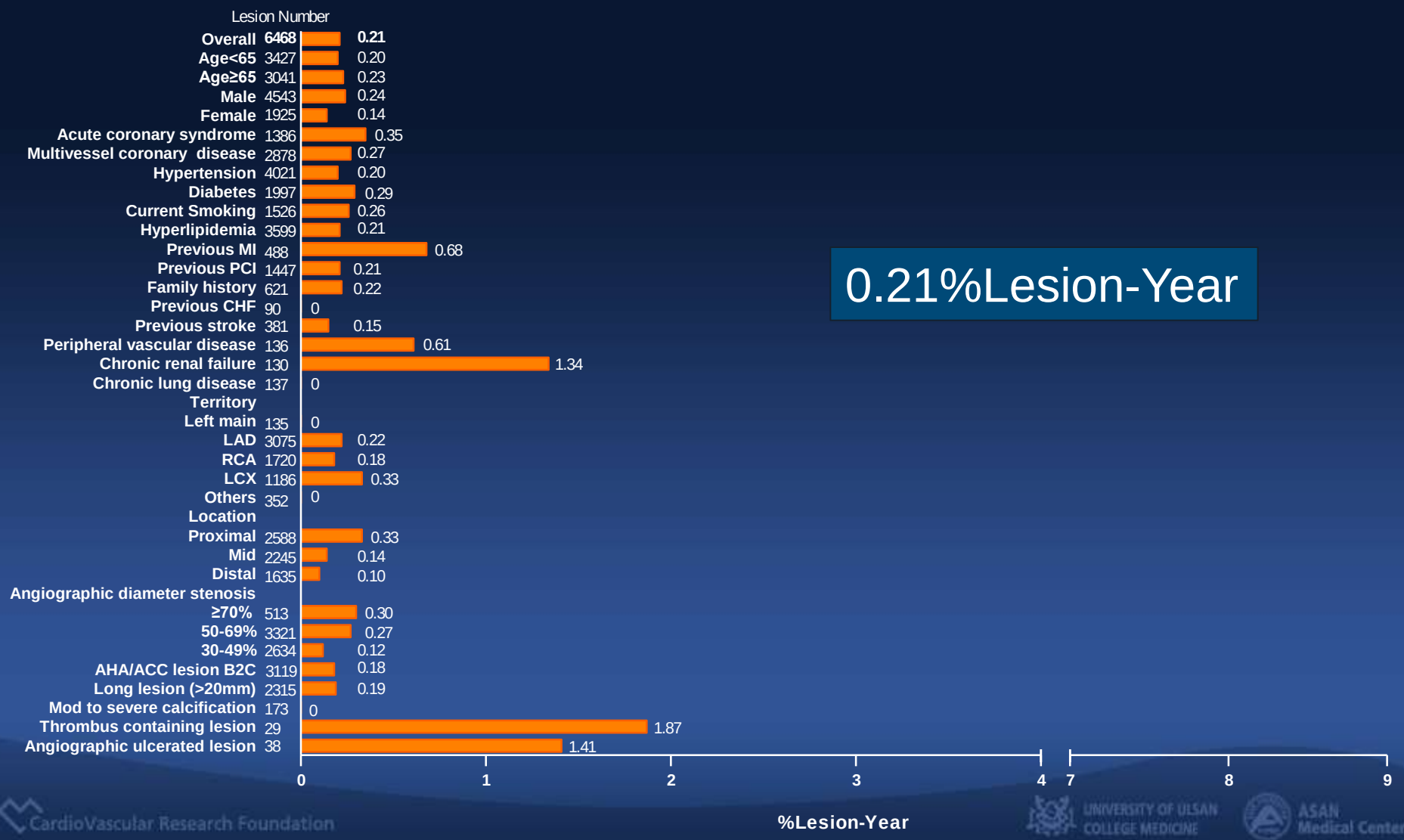
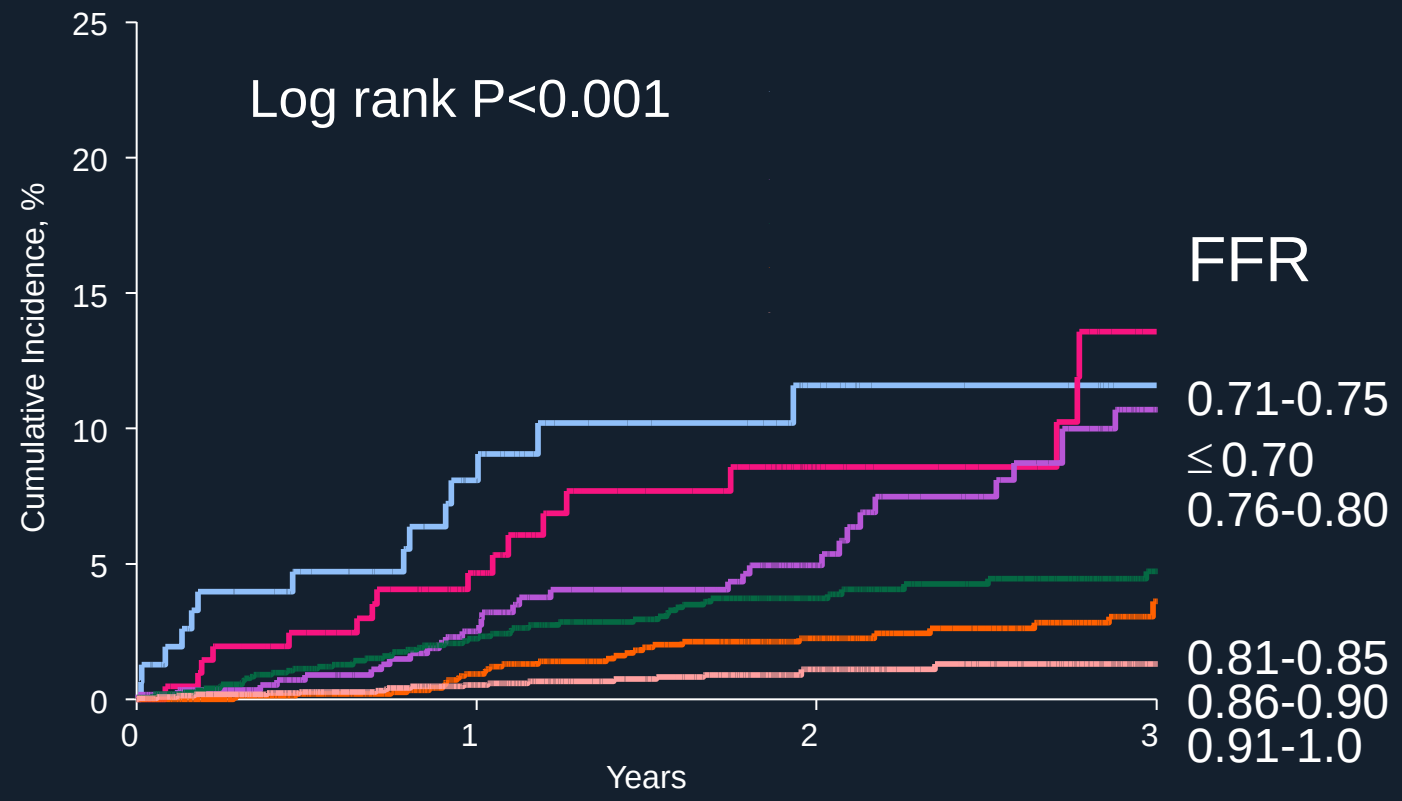
Incidence Rate of Cardiac Death/MI



