Impact of Functional Angioplasty to Current Practice; Trends in Clinical Outcomes of PCI with Drug Eluting Stent

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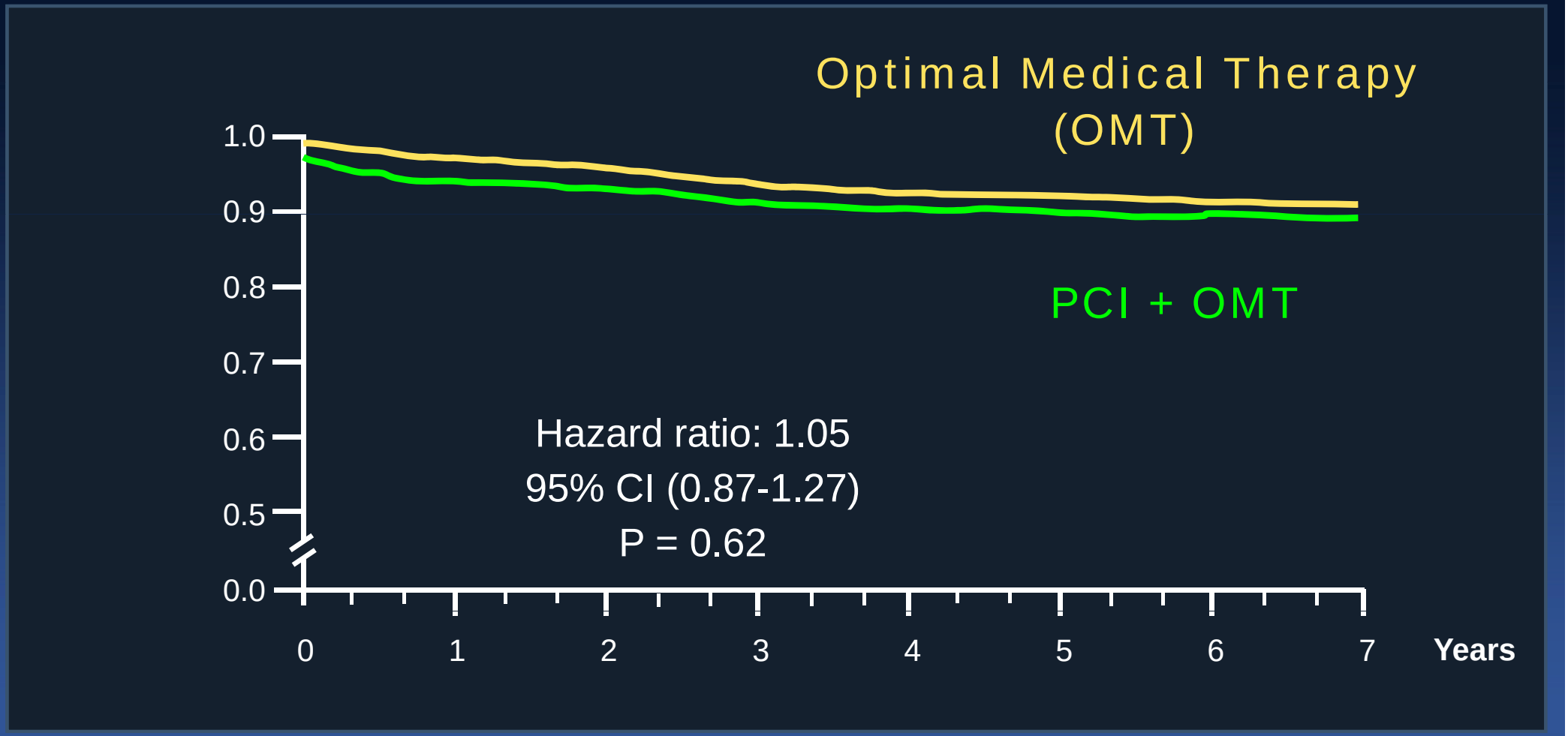
What is the Concept of Functional Angioplasty ?

Optimal Medical Treatment,
Reasonable Incomplete Revascularization.

FFR Guided PCI is Better,
Integrated Use of FFR and IVUS.

Benefit of Stents
Over Medications in Stable Disease

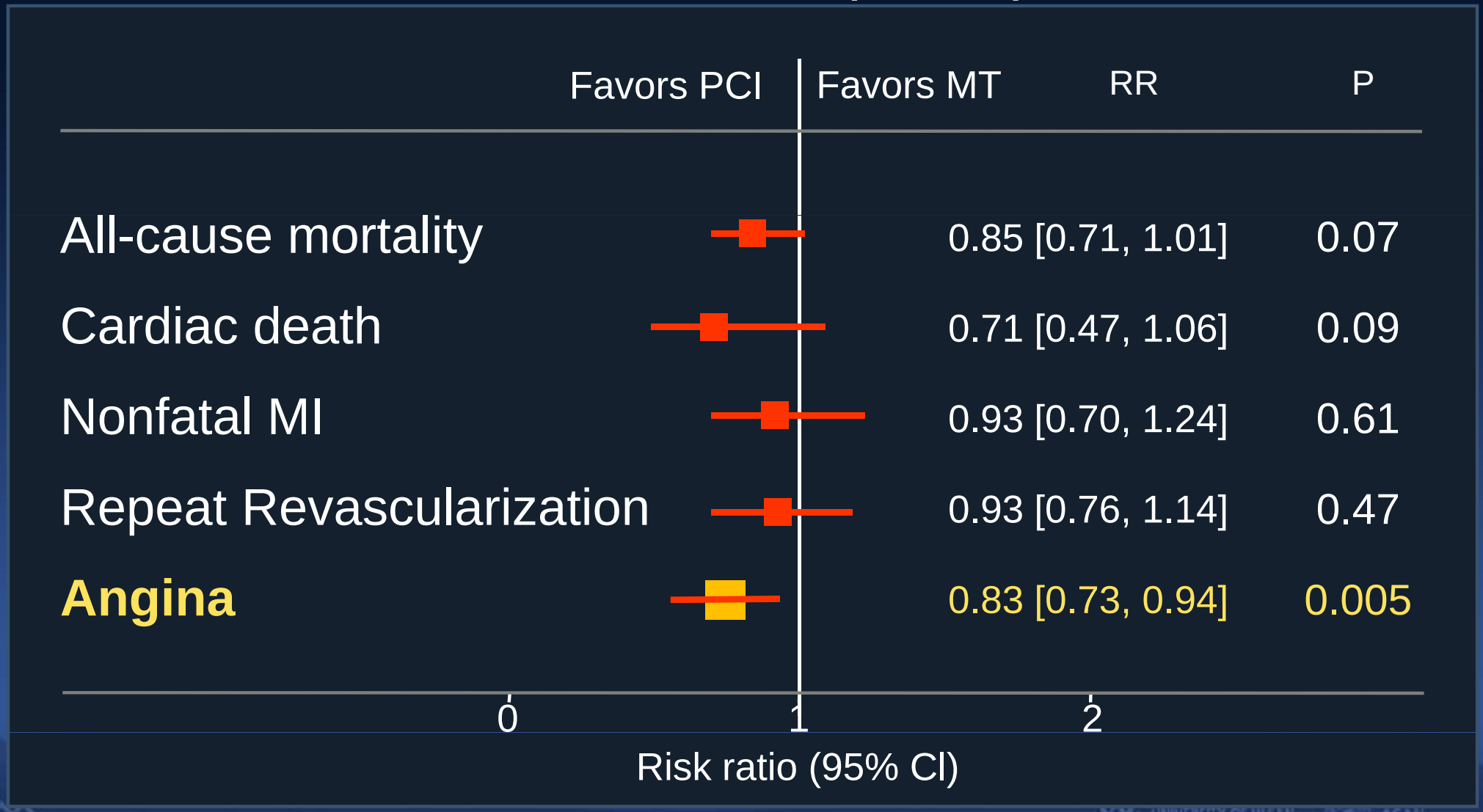
Survival Free From Death and MI (COURAGE,n=2,287)



Boden W, N Engl J Med 2007; 356:1503-1516

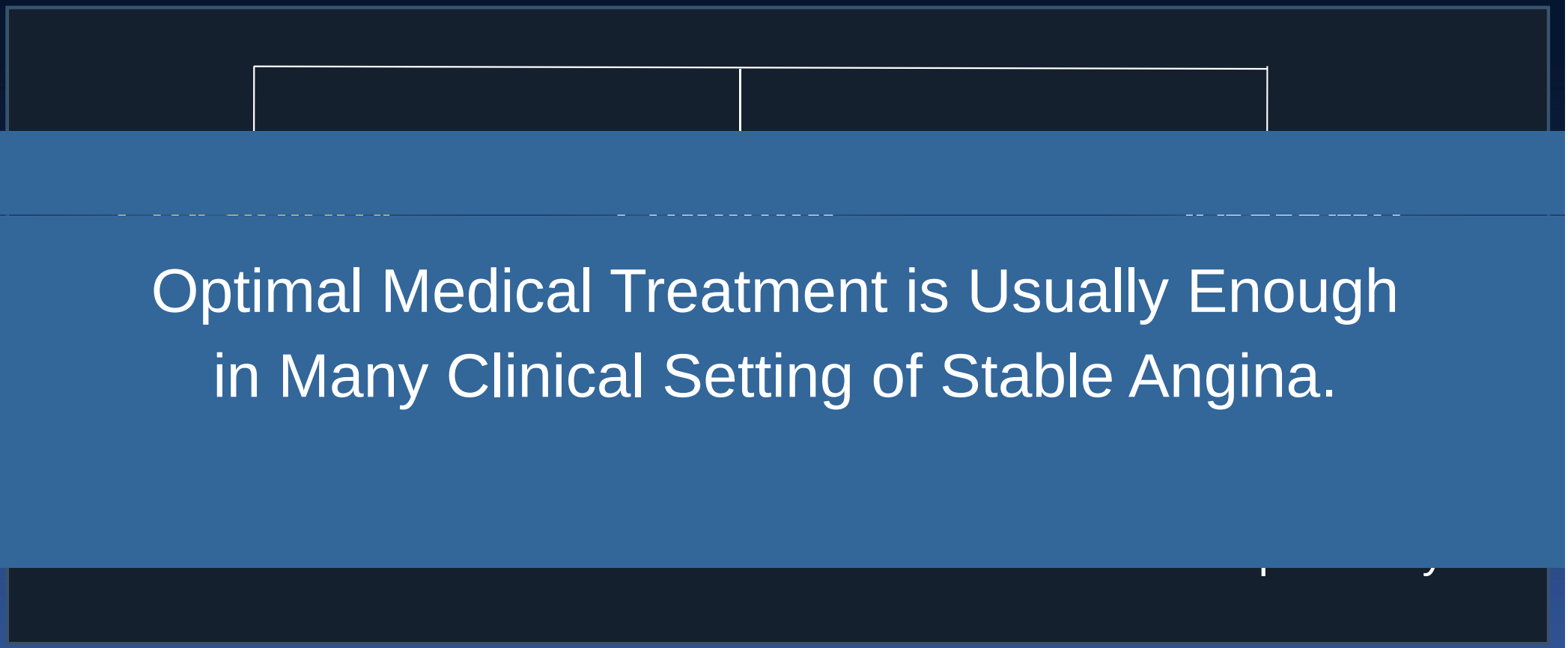
Benefit of Stents
Over Medications in Stable Disease

12 RCTs, 7182 participants



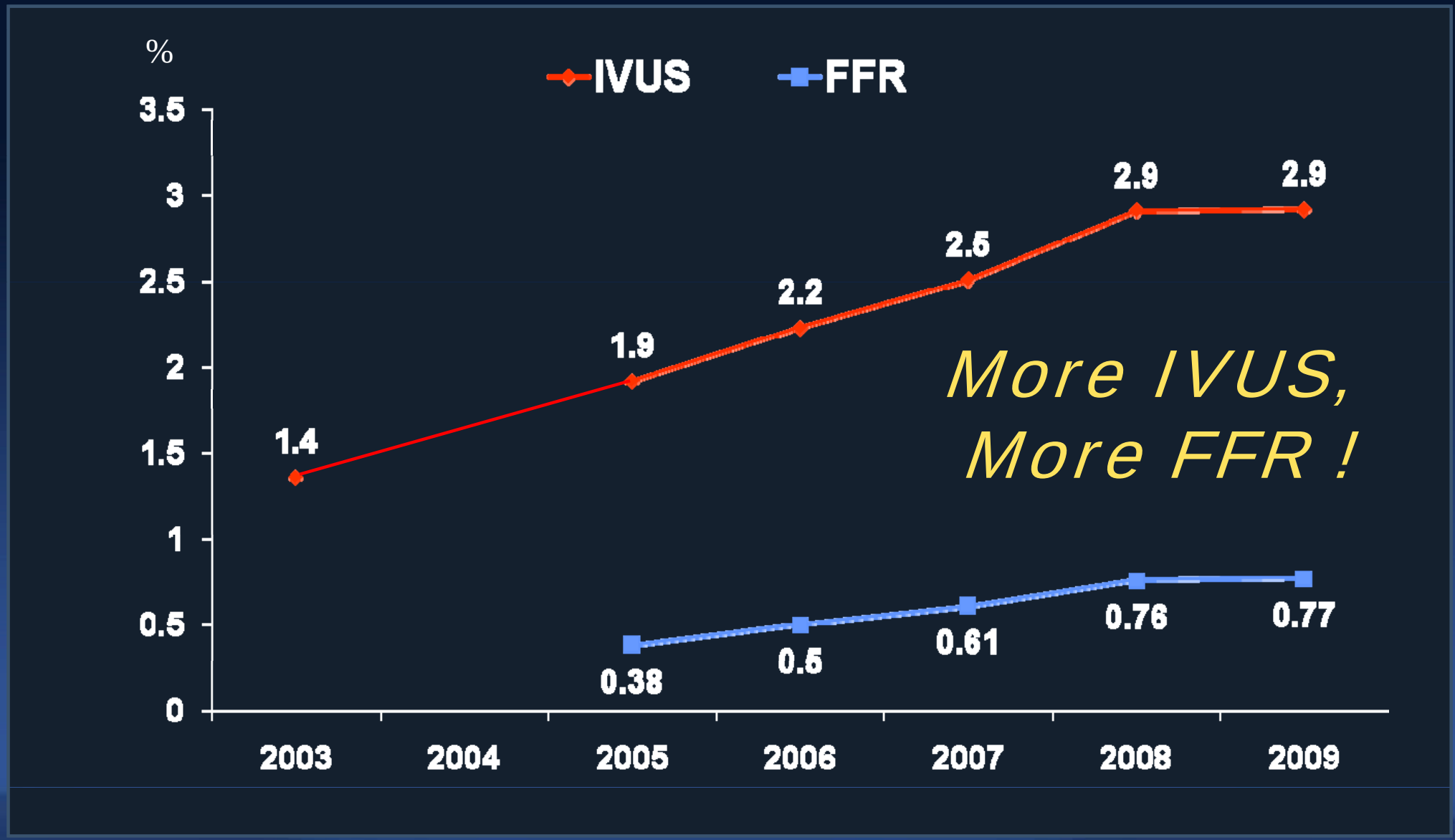
Pursnani et al, Circ CV Intv 2012

Optimal Medical Treatment With Reasonable Incomplete Revascularization



Optimal Medical Treatment is Usually Enough in Many Clinical Setting of Stable Angina.

Our Practice Is Changing Now !



Riley RF et al. Circ Cardiovasc Qual Outcomes. 2011;4:193-197.

Impact of FFR
for Multi-Vessel Disease

"Totally Different World"
"Different Concept and
Different Clinical Outcomes" !

Tonino et al, JACC 2010;55:2816-2821

Meta-Analysis
FFR vs. CAG Guided PCI

A total of 9,301 patients

(1 randomized trial and 4 observational studies)

Park SJ, Ahn JM, Unpublished Data, 2013

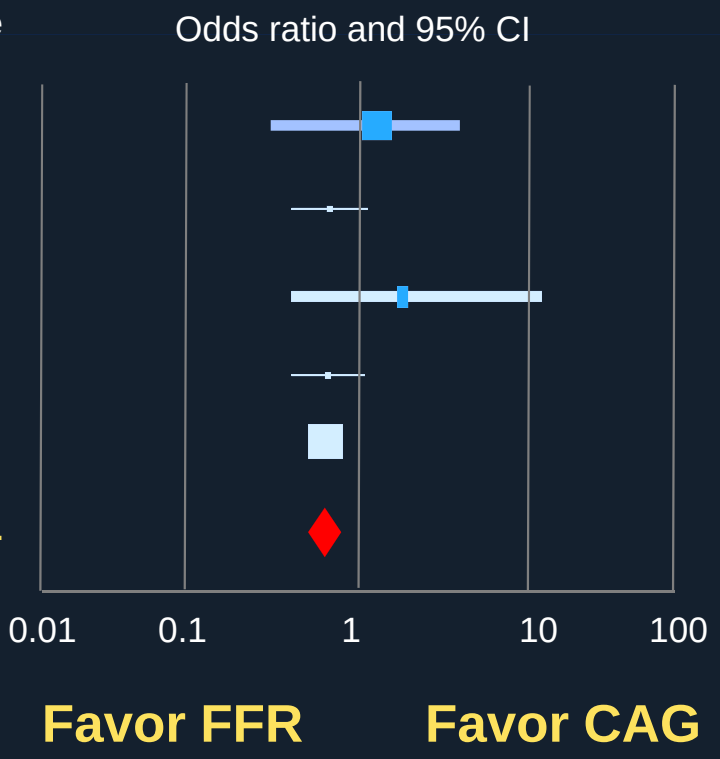
FFR vs. Angio-Guided PCI

(Meta-analysis n=9,301)

Death

		Odds Ratio	Lower Limit	Upper Limit	Z-Value	P-Value
Wongpraparut	2005	1.25	0.24	6.59	0.26	0.80
Pijls	2010	0.68	0.33	1.38	-1.08	0.28
Angkananard	2011	2.09	0.36	12.16	0.82	0.41
Puymirat	2012	0.61	0.30	1.20	-1.44	0.15
Lerman	2013	0.56	0.48	0.66	-7.22	0.00
Random pooled estimate		0.58	0.50	0.67	-724	<0.001

$I^2=0$



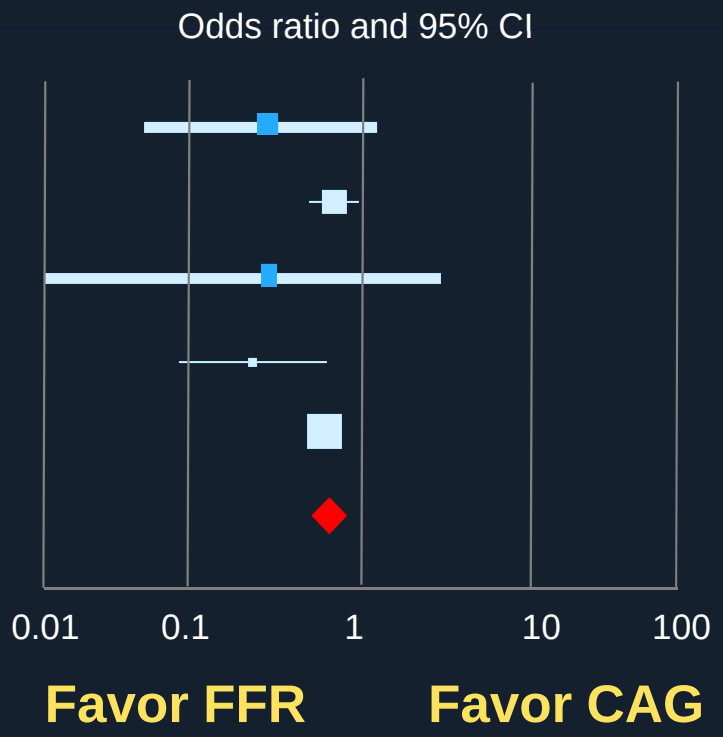
FFR vs. Angio-Guided PCI

(Meta-analysis n=9,301)

Myocardial Infarction

		Odds Ratio	Lower Limit	Upper Limit	Z-Value	P-Value
Wongpraparut	2005	0.21	0.02	1.75	-1.45	0.15
Pijls	2010	0.59	0.37	0.94	-2.20	0.03
Angkananard	2011	0.20	0.01	4.19	-1.04	0.30
Puymirat	2012	0.13	0.03	0.53	-2.88	0.00
Lerman	2013	0.49	0.39	0.62	-6.04	0.00
Random pooled estimate		**0.47**	**0.34**	**0.65**	**-4.55**	**<0.001**

I^2=21



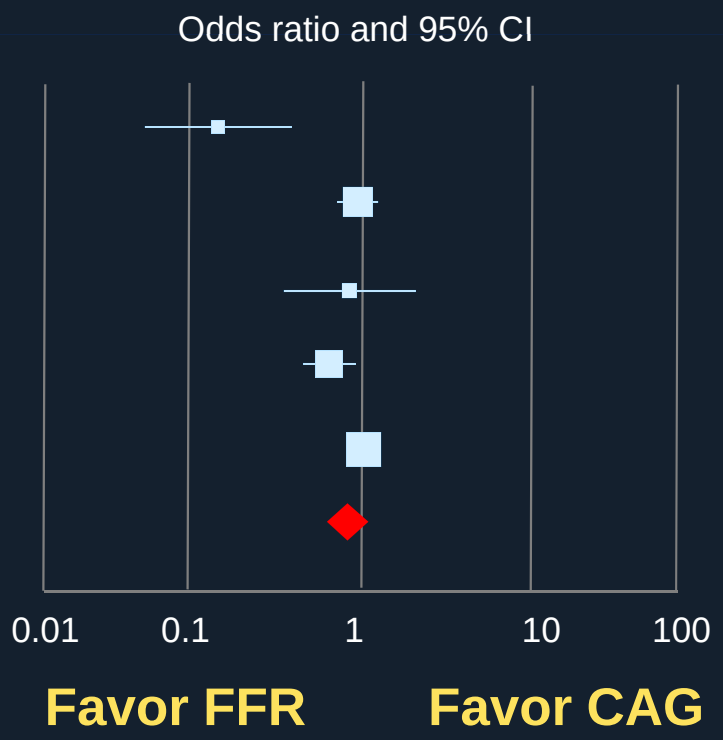
FFR vs. Angio-Guided PCI

(Meta-analysis n=9,301)

Repeat Revascularization

		Odds Ratio	Lower Limit	Upper Limit	Z-Value	P-Value
Wongpraparut	2005	0.18	0.05	0.68	-2.51	0.15
Pijls	2010	0.82	0.55	1.20	-1.04	0.03
Angkananard	2011	0.73	0.22	2.49	-0.50	0.30
Puymirat	2012	0.51	0.31	0.83	-2.70	0.00
Lerman	2013	0.96	0.84	1.10	-0.64	0.00
Random pooled estimate		**0.70**	**0.48**	**1.02**	**-1.88**	**0.06**