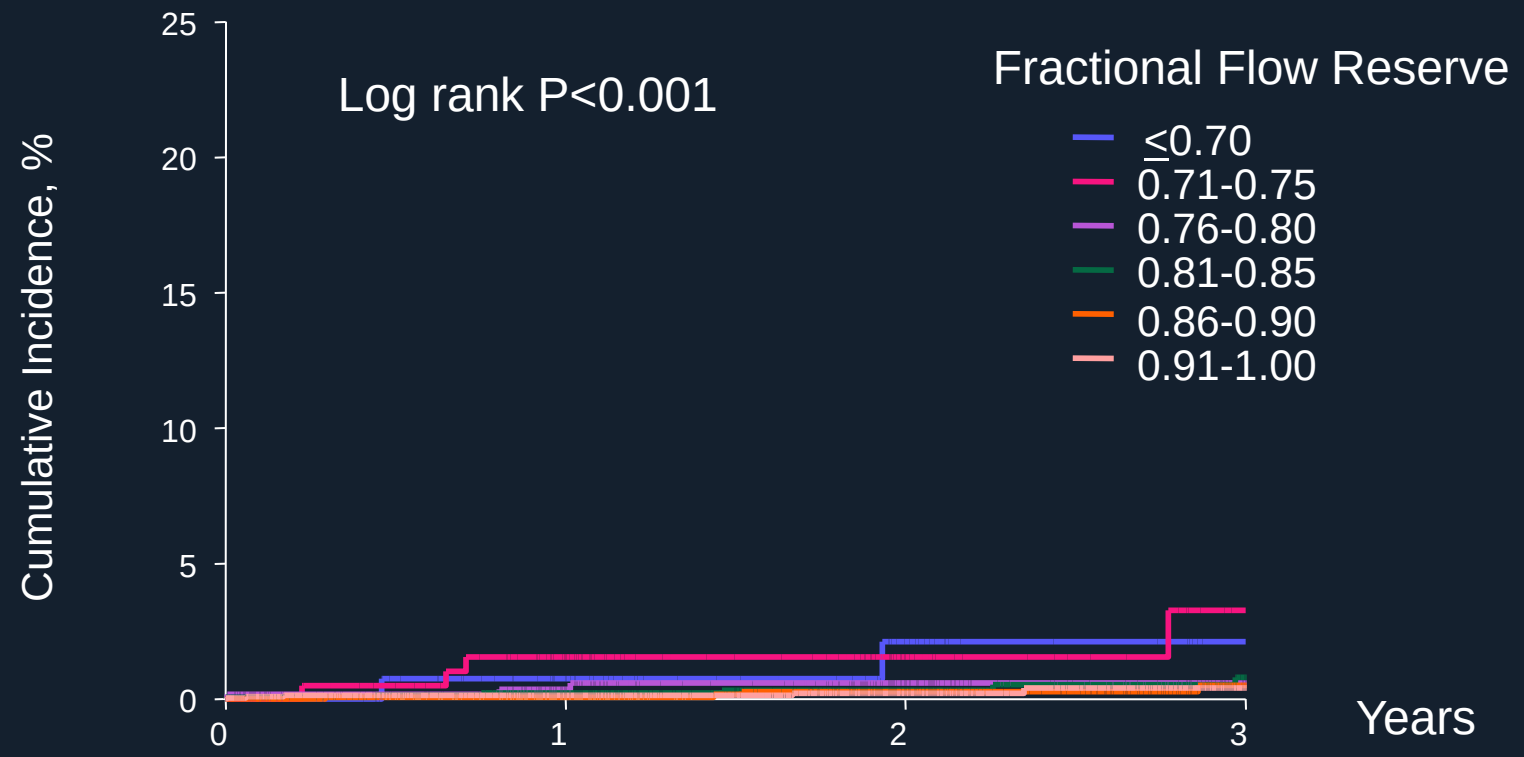
0.21%Lesion-Year

Deferred Lesion Failure



≤0.70	156	99	56	27
0.71-0.75	212	155	73	43
0.76-0.80	596	430	240	110
0.81-0.85	1510	1088	656	333
0.86-0.90	1665	1214	696	338
0.91-1.0	2328	1695	877	328

Cardiac Death or MI



≤0.70	156	109	60	27
0.71-0.75	212	160	78	45
0.76-0.80	596	440	253	126
0.81-0.85	1510	1109	682	350
0.86-0.90	1665	1220	708	348
0.91-1.0	2328	1703	888	333

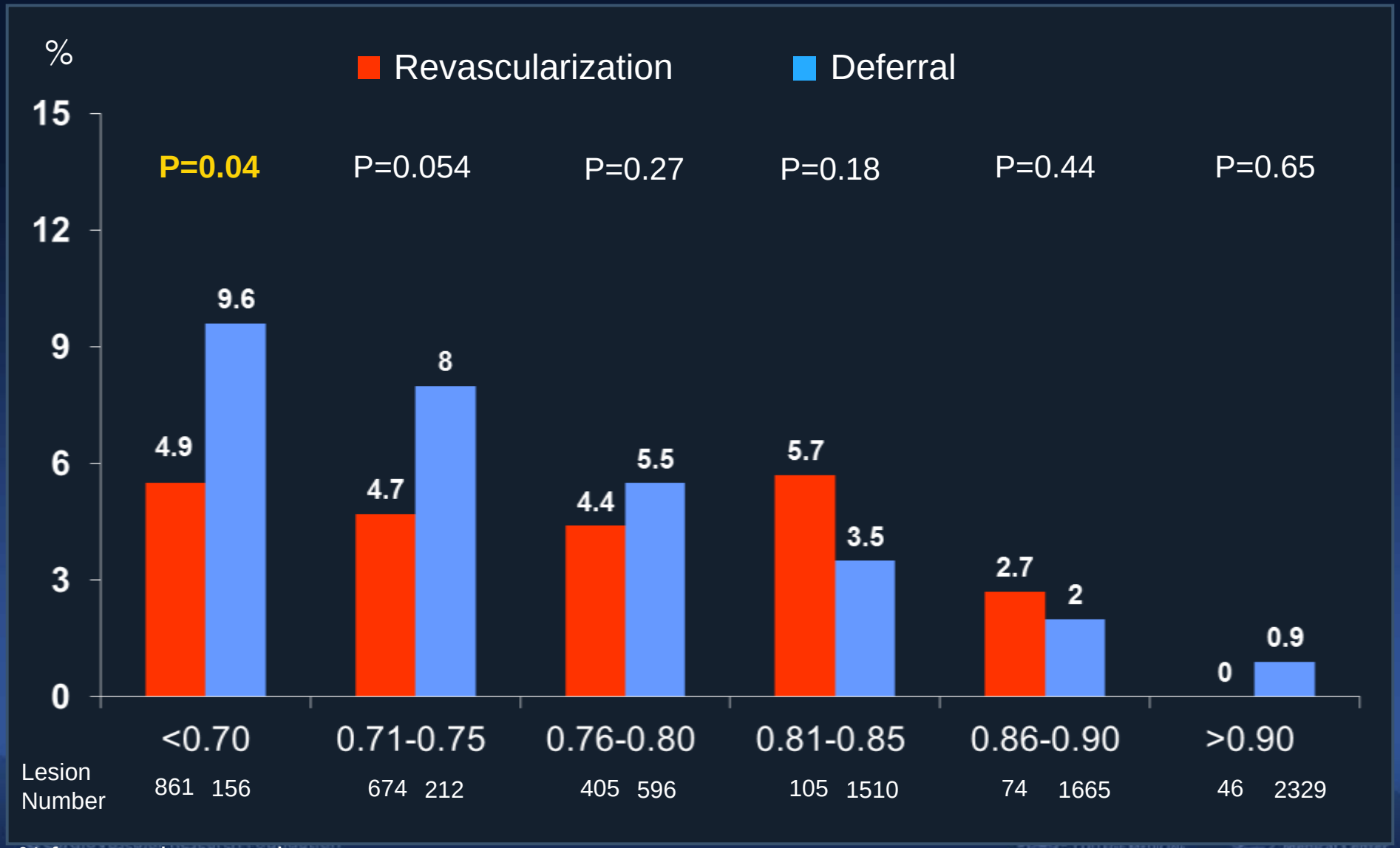
Adjusted Risk of Deferred Lesion Outcomes

	FFR as categorical variables						
	Hazard ratio (95% confidence interval)						
FFR	≤0.70 (N=156)	0.71-0.75 (N=212)	0.76-0.80 (N=596)	0.81-0.85 (N=1510)	0.86-0.90 (N=1665)	0.91-1.00 (N=2329)	P for trend
Deferred lesion Failure	4.17 (2.45 – 7.11)	3.72 (2.17 – 6.39)	3.85 (2.29 – 6.47)	2.91 (1.76 – 4.80)	1.69 (0.98 – 2.89)	1 Reference	< 0.001
Cardiac death	1.64 (0.21 – 12.8)	1.64 (0.21 – 12.9)	1.82 (0.29 – 11.4)	0.41 (0.03 – 5.36)	0.74 (0.11 – 4.96)	1 Reference	0.378
MI	6.97 (1.97 – 24.6)	6.42 (1.78 – 23.2)	4.91 (1.30 – 18.6)	2.70 (0.70 – 10.5)	1.03 (0.21 – 5.10)	1 Reference	< 0.001
Cardiac death or MI	5.59 (2.02 – 15.4)	5.18 (1.84 – 14.5)	3.76 (1.28 – 11.1)	1.95 (0.63 – 6.0)	1.06 (0.31 – 3.69)	1 Reference	< 0.001
Deferred lesion Intervention	3.92 (2.18 – 7.05)	3.71 (2.06 – 6.70)	3.75 (2.12 – 6.63)	3.20 (1.86 – 5.50)	1.92 (1.07 – 3.44)	1 Reference	< 0.001

Predictors of Deferred Lesion Failure

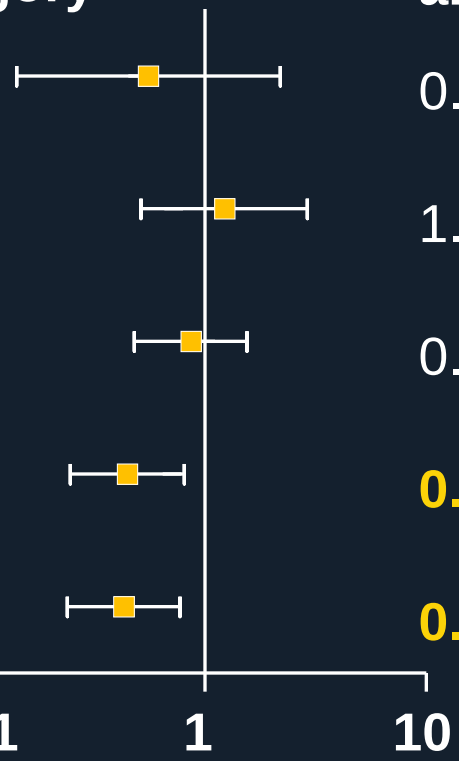
	HR (95% CI)	P value
FFR (by increase of 0.01)	0.94 (0.93-0.96)	<0.001
Multivessel CAD	1.66 (1.19-2.33)	0.003
Thrombus containing lesion	5.46 (1.98-15.0)	0.001
Diameter stenosis		<0.001
30-50%	1 (reference)	
50-70%	2.20 (1.41-3.44)	<0.001
>70%	2.50 (1.41-4.44)	0.002