I^2=66



FFR vs. Angio-Guided PCI

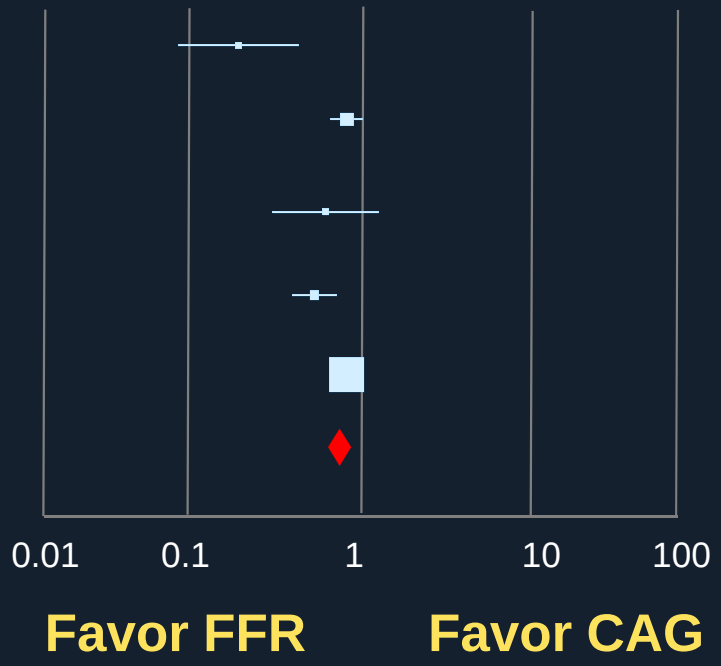
(Meta-analysis n=9,301)

MACE

(Death, MI or Repeat Revascularization)

		Odds Ratio	Lower Limit	Upper Limit	Z-Value	P-Value
Wongpraparut	2005	0.24	0.08	0.72	-2.52	0.01
Pijls	2010	0.76	0.55	1.03	-1.78	0.08
Angkananard	2011	0.51	0.19	1.39	-1.31	0.19
Puymirat	2012	0.42	0.27	0.64	-4.00	0.00
Lerman	2013	0.75	0.66	0.86	-4.29	0.00
Random pooled estimate		**0.71**	**0.64**	**0.80**	**-5.88**	**<0.001**

I^2=64



FFR vs. Angio-Guided PCI

(Meta-analysis n=9,301)

	Relative	
FFR Guided PCI Has Better Clinical Outcomes !		
MACE	**↓ 29%**	**<0.001**

Park SJ, Ahn JM et al. Unpublished data, 2013

Impact of FFR Guided PCI In AMC Practice.

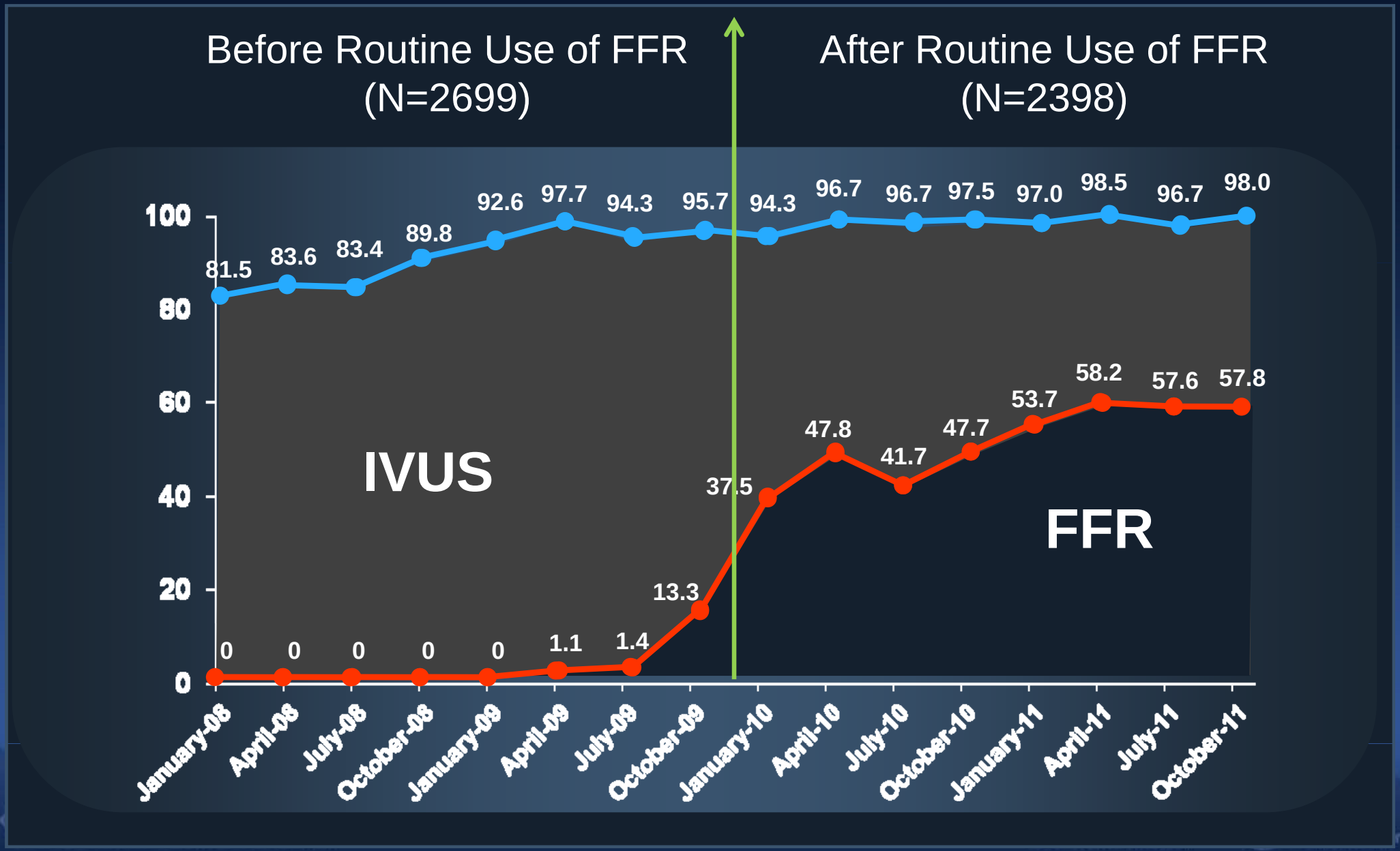
Park SJ, Ahn JM. AMC Registry Data Analysis

Study Population

Between January 2008 and December 2011, a total of 5097 patients were enrolled. Since January 2010, the investigators have routinely used FFR in assessing the functional severity of intermediate coronary stenosis (visual estimated DS between 50% and 80%).

Integrated Use of FFR and IVUS

(AMC data, n=5097)



Baseline Clinical Characteristics

	Unadjusted Group			Propensity Matched Group		
	Before Routine FFR (N=2699)	After Routine FFR (N=2398)	P	Before Routine FFR (N=2178)	After Routine FFR (N=2178)	P
Age, year	62.0±9.9	62.6±10.3	0.04	62.4±9.8	62.3±10.3	0.87
Male sex	1982 (70.5)	1685 (74.2)	0.003	1585 (72.8)	1574 (72.3)	0.73
Hypertension	1615 (59.8)	1483 (61.8)	0.15	1328 (61.0)	1333 (61.2)	0.90
DM	834 (30.9)	794 (33.1)	0.09	705 (32.4)	705 (32.4)	>0.99
Current smoker	803 (29.8)	681 (28.4)	0.29	634 (29.1)	632 (29.0)	0.97
Hyperlipidemia	1535 (56.9)	1600 (66.7)	<0.001	1388 (63.7)	1396 (64.1)	0.77
Previous CABG	113 (4.2)	44 (1.8)	<0.001	51 (2.3)	44 (2.0)	0.40
Previous MI	154 (5.7)	112 (4.7)	0.10	106 (4.9)	108 (5.0)	0.95
Previous PCI	473 (17.5)	411 (17.1)	0.72	369 (16.9)	363 (16.7)	0.84

Baseline Clinical Characteristics

	Unadjusted Group			Propensity Matched Group		
	Before Routine FFR (N=2699)	After Routine FFR (N=2398)	P	Before Routine FFR (N=2178)	After Routine FFR (N=2178)	P
Previous CHF	20 (0.7)	26 (1.1)	0.20	19 (0.9)	22 (1.0)	0.76
Previous stroke	153 (5.7)	149 (6.2)	0.41	131 (6.0)	126 (5.8)	0.79
Peripheral vascular Dz	46 (1.7)	59 (2.5)	0.06	46 (1.9)	44 (2.0)	0.91
Chronic renal failure	67 (2.5)	82 (3.4)	0.05	57 (2.6)	59 (2.7)	0.92
COPD	36 (1.3)	57 (2.4)	0.005	36 (1.7)	30 (1.4)	0.53
LVEF, %	58.7±7.9	59.2±9.1	0.09	58.7±7.9	59.2±9.1	0.37
Clinical presentation			0.18			0.10
Stable angina	1687 (62.5)	1552 (64.7)		1394 (64.0)	1411 (64.8)	
Unstable angina	750 (27.8)	642 (26.8)		582 (26.7)	584 (26.8)	
AMI	262 (9.7)	204 (8.5)		202 (9.3)	183 (8.4)	

Baseline Angiographic Characteristics

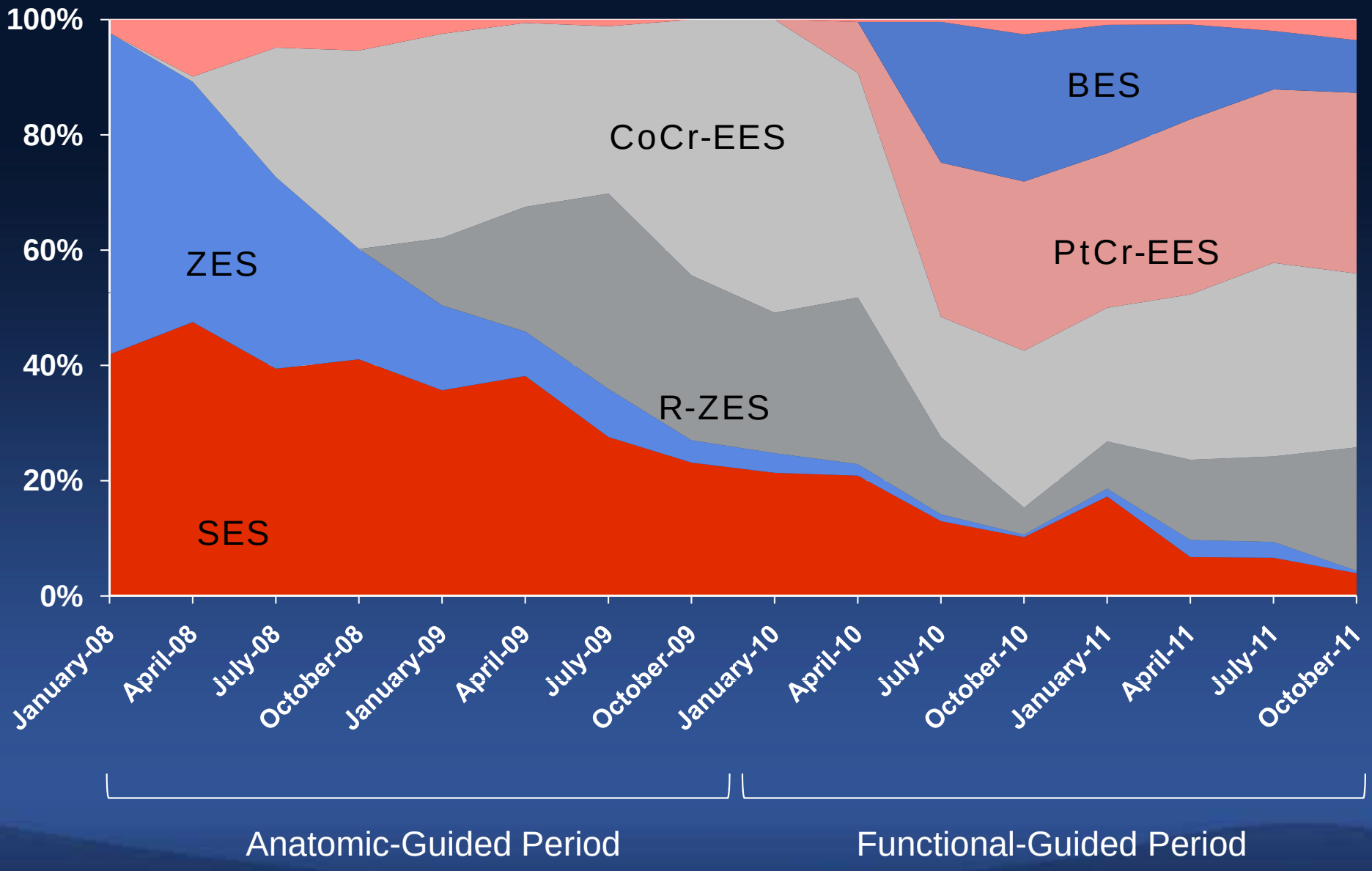
	Unadjusted Group			Propensity Matched Group		
	Before Routine FFR (N=2699)	After Routine FFR (N=2398)	P	Before Routine FFR (N=2178)	After Routine FFR (N=2178)	P
Extent			0.21			0.38
1VD	1216 (45.1)	1138 (47.5)		994 (45.6)	1051 (48.3)	
2VD	787 (29.2)	644 (26.9)		637 (29.2)	570 (26.2)	
3VD	377 (14.0)	346 (14.4)		313 (14.4)	306 (14.0)	
LMCA stenosis	319 (11.8)	270 (11.3)		234 (10.7)	251 (11.5)	
Bifurcation	1242 (46.0)	1048 (43.7)	0.10	1205 (55.3)	1200 (55.1)	0.90
Restenotic lesion	207 (7.7)	173 (7.2)	0.54	155 (7.1)	151 (6.9)	0.86
Long lesion (>20mm)	2215 (82.1)	1879 (78.4)	0.001	1742 (80.0)	1748 (80.3)	0.84
CTO	148 (5.5)	177 (7.4)	0.006	141 (6.5)	129 (5.9)	0.48
Calcified lesion	214 (7.9)	157 (6.5)	0.06	147 (6.7)	144 (6.6)	0.90