Major Adverse Cardiac Events



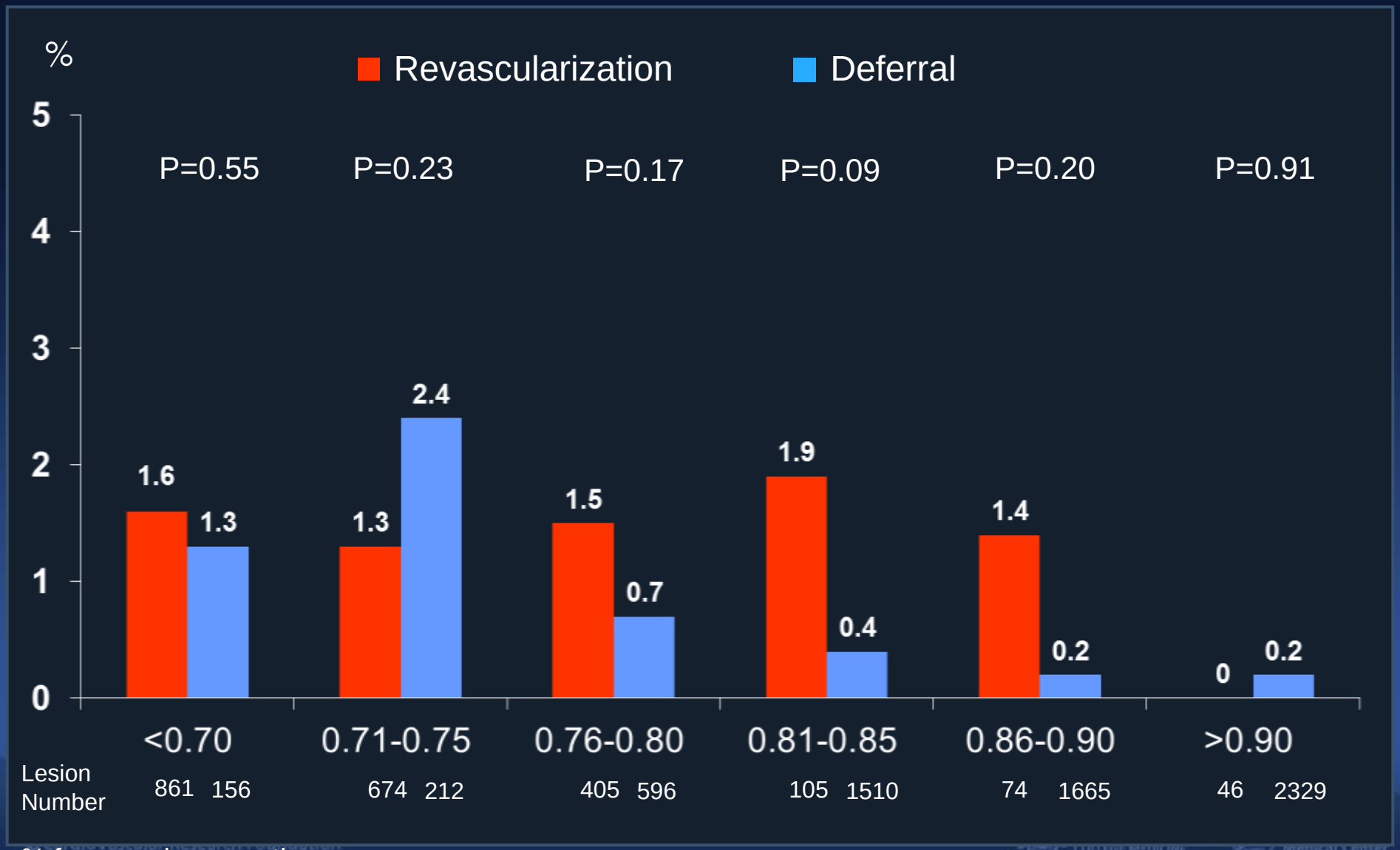
% from crude proportion

Adjust Hazard Ratio: MACE



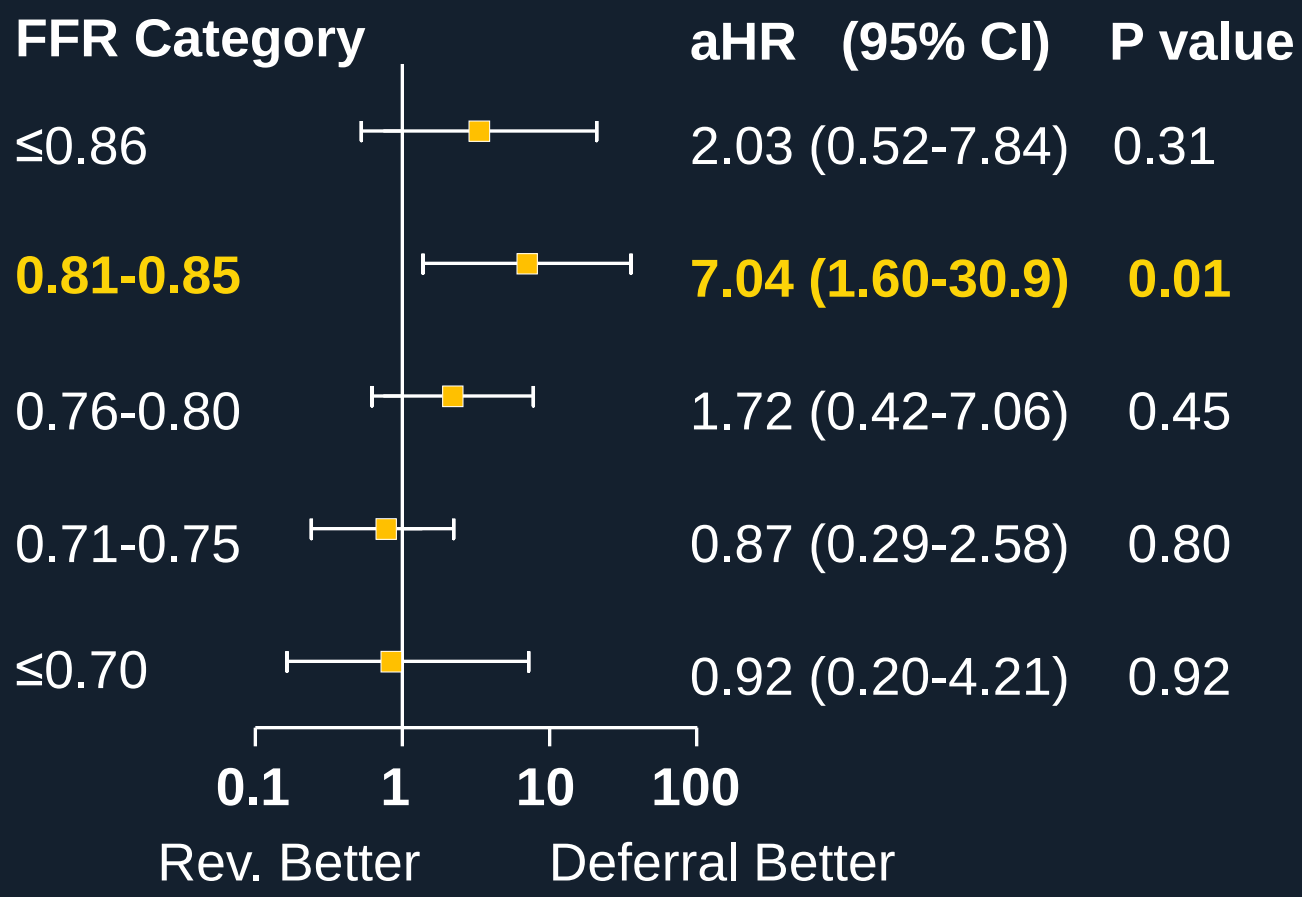
FFR Category	aHR (95% CI)	P value
≥0.86	0.42 (0.09-1.97)	0.27
0.81-0.85	1.21 (0.44-3.36)	0.71
0.76-0.80	0.83 (0.46-1.50)	0.53
0.71-0.75	**0.47 (0.24-0.89)**	**0.021**
≤0.70	**0.47 (0.26-0.84)**	**0.012**

Cardiac Death or MI



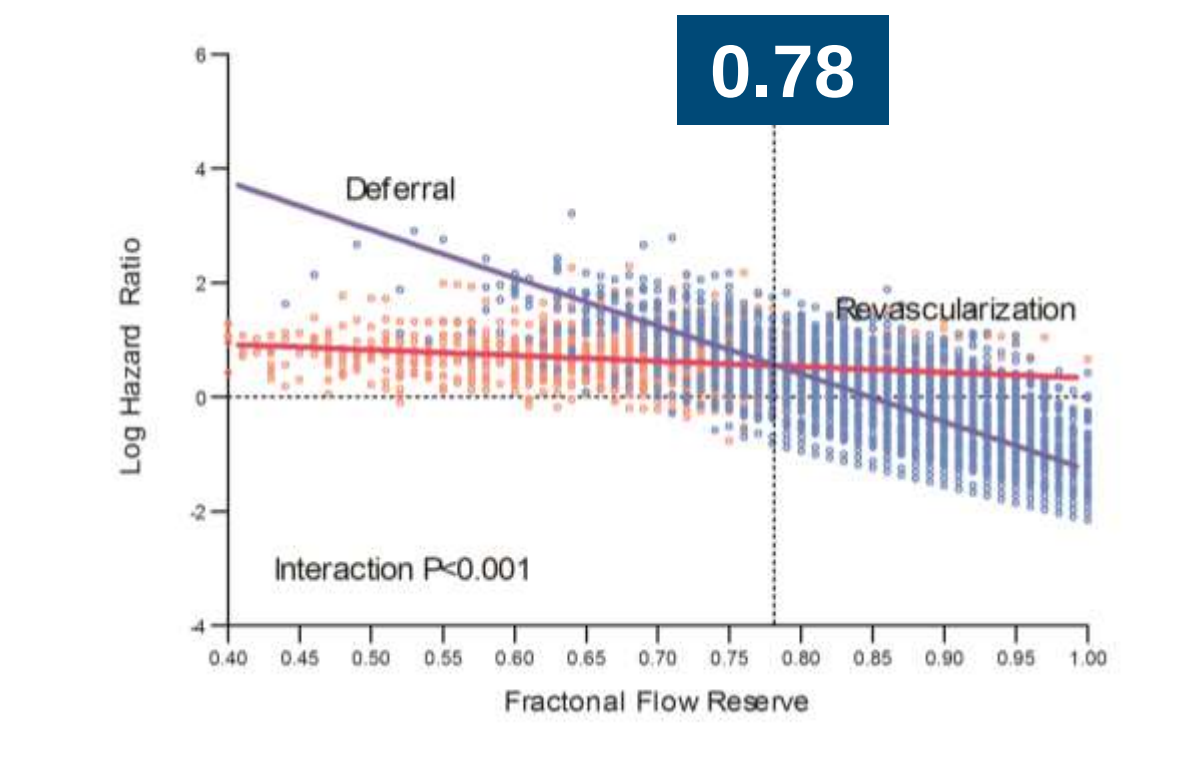
% from crude proportion

Adjust HR: Cardiac Death and MI



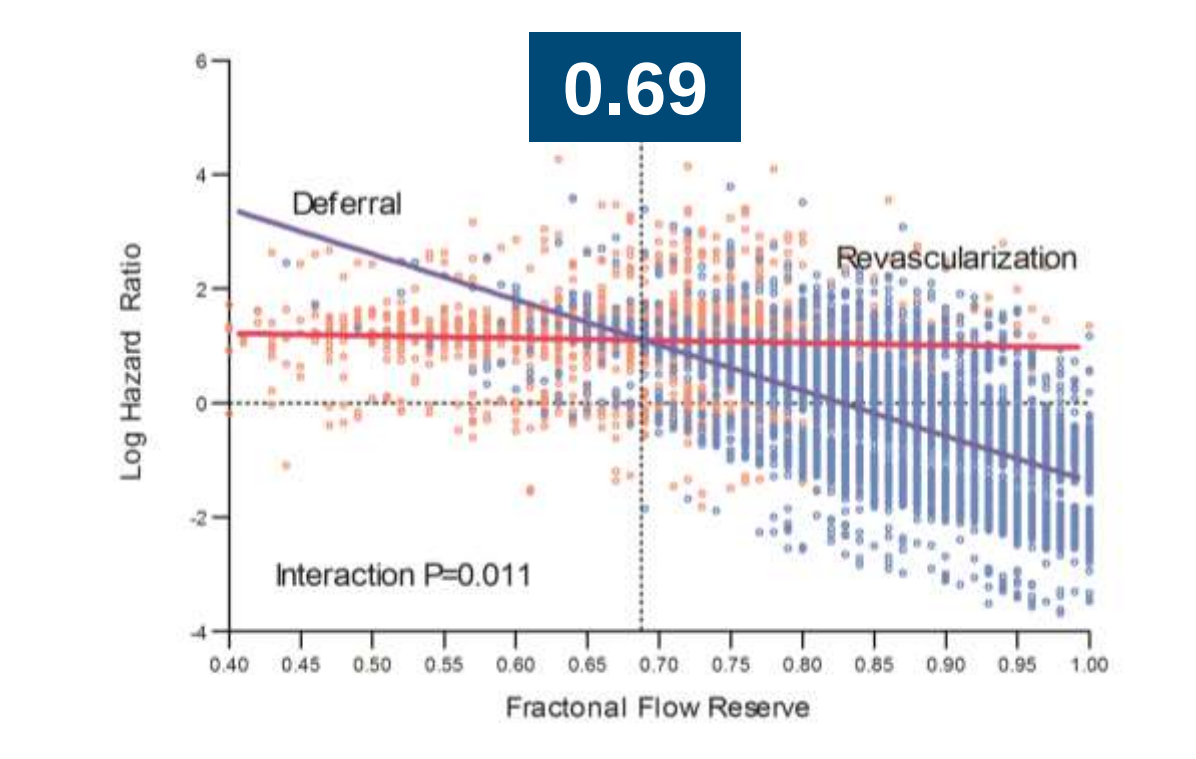
Outcome Derived Revascularization Threshold of FFR

Major Adverse Cardiac Events



Outcome Derived Revascularization Threshold of FFR

Cardiac Death or Myocardial Infarction



What We've Learned

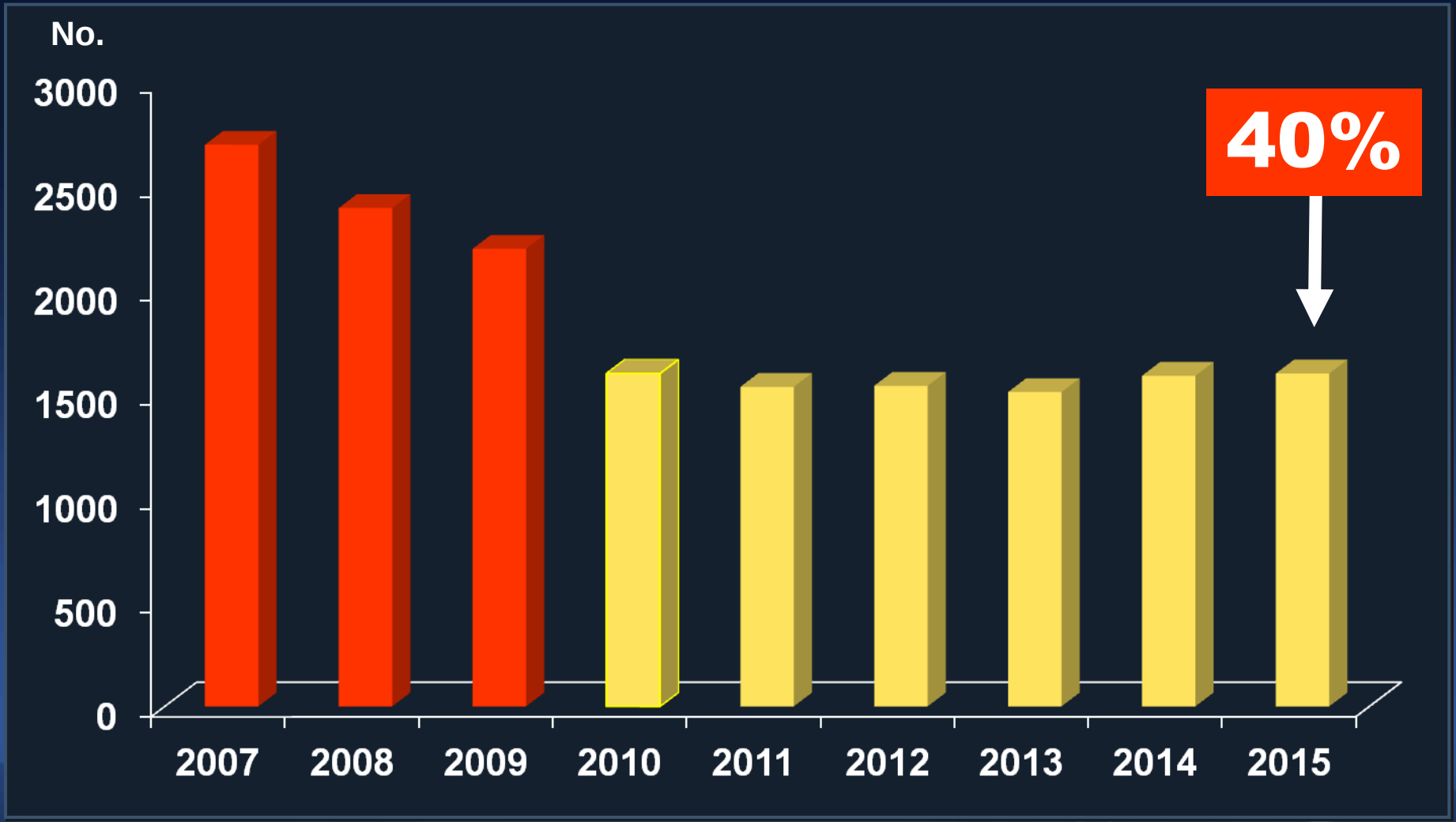
- We confirmed the value of FFR for decision making in daily practice by its stratifying value for clinical outcome: stenosis with low FFR benefit from revascularization, stenosis with high FFR can be better treated medically.