Procedural Characteristics

Propensity Score Matched Population

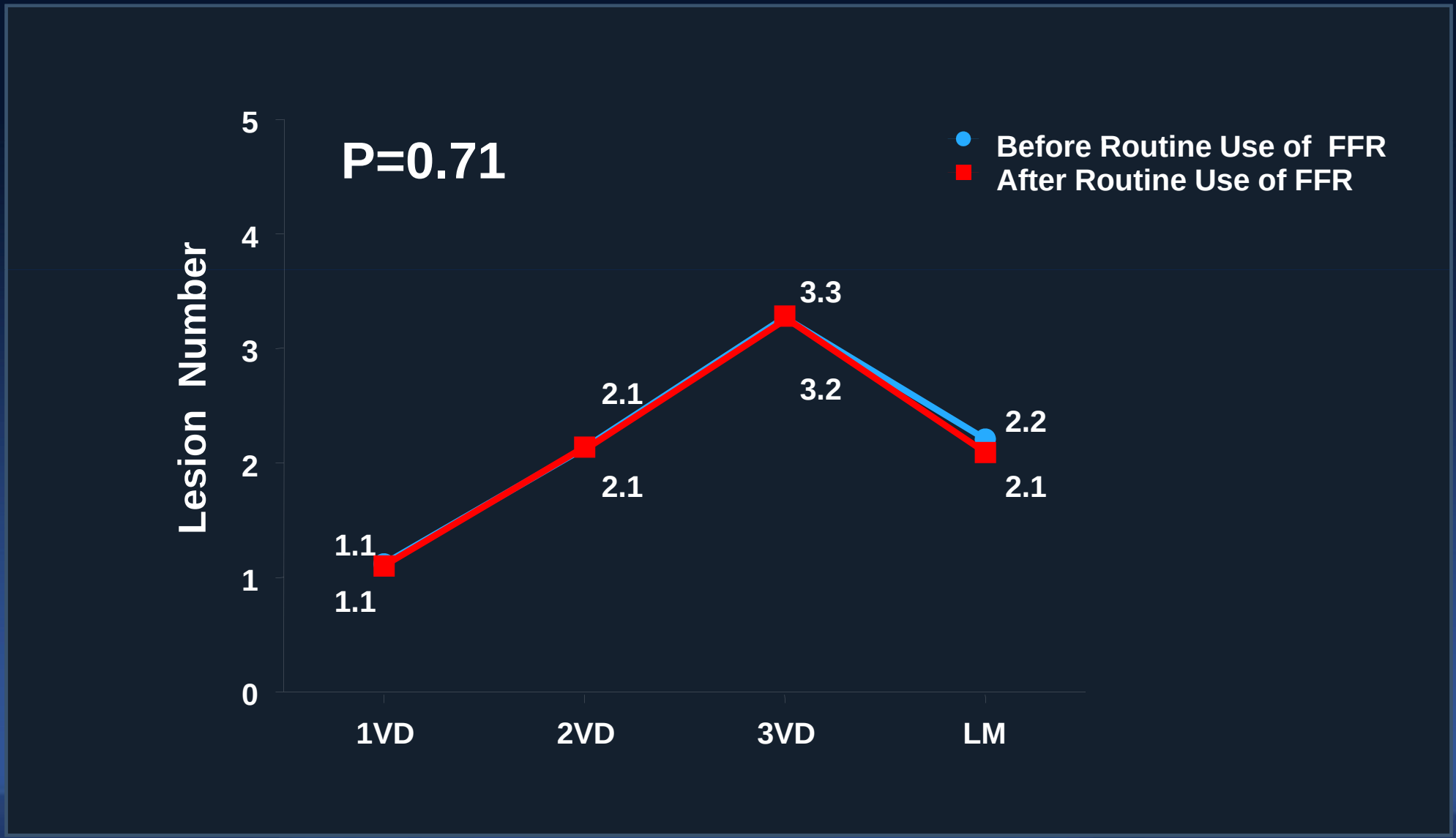
	Before Routine FFR (N=2178)	After Routine FFR (N=2178)	P value
Fractional flow reserve	47 (2.2)	1093 (50.2)	<0.001
Intravascular ultrasound	1967 (90.3)	2114 (97.1)	<0.001
No. of lesions	1.8±0.9	1.8±1.0	0.71
Average stent diameter, mm	3.3±0.3	3.3±0.4	0.31
No. of treated lesions	1.4±0.7	1.1±0.8	<0.001
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
Multivessel stenting	772 (35.4)	563 (25.8)	<0.001

Type of DES

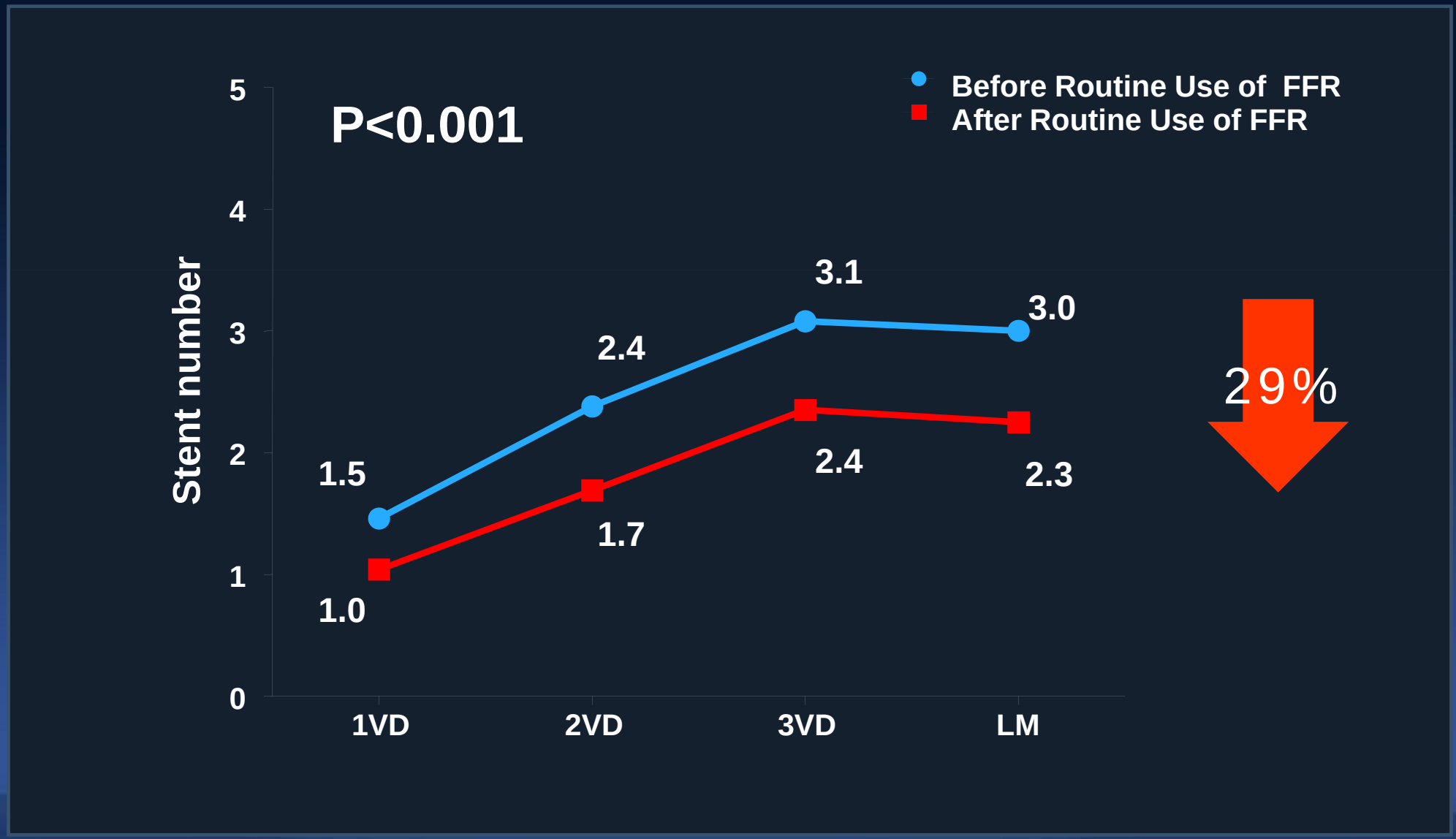

100%
80%
60%
40%
20%
0%
ZES
SES
CoCr-EES
R-ZES
BES
PtCr-EES
January-08
April-08
July-08
October-08
January-09
April-09
July-09
October-09
January-10
April-10
July-10
October-10
January-11
April-11
July-11
October-11
Anatomic-Guided Period
Functional-Guided Period