MACE cut-off ; 0.78
Death or MI cut-off ; 0.69

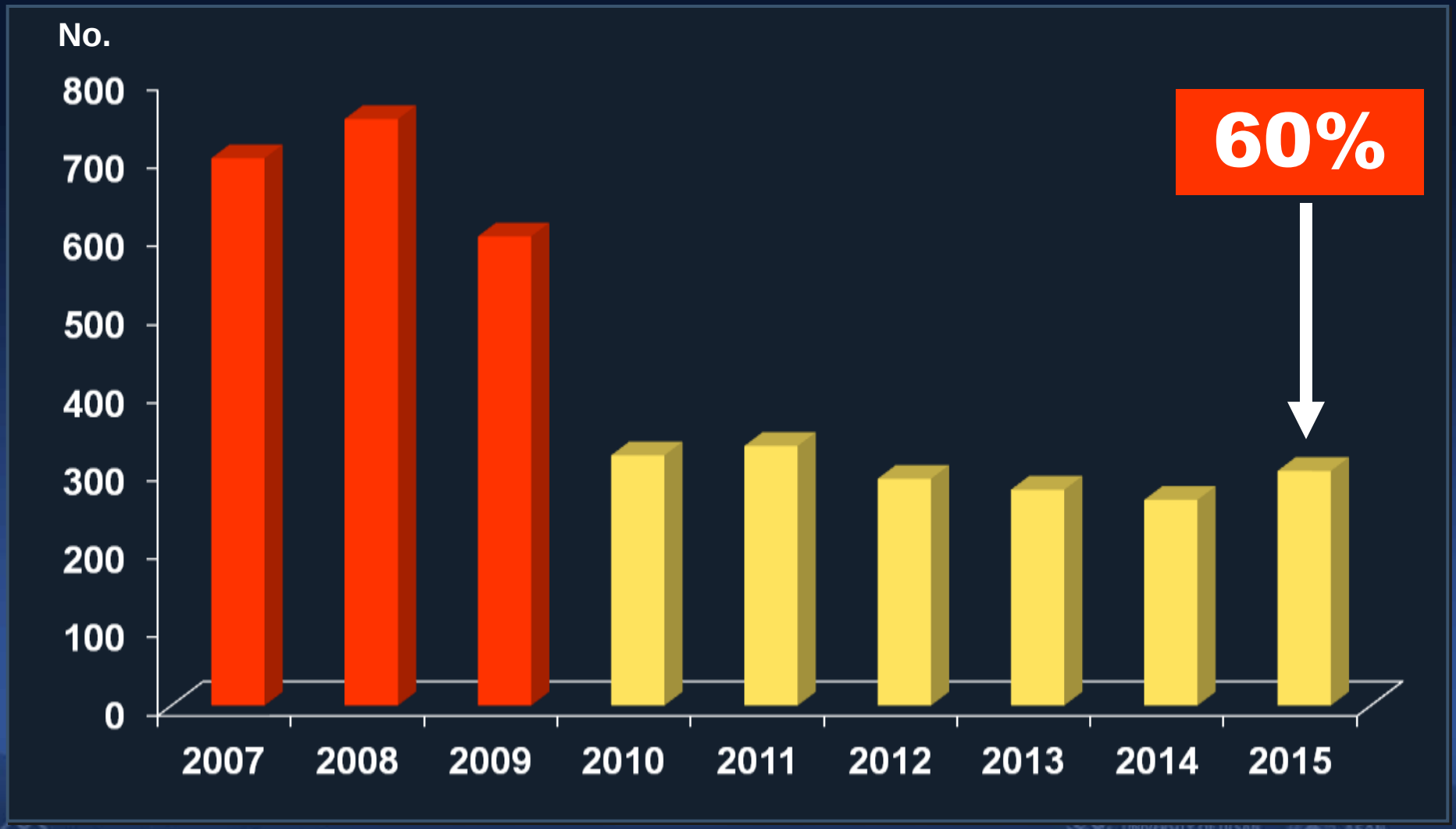
Q2,

How to Change Our Practice ?
After FFR Implementation

PCI Decreased



CABG Decreased



Impact of FFR for PCI Outcomes (n=5,097)

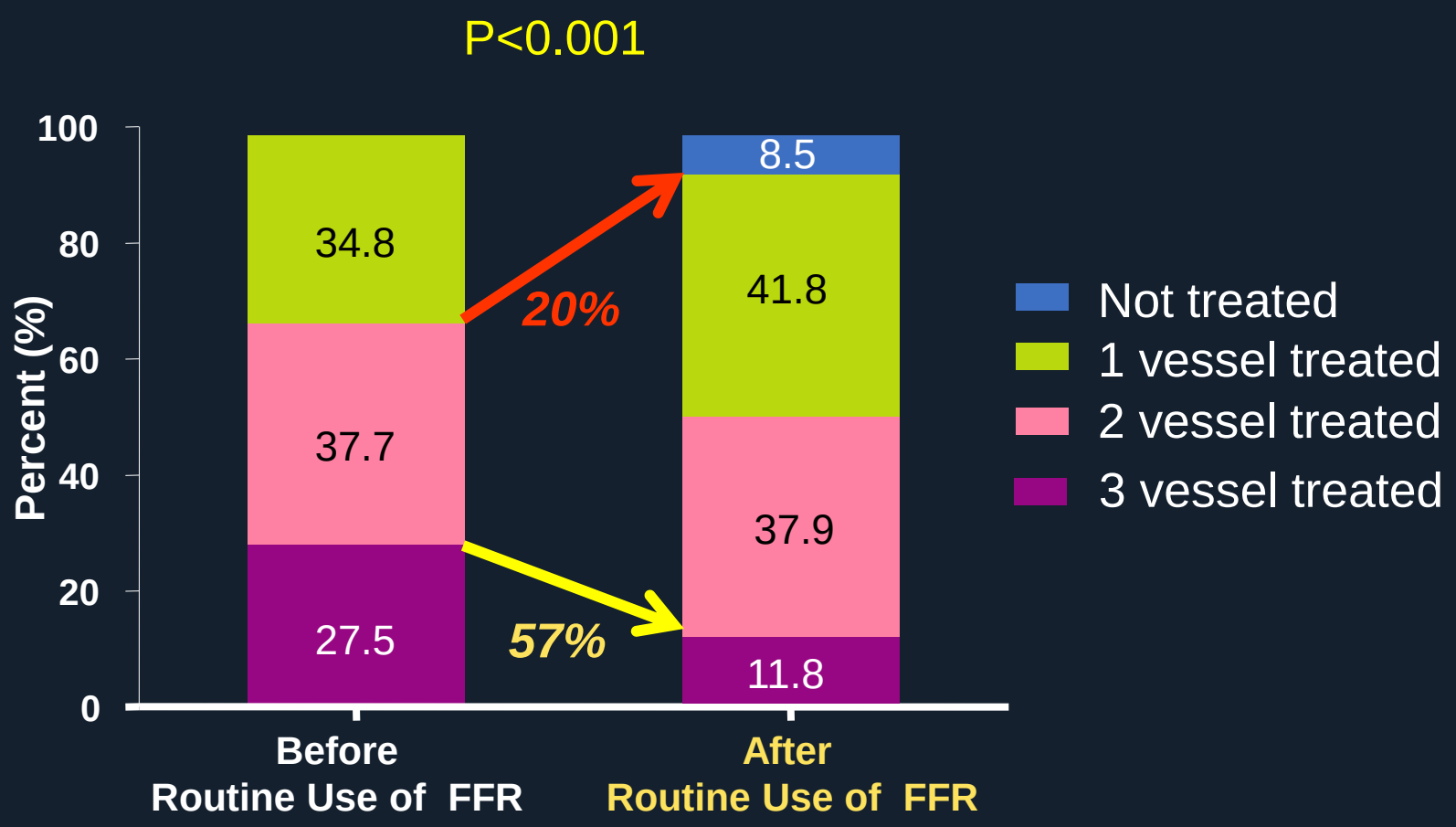
Park SJ, European Heart Journal. 2013 Nov;34(43):3353-61.

Procedural Characteristics

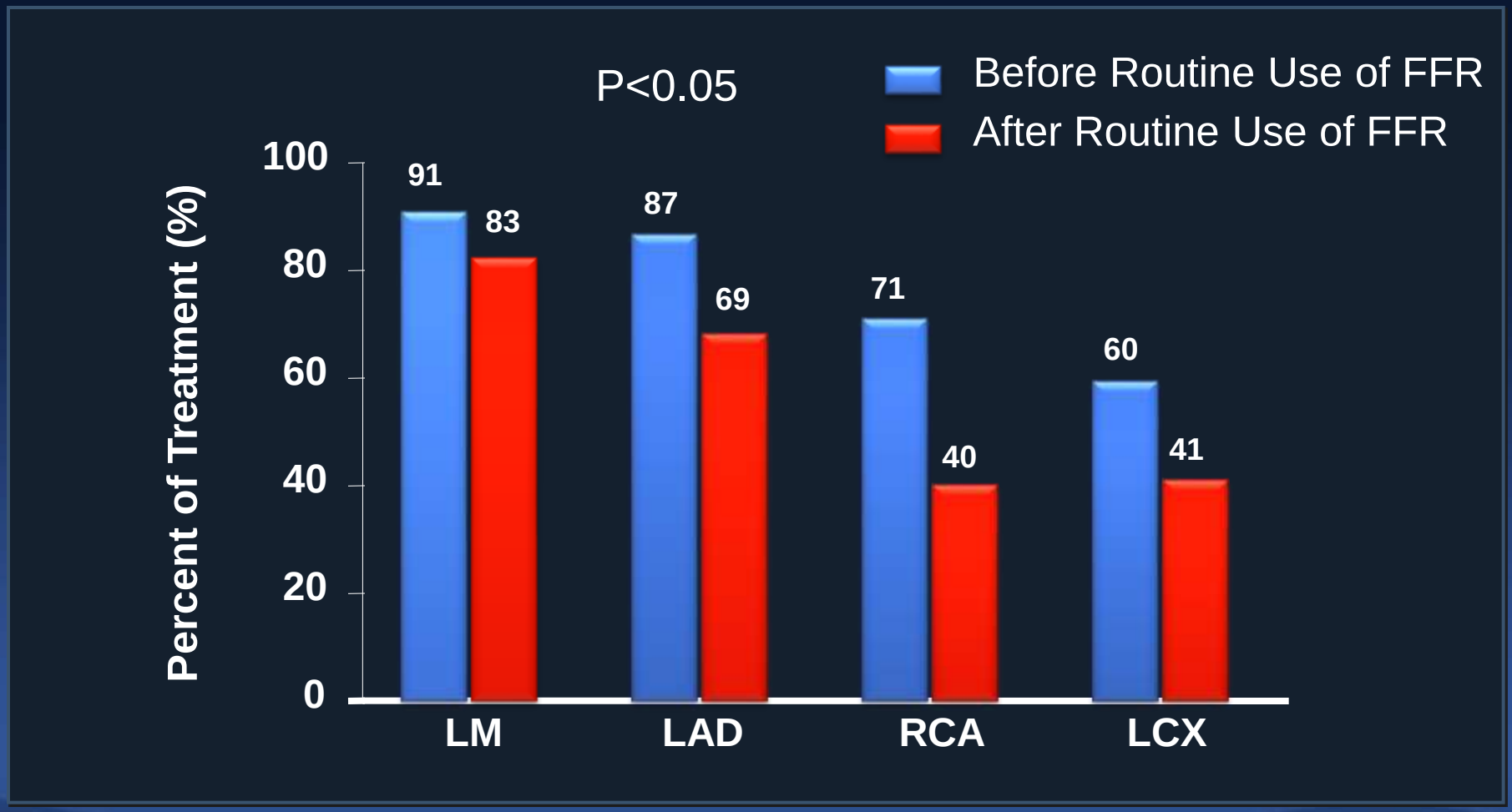
	Before Routine FFR (N=2178)	After Routine FFR (N=2178)	P value
FFR	47 (2.2)	1093 (50.2)	<0.001
IVUS	1967 (90.3)	2114 (97.1)	<0.001
No. of lesions	1.8±0.9	1.8±1.0	0.71
Stent diameter, mm	3.3±0.3	3.3±0.4	0.31
No. of treated lesions	1.4±0.7	1.1±0.8	<0.001
No. of stents	2.1±1.3	1.5±1.2	<0.001
Total stent length, mm	53.7±36.1	40.1±34.1	<0.001
Multi-vessel stenting	772 (35.4)	563 (25.8)	<0.001

3 Vessel Disease Treatment

Multi-Vessel Stenting Decreased !

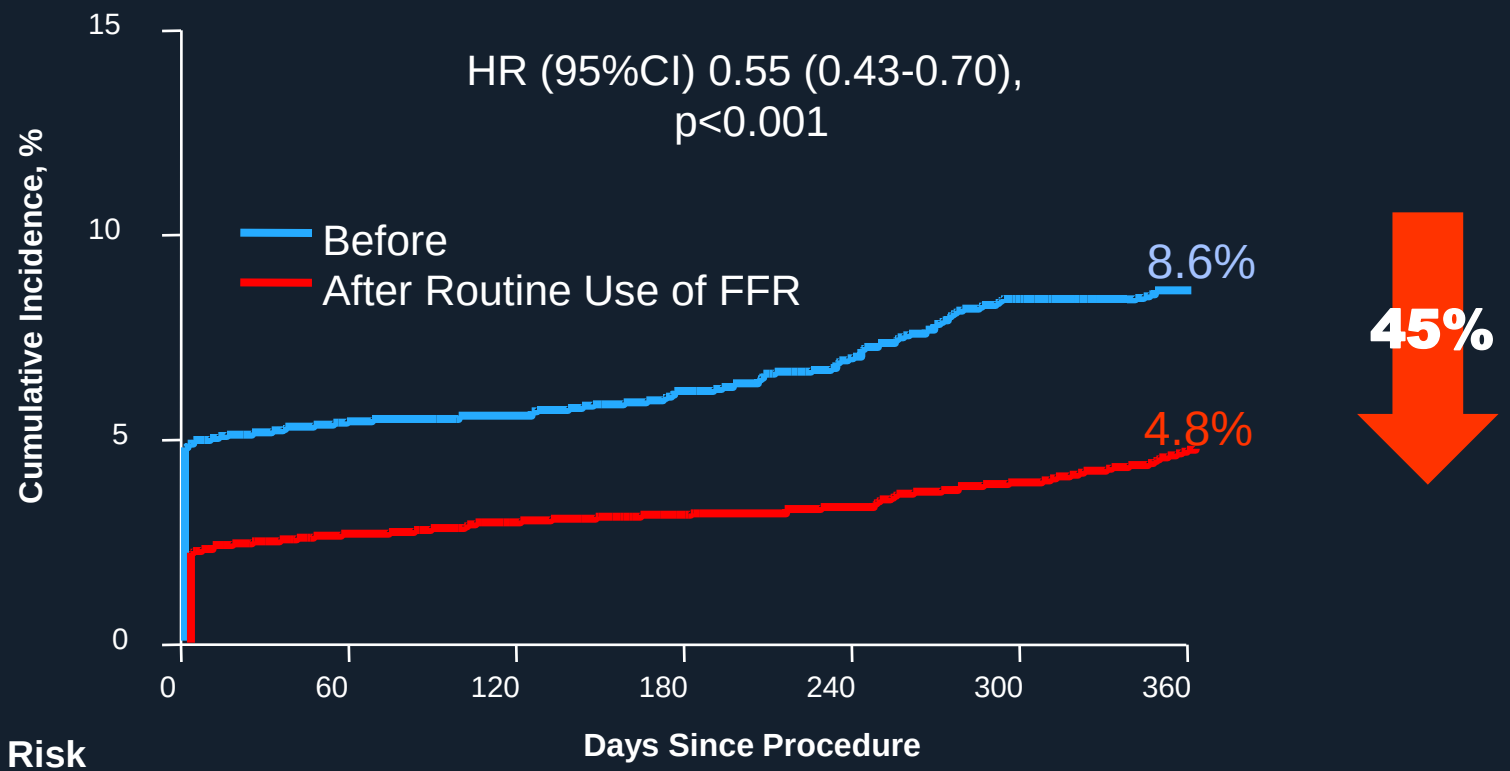


Treated Vessel Territory,
Less PCI for RCA and LCX !



Improved PCI Outcomes

Death /MI or Repeat Revascularization



No. at Risk

Before Routine Use	2178	2066	2011	1960
After Routine Use	2178	2092	2067	2037

Park SJ, European Heart Journal. 2013 Nov;34(43):3353-61.

Impact of FFR for LM and 3-Vessel Disease Treatment Outcomes (n=2,512)

Ahn JM, AJC. 2015 July 27

Procedural Changes of PCI

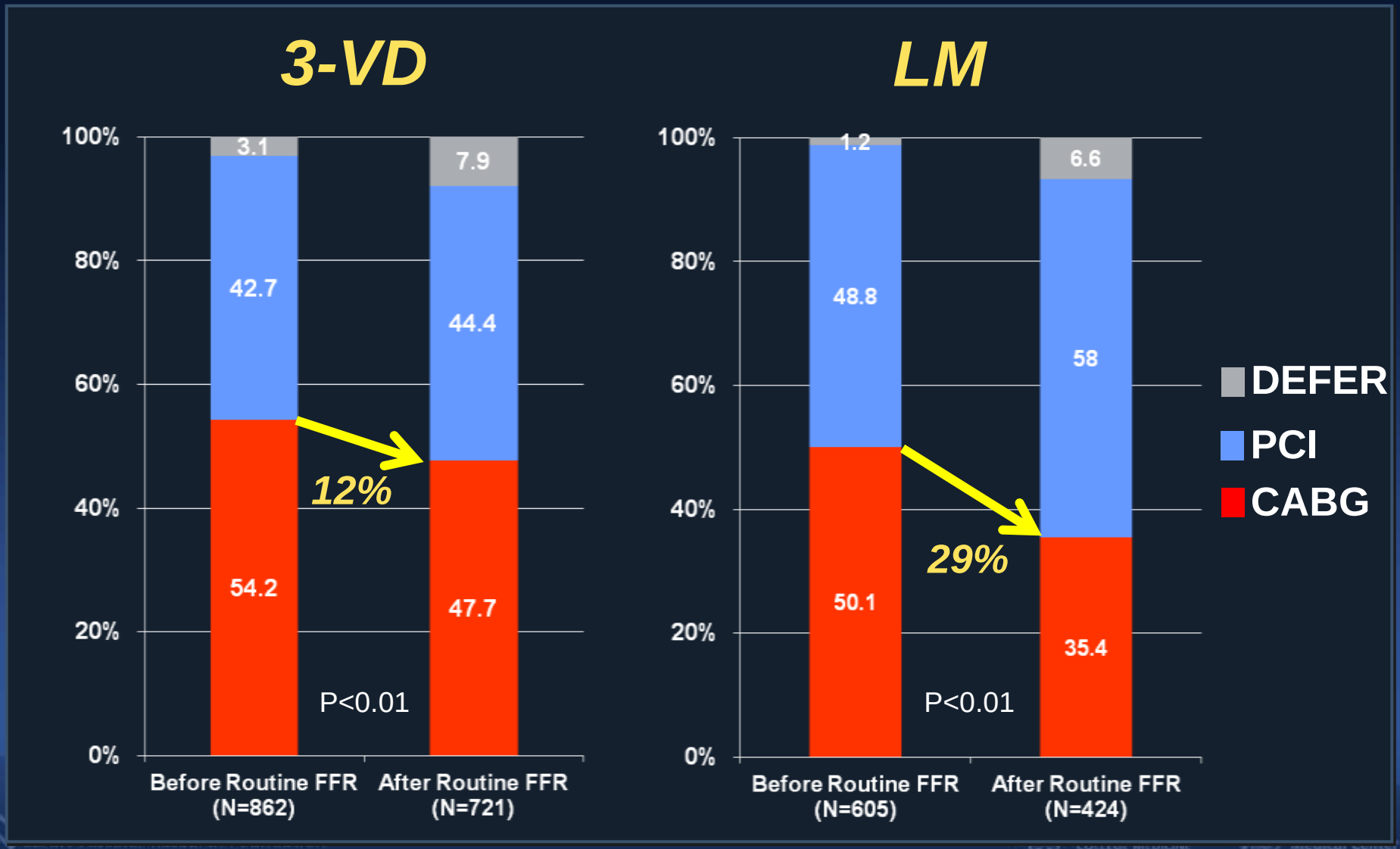
	Before Routine FFR (N=663)	After Routine FFR (N=566)	P value
Fractional flow reserve	13 (2.0)	237 (41.9)	<0.001
Mean	0.87±0.08	0.77±0.12	
>0.80	13 (86.7)	133 (39.8)	
0.75-0.80	0	77 (23.1)	
<0.75	2 (13.3)	124 (37.1)	
N. of Deferred lesions	13 (86.7)	145 (43.4)	
No. of stents	3.04±1.52	2.51±1.39	<0.001
Total stent length, mm	77.7±40.9	65.6±39.0	<0.001
Average stent diameter, mm	3.32±0.28	3.33±0.32	0.63