Results

Angiographic Assessed
Lesion Number

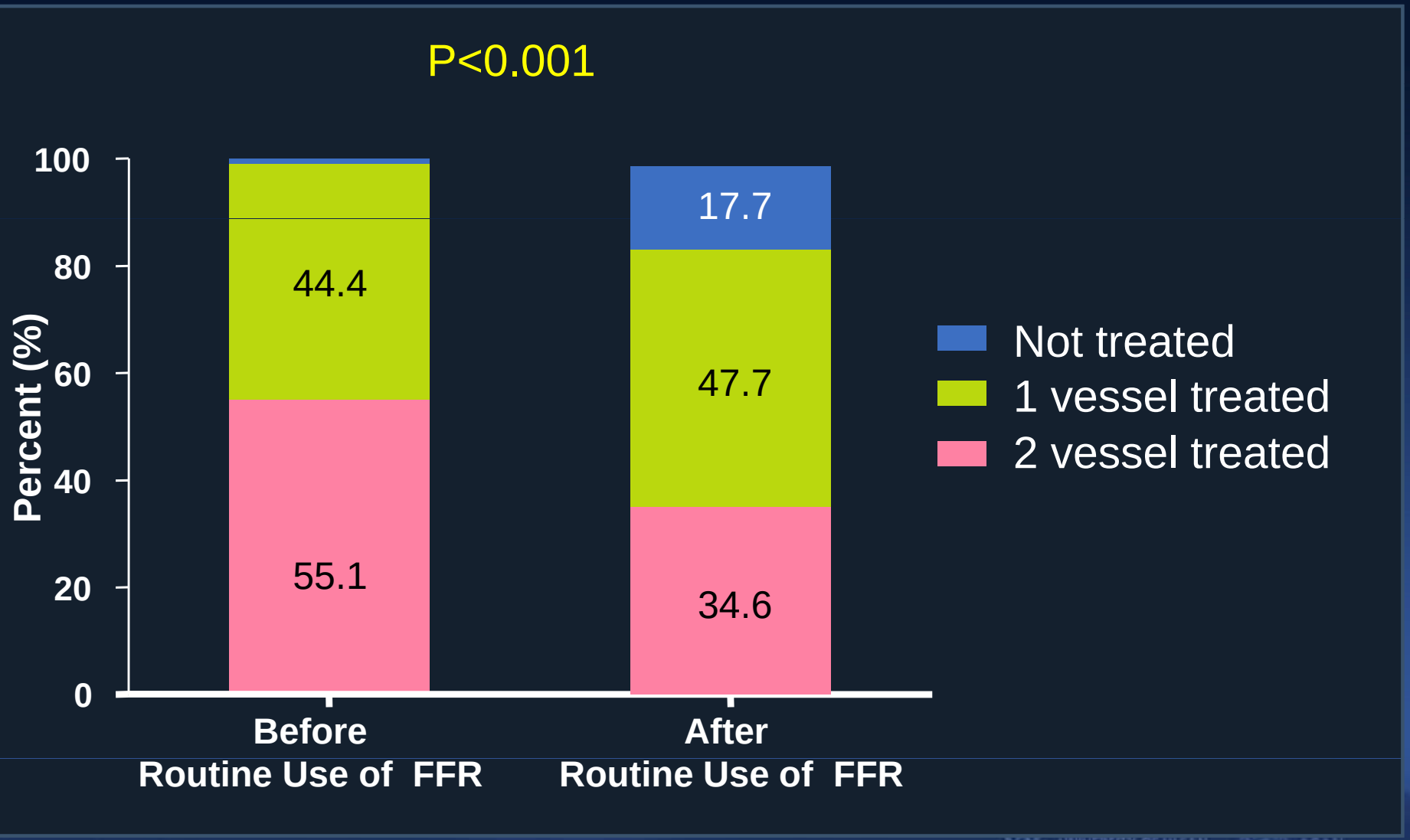


Stent Number

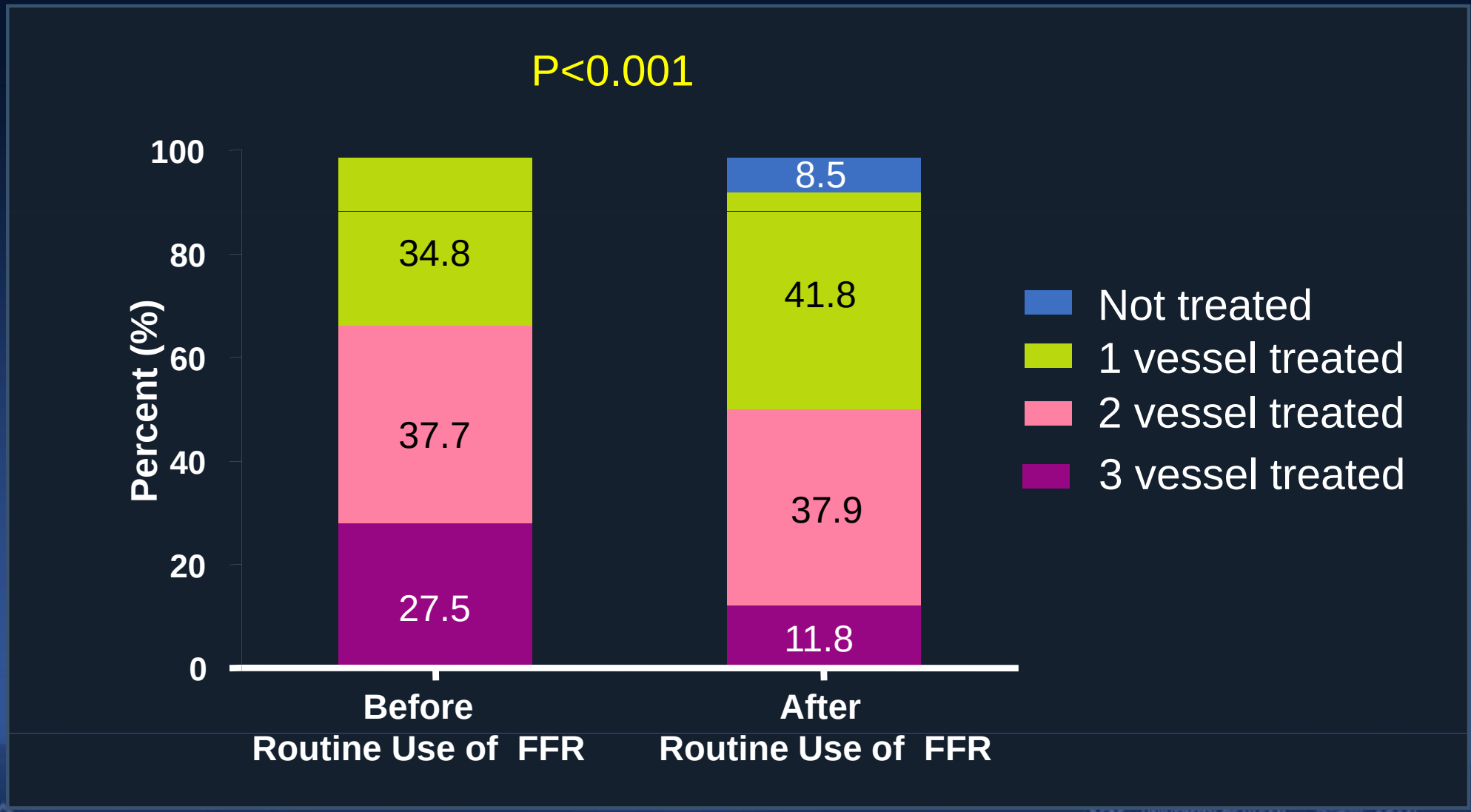


Stent Length

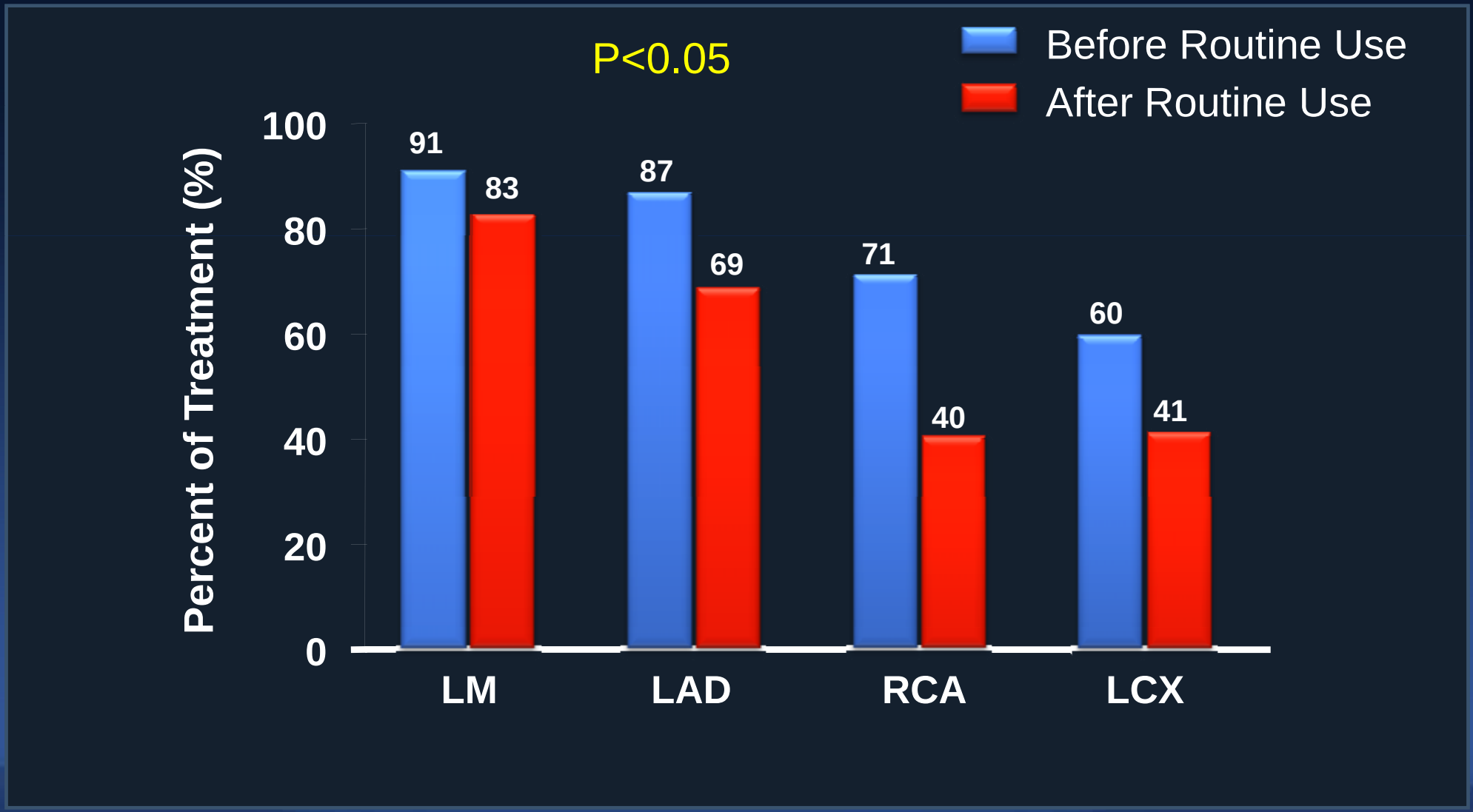
Angiographic 2 Vessel Disease



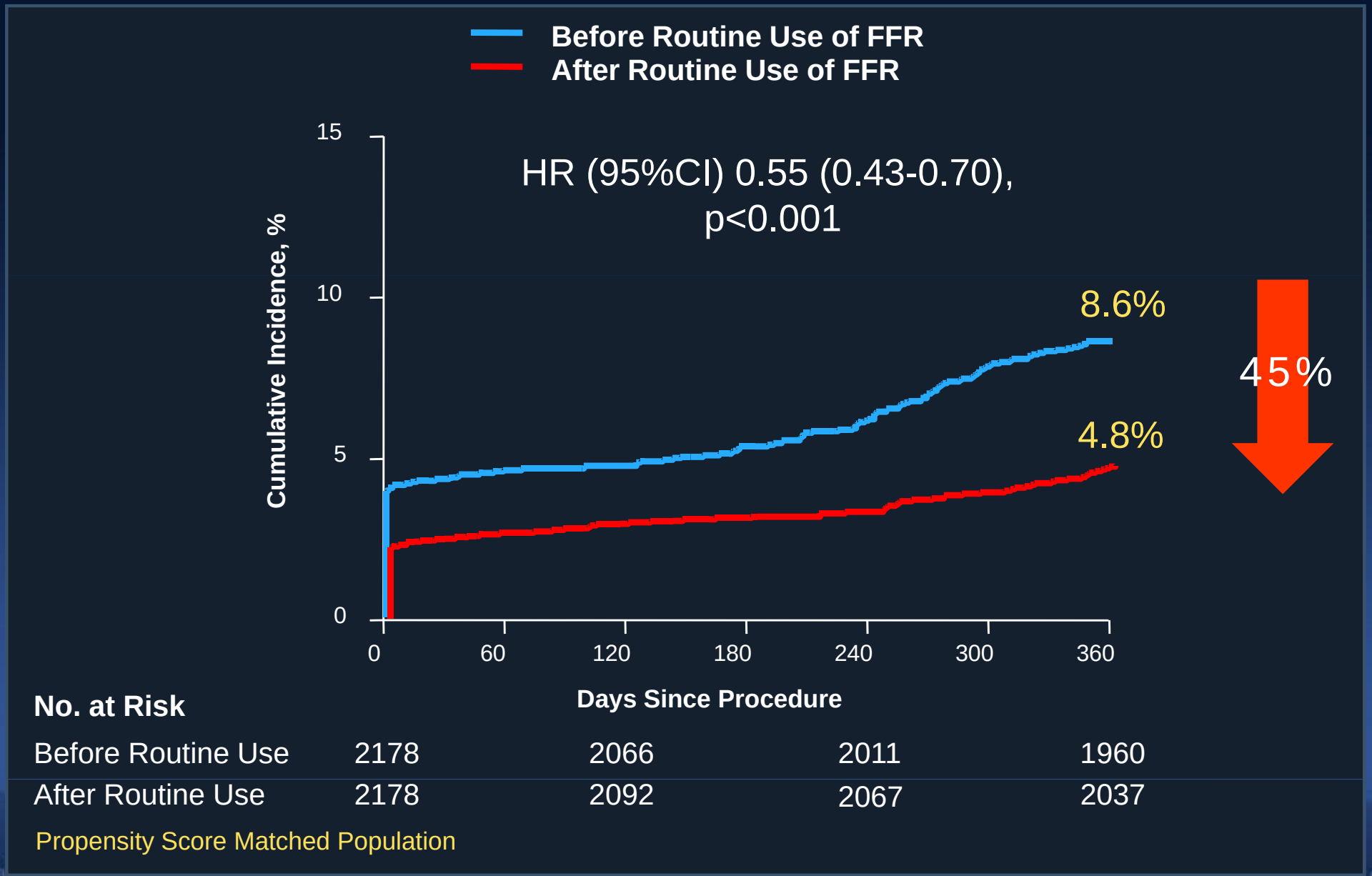
Angiographic
3 Vessel Disease



Treated Vessel Territory



Primary End Point
(Death, MI, or Repeat Revascularization)

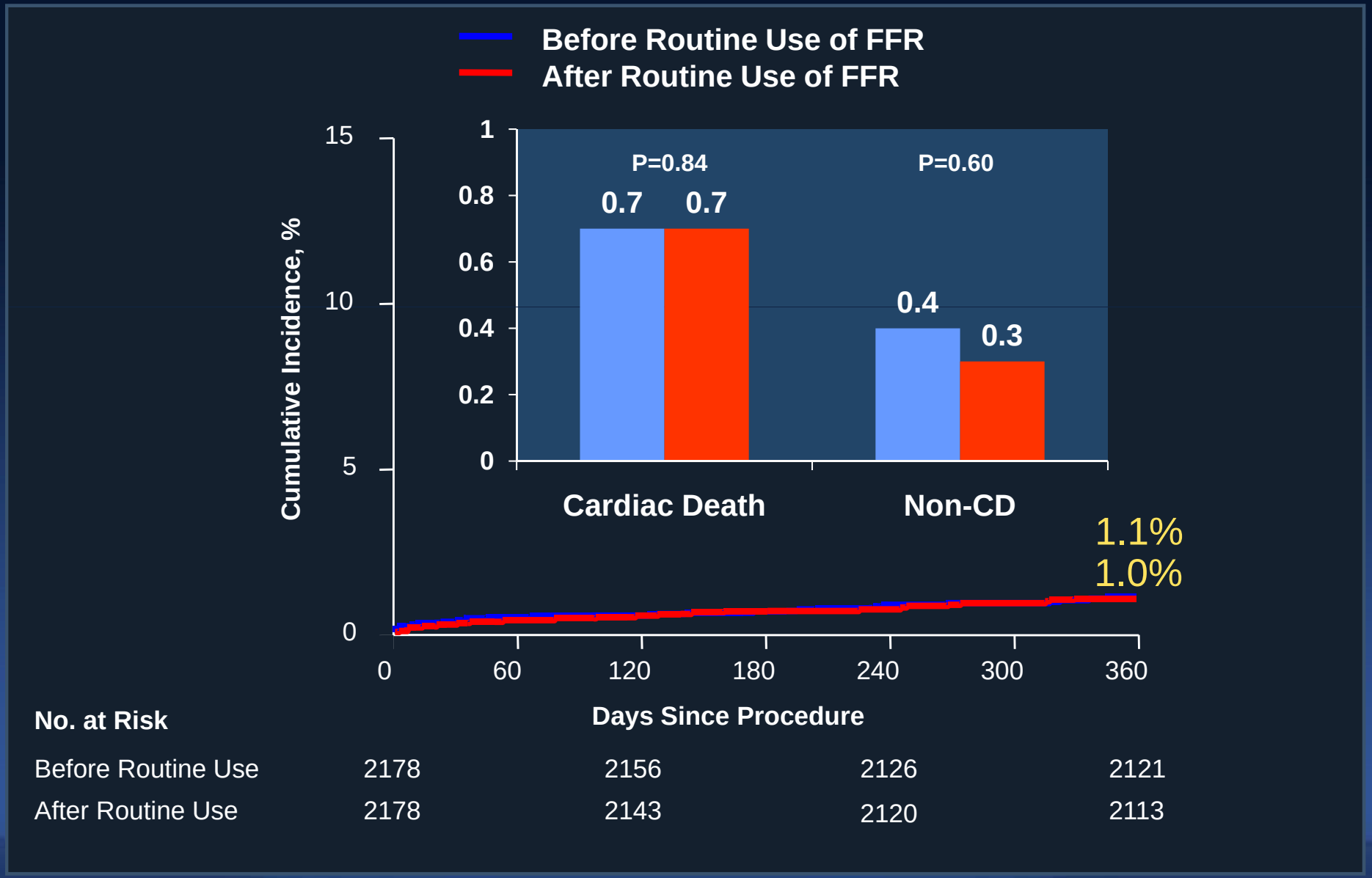


No. at Risk

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

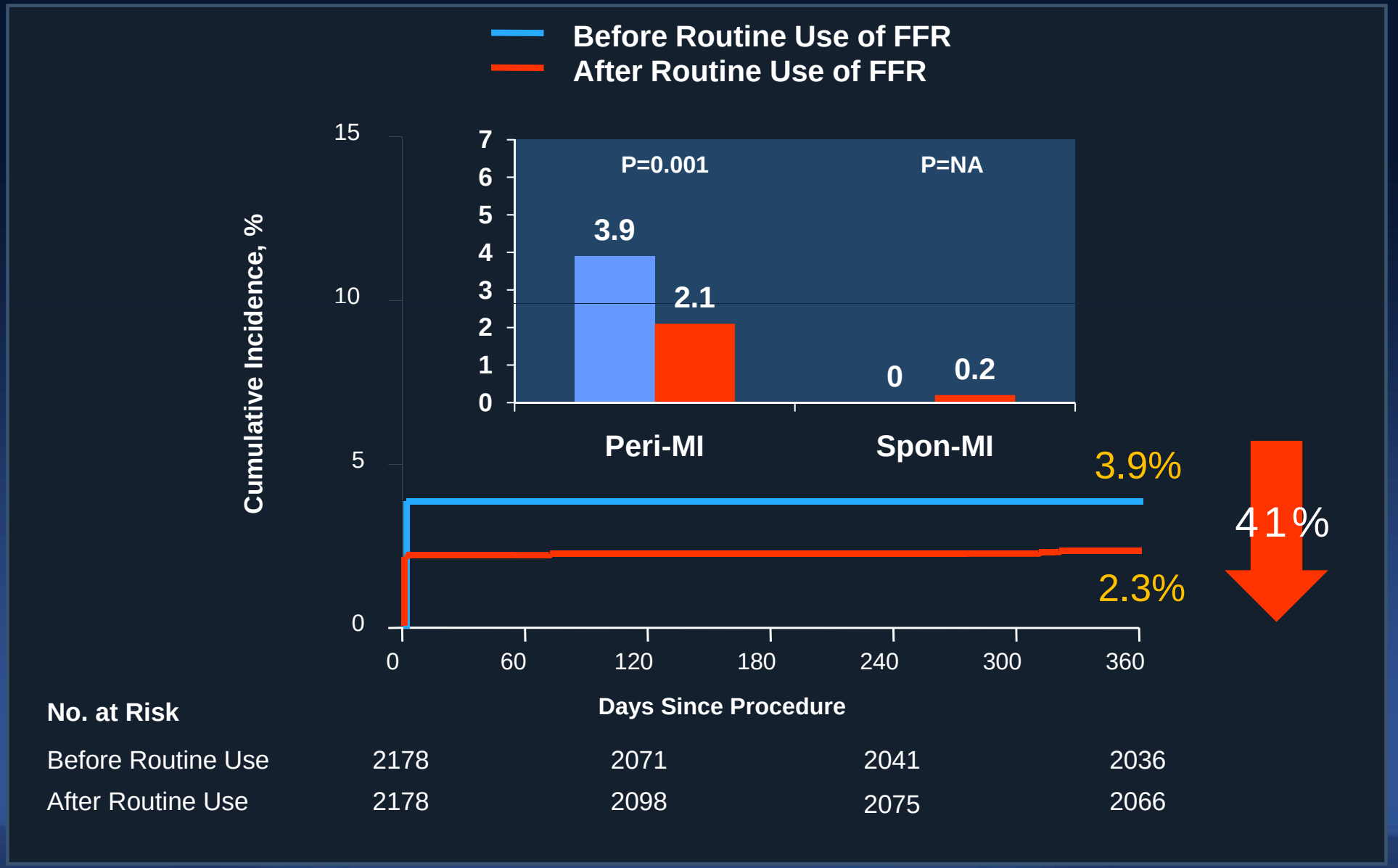
Propensity Score Matched Population

Death



No. at Risk				
Before Routine Use	2178	2156	2126	2121
After Routine Use	2178	2143	2120	2113