Procedural Changes of CABG

	Before Routine FFR (N=770)	After Routine FFR (N=494)	P value
Number of conduit	2.97±0.94	3.08±0.94	0.038
Number of vein conduit	1.17±0.90	1.30±0.85	0.009
Number of arterial conduit	1.80±0.87	1.78±0.90	0.69
Internal thoracic artery	757 (98.3)	481 (97.4)	0.25
Off-pump	499 (64.8)	433 (87.7)	<0.001

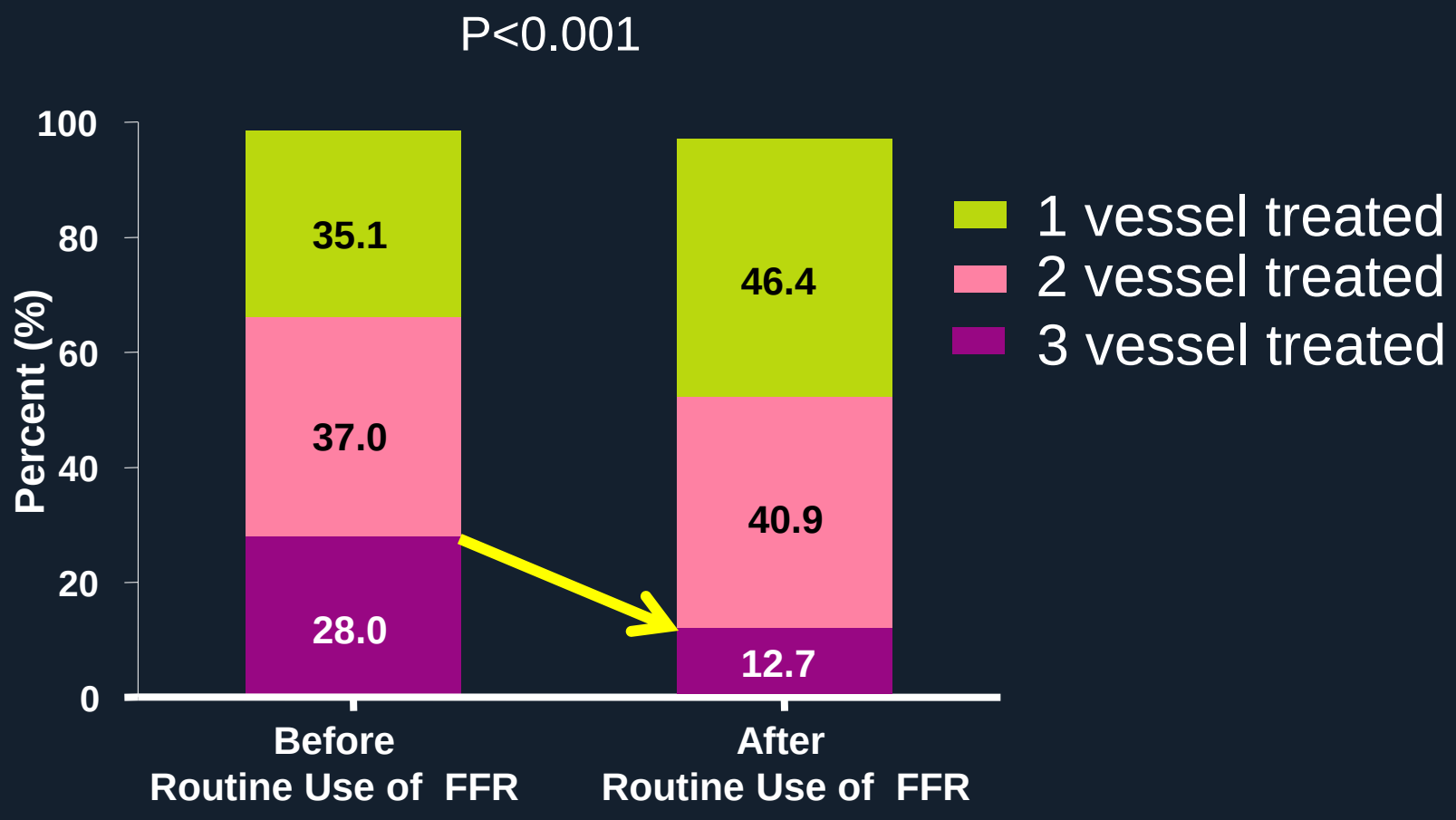
Treatment Strategy

CABG Decreased !



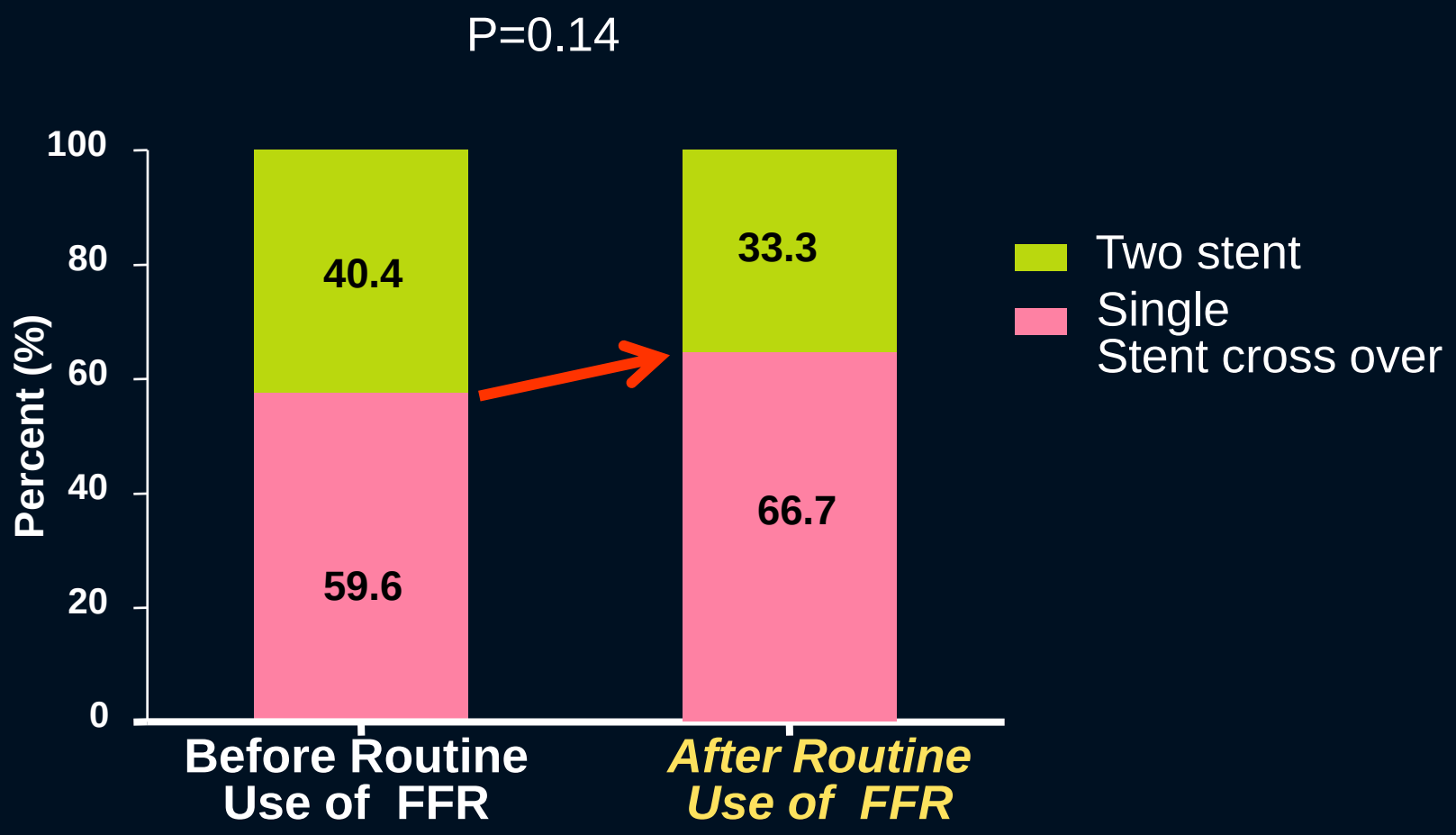
3 Vessel Disease Treatment

Multi-Vessel Stenting Decreased !



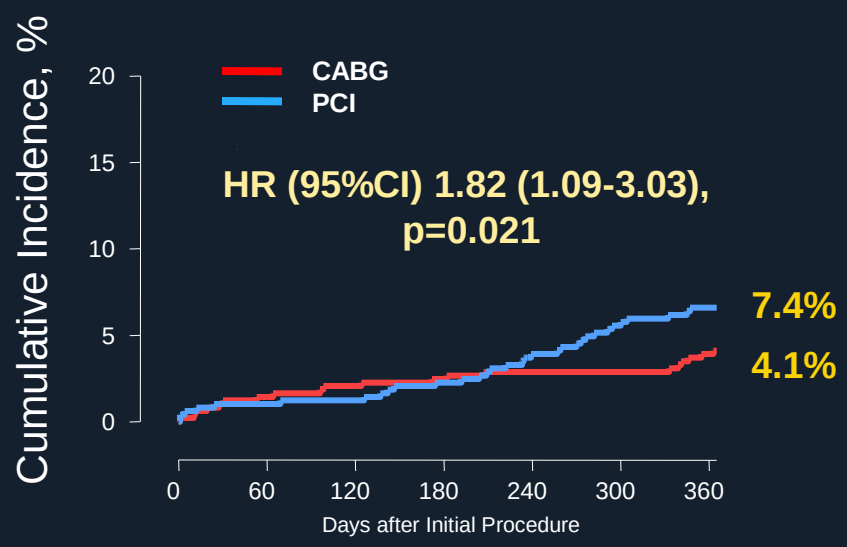
Distal LM Stent Technique

Simple Procedure Increased !