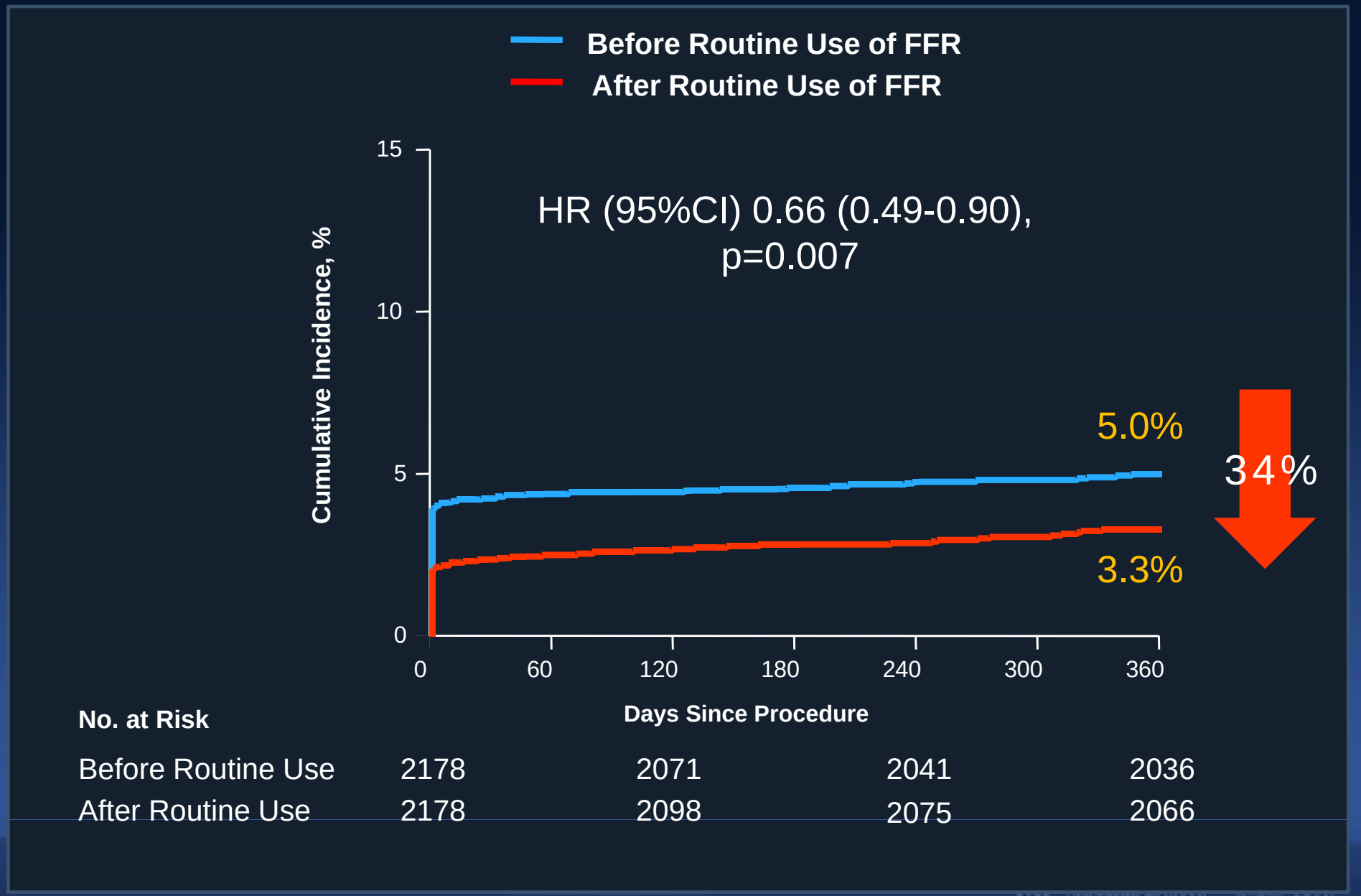
Myocardial Infarction



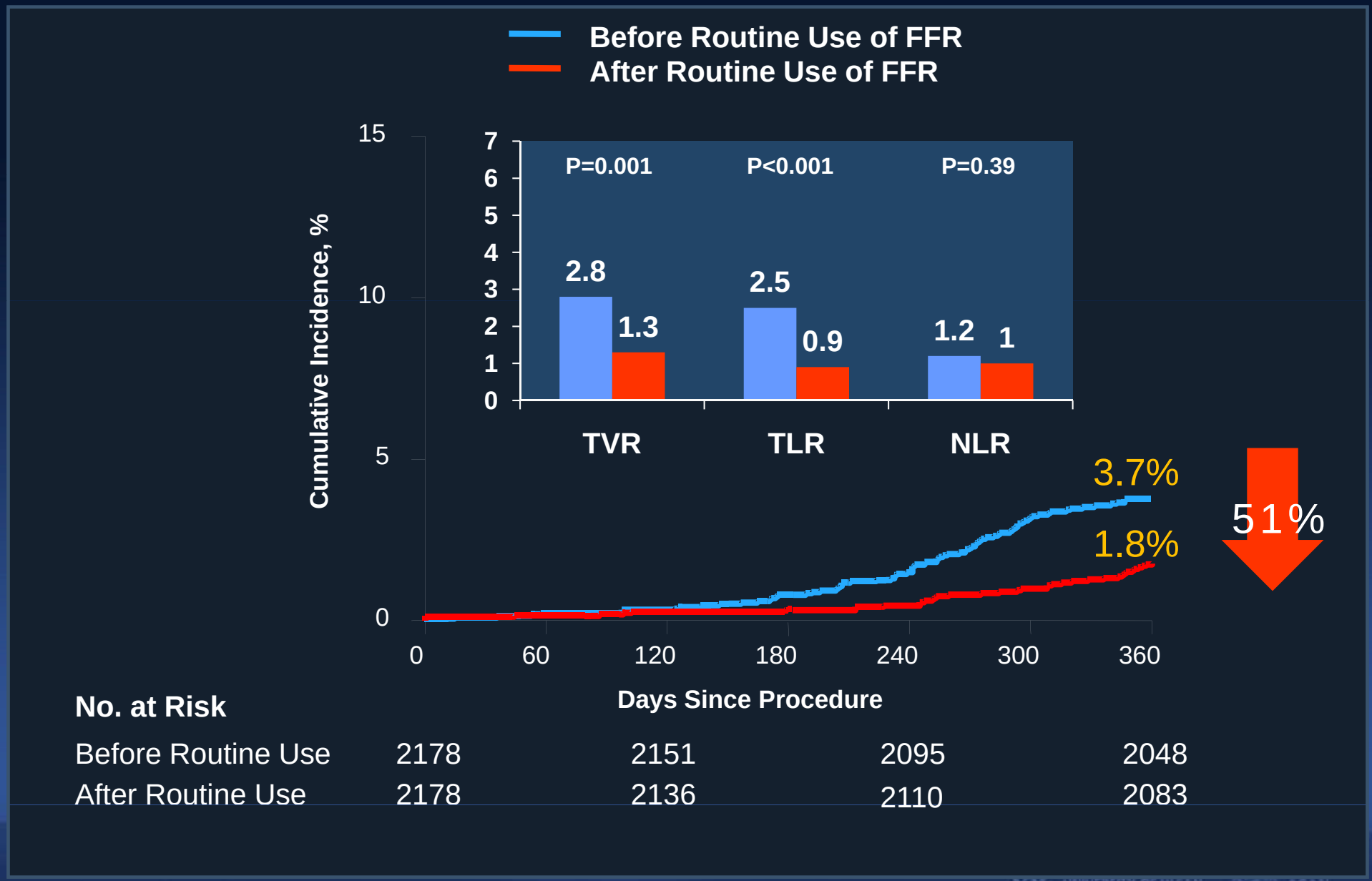
No. at Risk

Before Routine Use	2178	2071	2041	2036
After Routine Use	2178	2098	2075	2066

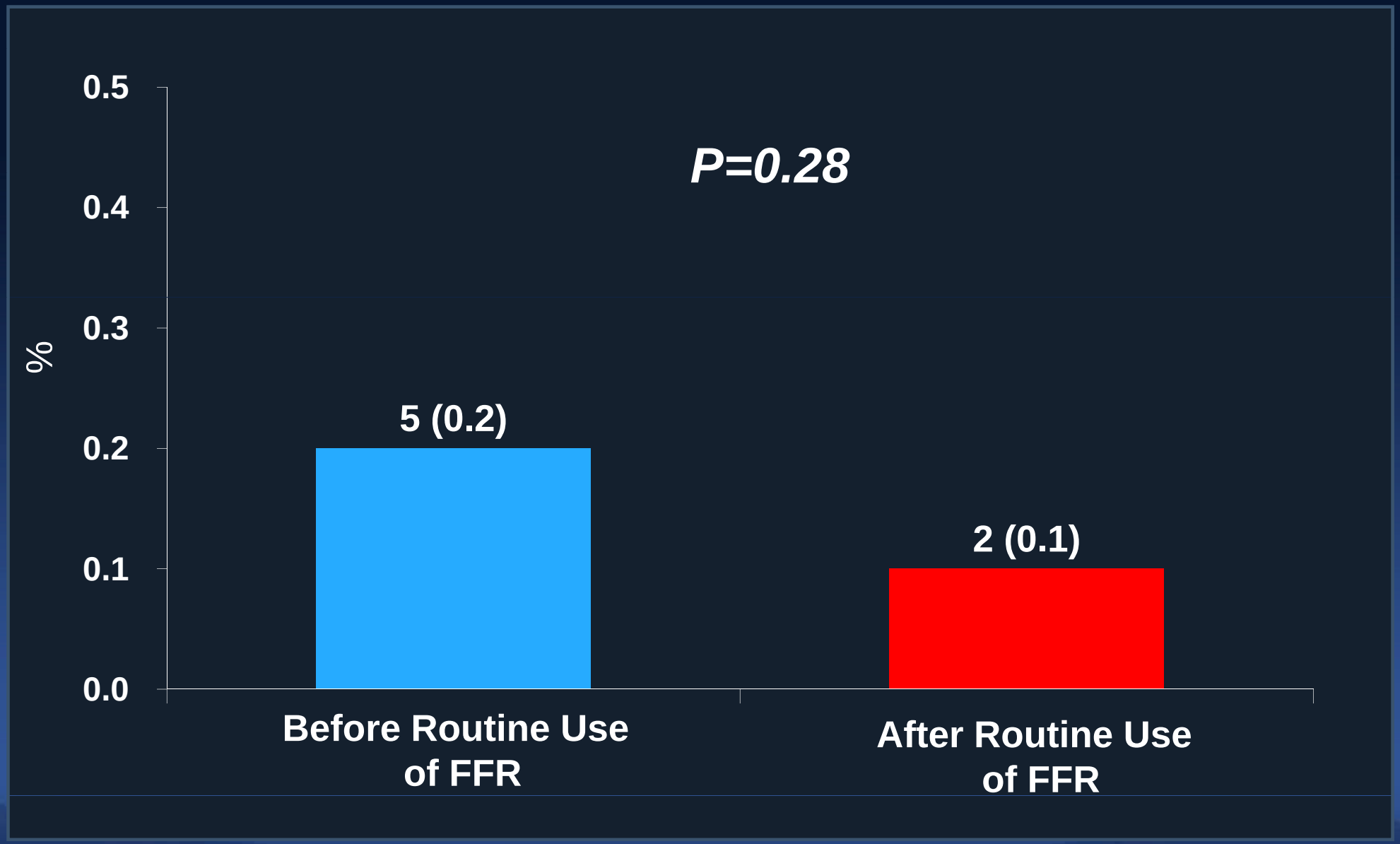
Death or Myocardial Infarction



Repeat Revascularization

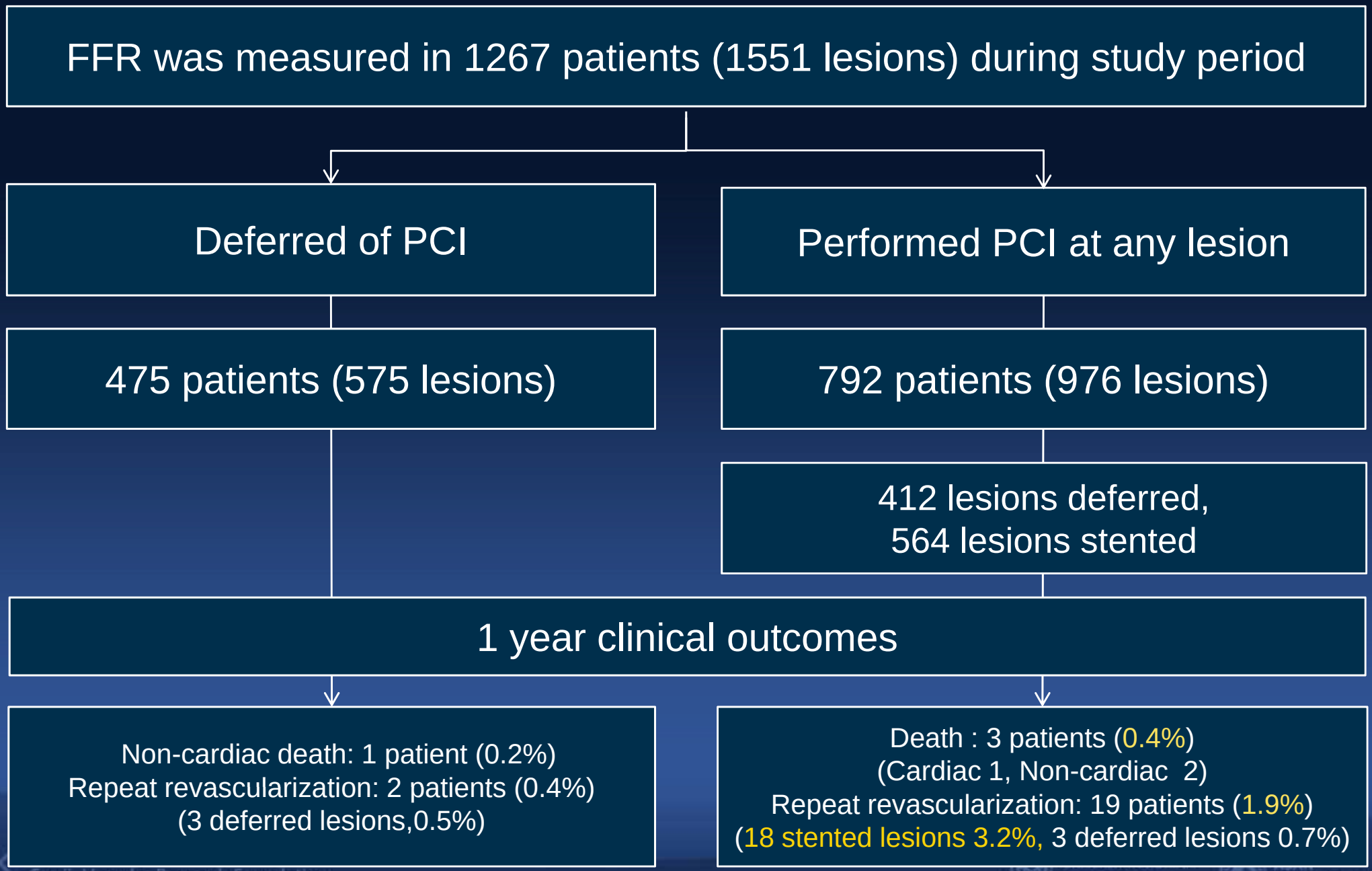


Stent Thrombosis at 12 Months*



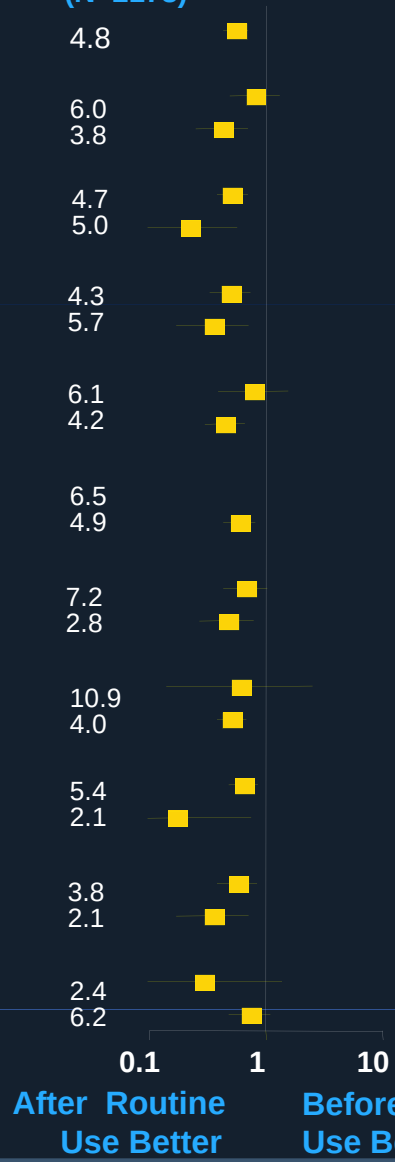
* ARC defined definite and probable stent thrombosis

One-Year Outcomes of Defer



Subgroup Analysis

Subgroup	Event Rate (%) of Primary Endpoints: Before Routine Use (N=2178)	Event Rate (%) of Primary Endpoints: After Routine Use (N=2178)	Hazard Ratio (95% CI)	P value	Interaction P value
Overall	8.6	4.8	0.55 (0.43, 0.70)	<0.001	
Age					0.08
≥65 yo (N=1917)	8.7	6.0	0.80 (0.49, 1.32)	0.38	
<65 yo (N=2439)	8.4	3.8	0.42 (0.25, 0.70)	0.001	
Sex					0.74
Male (N=3159)	8.4	4.7	0.50 (0.38, 0.70)	<0.001	
Female (N=1197)	8.9	5.0	0.22 (0.08, 0.57)	0.002	
Presentation					0.82
sAP (N=2805)	7.7	4.3	0.49 (0.33, 0.74)	0.001	
ACS (N=1551)	10.0	5.7	0.35 (0.17, 0.71)	0.004	
Diabetes					0.12
Yes (N=1410)	9.6	6.1	0.78 (0.39, 1.56)	0.48	
No (N=2946)	8.1	4.2	0.44 (0.30, 0.66)	<0.001	
Ejection fraction					NA
≤40% (N=154)	13.3	6.5	NA	NA	
>40% (N=3840)	7.9	4.9	0.63 (0.48, 0.83)	0.001	
Bifurcation					0.27
Yes (N=1951)	11.2	7.2	0.67 (0.43, 1.03)	0.067	
No (N=2405)	6.4	2.8	0.47 (0.27, 0.79)	0.005	
Left main disease					0.56
Yes (N=485)	15.0	10.9	0.60 (0.14, 2.51)	0.48	
No (N=3871)	7.8	4.0	0.50 (0.38, 0.68)	<0.001	
Long (>20mm) lesion					0.044
Yes (N=3490)	9.2	5.4	0.64 (0.48, 0.85)	0.002	
No (N=866)	6.0	2.1	0.17 (0.04, 0.75)	0.019	
Multivessel disease					0.48
Yes (N=2311)	6.5	3.8	0.57 (0.38, 0.84)	0.005	
No (N=2045)	2.8	2.1	0.35 (0.17, 0.71)	0.004	
Type of DES					0.30
Previous DES (N=1589)	8.1	2.4	0.29 (0.06, 1.38)	0.12	
New DES (N=2351)	9.5	6.2	0.73 (0.48, 1.09)	0.13	



Independent Predictors of Primary End Point

	Hazard Ratio (95% CI)	P value
Chronic renal failure	2.41 (1.61-3.59)	<0.001
Multivessel disease	1.89 (1.45-2.46)	<0.001
Peripheral vascular disease	1.84 (1.07-3.17)	0.027
Bifurcation lesion	1.37 (1.09-1.71)	0.006
Acute coronary syndrome	1.37 (1.10-1.69)	0.004
Total stent length per patient	1.01 (1.00-1.01)	<0.001
Fractional flow reserve	0.72 (0.53-0.98)	0.036
Intravascular ultrasound	0.57 (0.40-0.81)	0.002

Absolutely Lower Rate of Death, MI and Any MACE in AMC Data.

Why ?

Additive Impact Of Routine Use of IVUS (98%) In Our Practice !

Meta-Analysis
IVUS vs. CAG Guided PCI

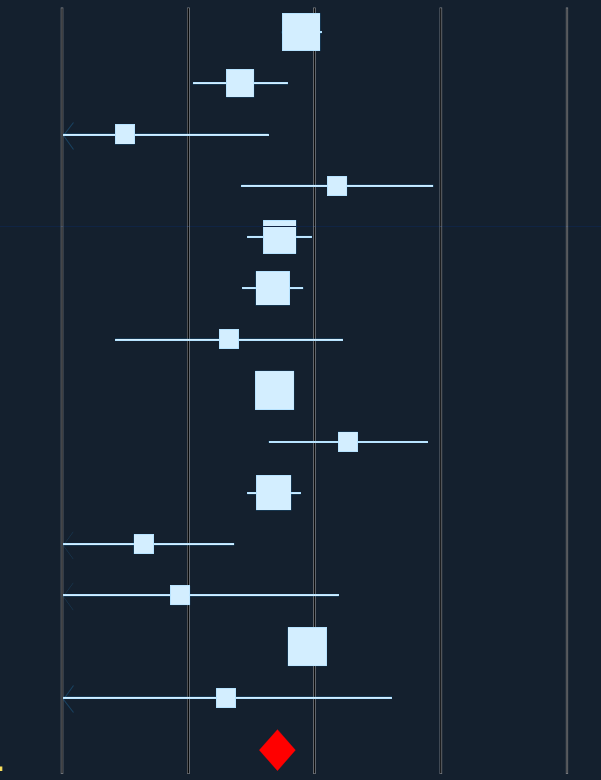
A total of 23,392 patients
(2 randomized trial and 12 observational studies)

Park SJ, Ahn JM, Unpublished Data, 2013

Death from Any Causes

Study name	Time point	OR	LL	UL	Z-Value	P
Roy	2008	0.79	0.54	1.16	-1.20	0.23
MAIN-COMPARE	2009	0.26	0.11	0.63	-2.98	0.00
Kim	2010	0.03	0.00	0.44	-2.57	0.01
HOME DES IVUS	2010	1.52	0.26	8.87	0.46	0.64
MATRIX	2011	0.53	0.29	0.97	-2.07	0.04
COBIS	2011	0.47	0.26	0.83	-2.62	0.01
Youn	2011	0.21	0.03	1.70	-1.46	0.14
Hur	2012	0.49	0.36	0.66	-4.60	0.00
EXCELLENT	2012	1.84	0.42	7.99	0.82	0.41
Ahn	2012	0.48	0.29	0.79	-2.88	0.00
Patel	2012	0.04	0.01	0.24	-3.66	0.00
Chen	2012	0.09	0.00	1.58	-1.65	0.10
ADAPT-DES	2012	0.88	0.64	1.20	-0.82	0.41
AVIO	2013	0.20	0.01	4.17	-1.04	0.30
Random pooled estimate		**0.50**	**0.36**	**0.69**	**-4.10**	**<0.001**

I^2=63



IVUS vs. Angio-Guided PCI

(Meta-analysis n=23,392)

	Relative	
Death/MI, Benefit !		
TVR	↓ 22%	0.02
Stent Thrombosis	↓ 45%	<0.001

Park SJ, Ahn JM et al. Unpublished data, 2013

Why Absolutely Lower Rate of Death, MI and Any MACE in AMC Data ?

We Maximized the Synergetic Incorporation of FFR (58%) and IVUS (98%) in Our Practice !

Conclusion

1. FFR-guided PCI significantly reduced that the risks of death, MI, or repeat revascularization at 1 year in a real-world patient population.
2. The benefit is primarily due to a reduced number of stents used per patients and a subsequent decreased risk of peri-procedural MI and repeat revascularization.

Conclusion

3. Profound reduction of stent used was observed in the territory of RCA and LCX, which can be explained by the higher incidence of “visual-functional mismatch” in this territory (relatively small myocardium).

4. The routine measurement of FFR in daily practice appeared to be associated with a more judicious use of stent implantation and improvement in clinical outcomes at 1 year.