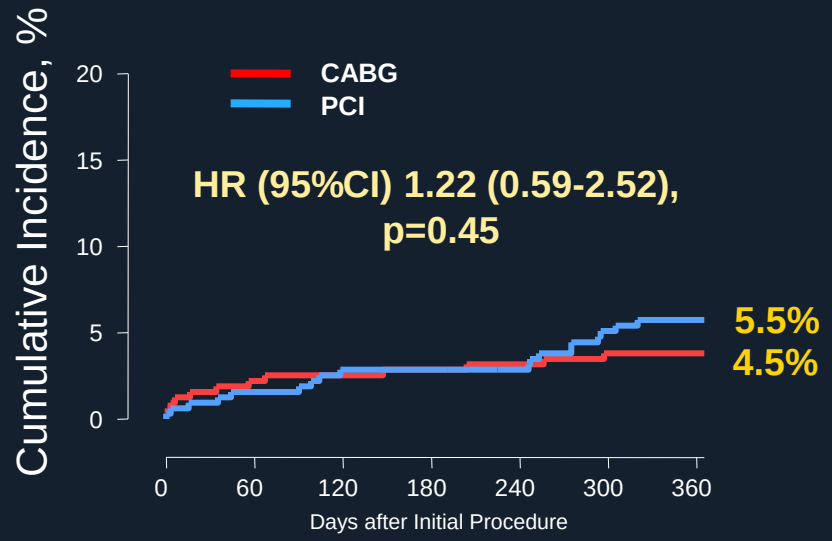
Left Main and 3 VD Registry

Before Routine FFR (2008-2009)



CABG	486	477	472	467
PCI	486	481	466	453

After Routine FFR (2010-2011)

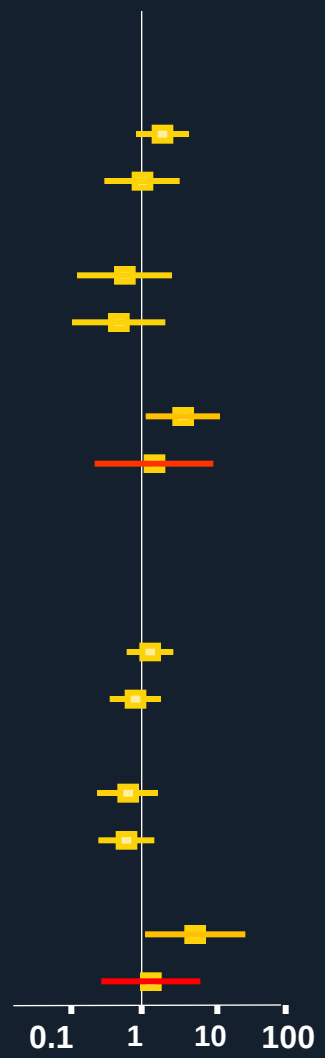


CABG	315	308	306	304
PCI	315	307	304	295

Ahn JM, Park SJ et al. Am J Cardiol. 2015 Oct 15;116(8):1163-71

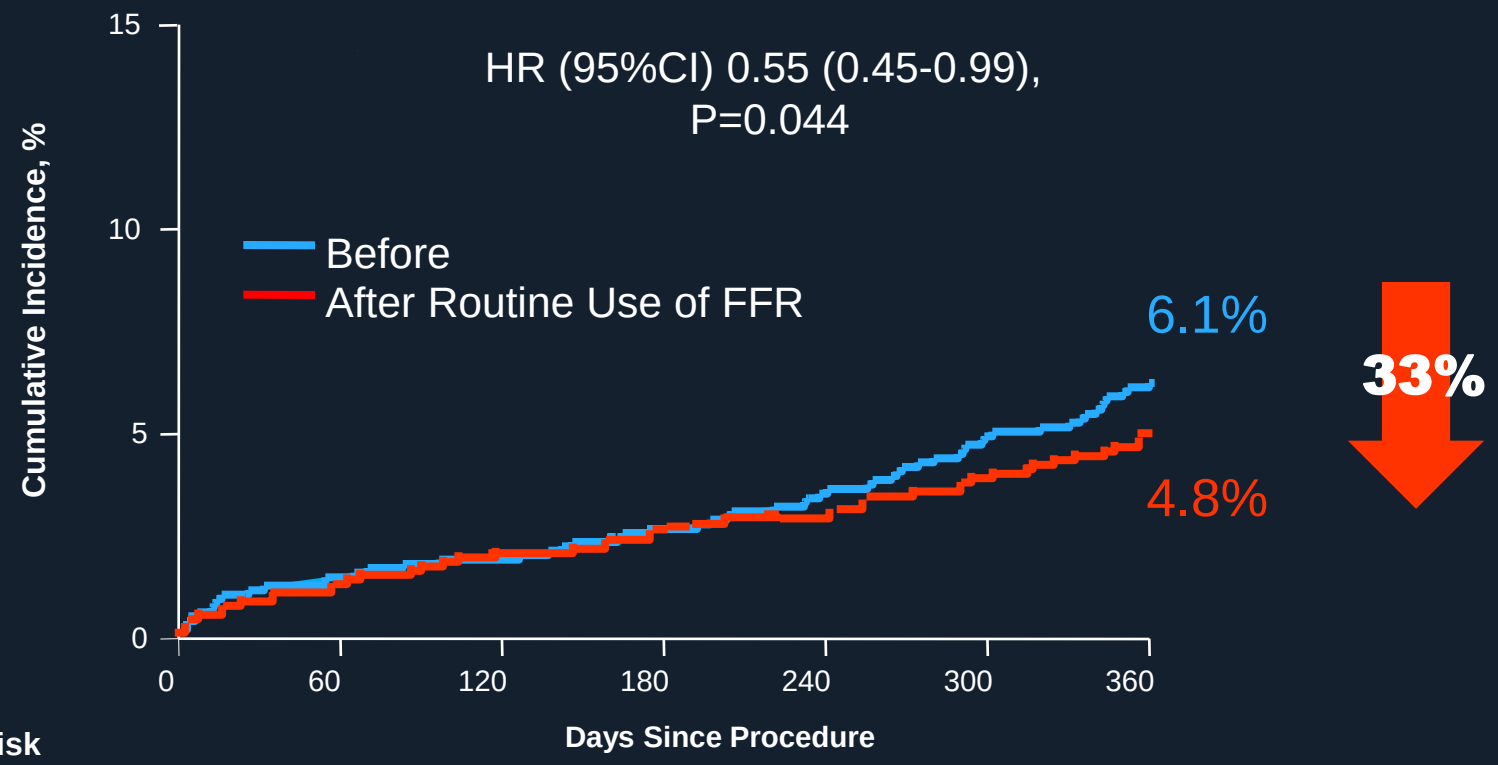
Subgroup Analysis

	1 Year Event Rate (%) CABG	PCI	Adjusted Hazard Ratio (95% CI)	P value
Left Main Disease	N=231	N=231		
MACCE				
Before Routine FFR	15 (5.0)	25 (8.5)	1.89 (0.84-4.25)	0.12
After Routine FFR	7 (4.6)	15 (6.2)	1.02 (0.32-3.21)	0.97
Death, MI, or stroke				
Before Routine FFR	10 (3.3)	4 (1.4)	0.60 (0.14-2.54)	0.49
After Routine FFR	6 (4.0)	6 (2.5)	0.50 (0.12-2.06)	0.34
Any Repeat Revascularization				
Before Routine FFR	5 (1.7)	21 (7.2)	3.53 (1.14-11.0)	0.029
After Routine FFR	2 (1.3)	10 (4.2)	1.48 (0.24-8.98)	0.67
3 Vessel Disease	N=529	N=529		
MACCE				
Before Routine FFR	21 (4.5)	24 (6.5)	1.30 (0.63-2.65)	0.48
After Routine FFR	18 (5.3)	15 (4.7)	0.83 (0.38-1.81)	0.65
Death, MI, or stroke				
Before Routine FFR	18 (3.9)	9 (2.5)	0.67 (0.27-1.65)	0.38
After Routine FFR	17 (5.0)	9 (2.8)	0.63 (0.27-1.48)	0.29
Any Repeat Revascularization				
Before Routine FFR	3 (0.7)	15 (4.2)	5.12 (1.11-23.7)	0.036
After Routine FFR	3 (0.9)	8 (2.5)	1.33 (0.30-5.97)	0.71



Improved Clinical Outcomes for LM and 3 VD Treatment

Death /MI /Stroke or Repeat Revascularization



No. at Risk				
Before Routine Use	917	901	883	857
After Routine Use	917	898	886	869

Ahn JM, et al, AJC 2015 Oct;116(8):1163-71.

Our Practice Has Been Changed ! 2016

- Less DES,
- More Less Surgery,
- Save Money,
- Improved Clinical Outcomes.

Ahn JM, et al, AJC 2015 Oct;116(8):1163-71.
Park SJ, et al, European Heart Journal. 2013 Nov;34(43):3353-61.

Thank You !!

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