

FFR Guided Clinical Practice: Learn From AMC Experience

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Current Status of FFR

Guideline

Ia

ESC

IIa

ACCF/AHA/SCAI

European Heart Journal (2010) 31, 2501–2555

Circulation. 2011;124

Current Status of FFR

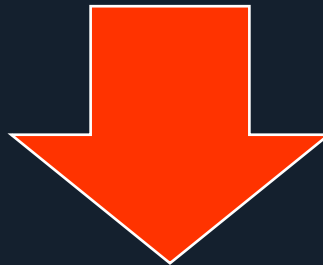
FFR Guided PCI

Death/MI
At 2 Years



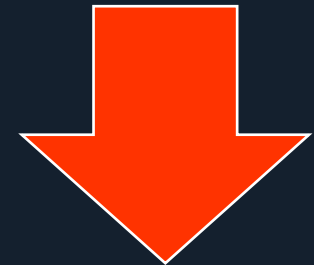
35%

Cost
at 1 Year



\$2400

Urgent RR
In sAP



87%

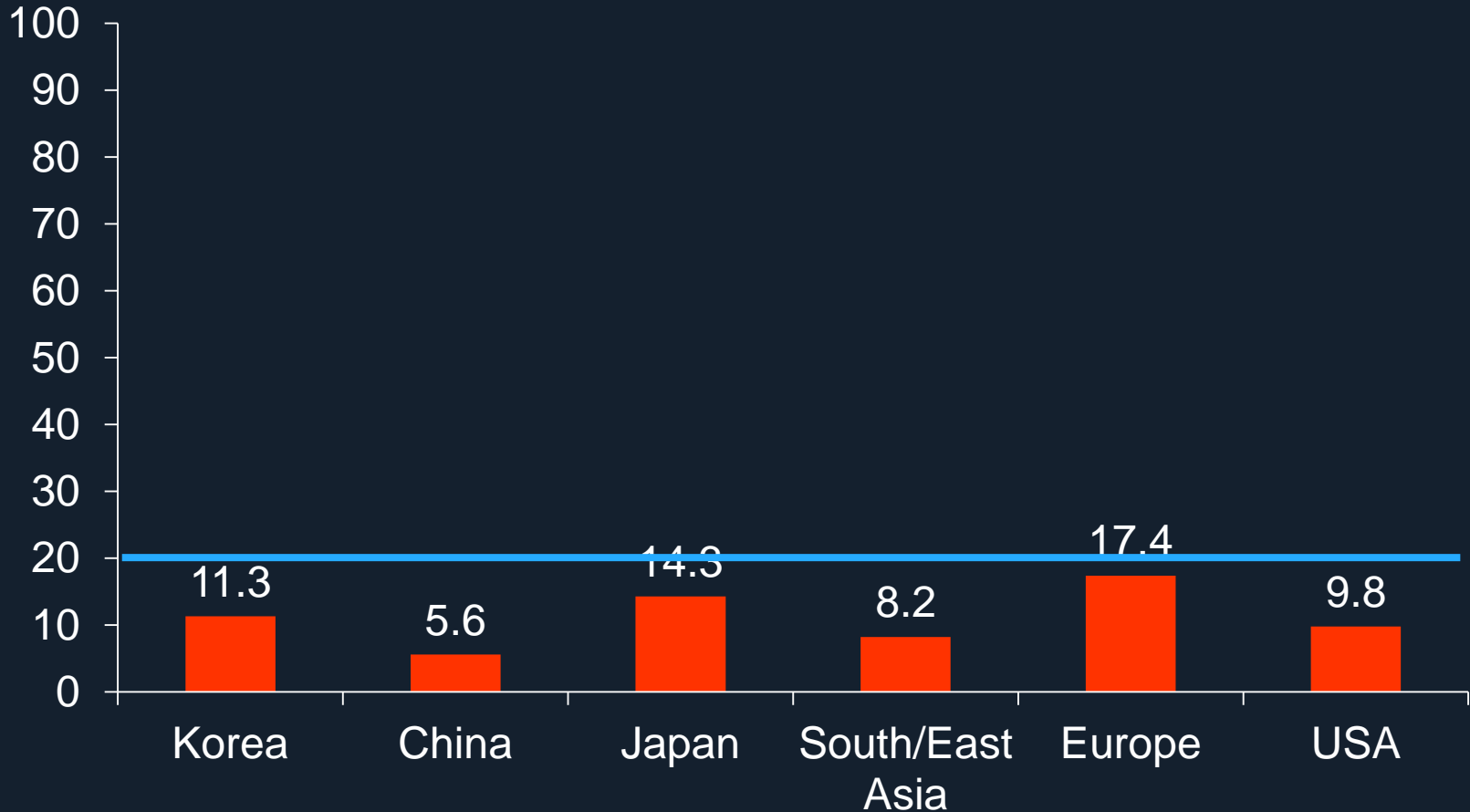
JACC 2010 Jul 13;56(3):177-84

Circulation. 2010 Dec 14;122(24):2545-50

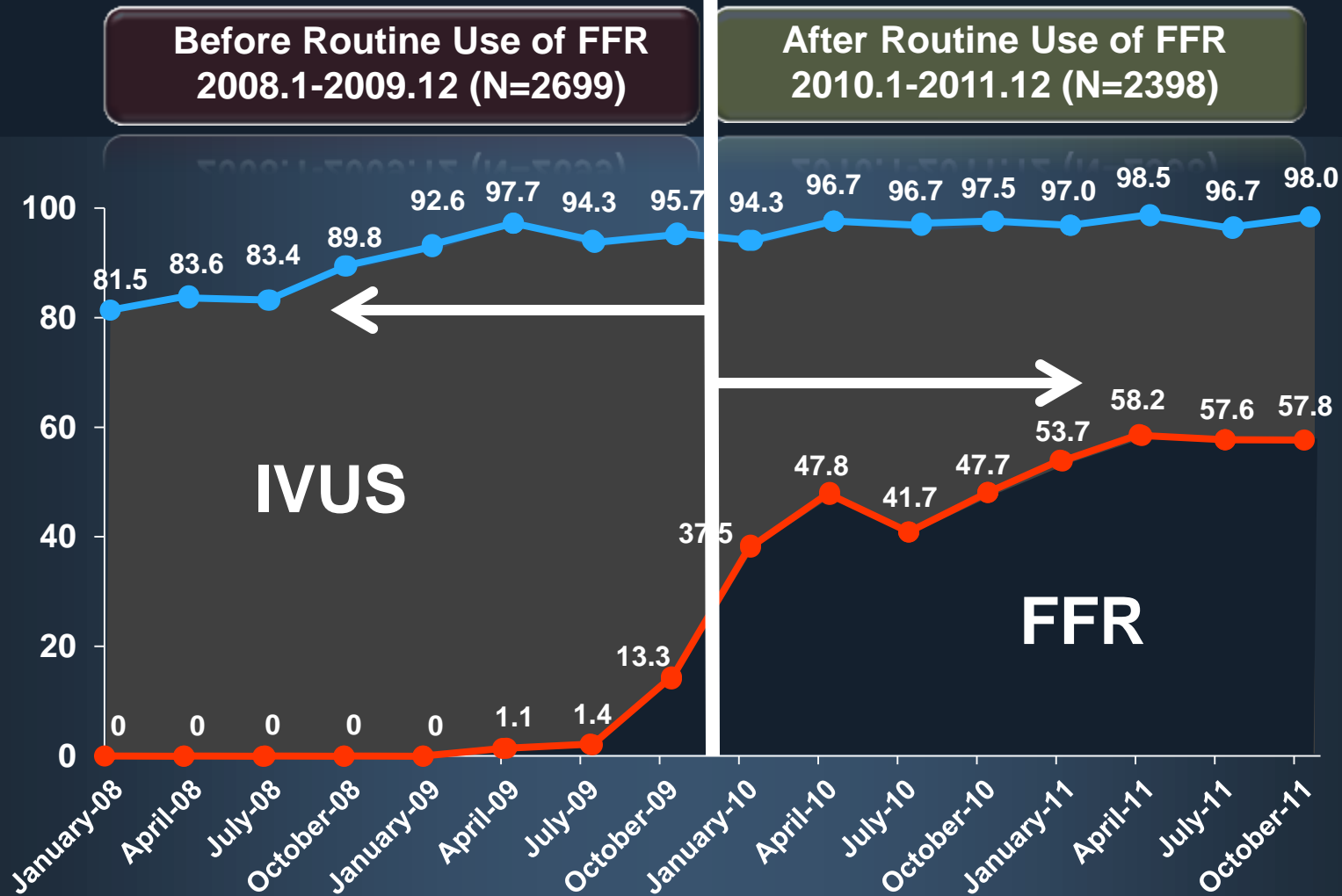
N Engl J Med. 2012 Sep 13;367(11):991-1001

Current Status of FFR

FFR Penetration Rate (No. of FFR/No. of PCI)



Rate of FFR Use in Asan Medical Center



What is the Routine Use?

Reasons for FFR not measured Between 2010 and 2011

	N=1183 (%)
Tight stenosis (visual estimated diameter stenosis>80%) or total occlusion	1115 (94.3)
Stenosis evaluated by non-invasive functional study	225 (19.0)
Unfavorable anatomy (e.g. severe calcified and/or tortuous vessel) or unstable hemodynamics for FFR measurement	75 (6.3)
Stenosis supplying small myocardium	47 (4.0)
No-specific reasons identified	43 (3.6)

ASAN Registry

- **ASAN PCI Registry (N=5097)**
How Improved PCI outcome before and after
- **ASAN Multivessel and LM Registry (N=2612)**
PCI vs. CABG before and after

ASAN PCI Registry

Total population: 5097 Patients

Propensity Matched Pairs: 2178 Pairs

Baseline Characteristics

Unadjusted Group

Propensity Matched Group

	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 Characteristics

Unadjusted Group

Propensity Matched Group

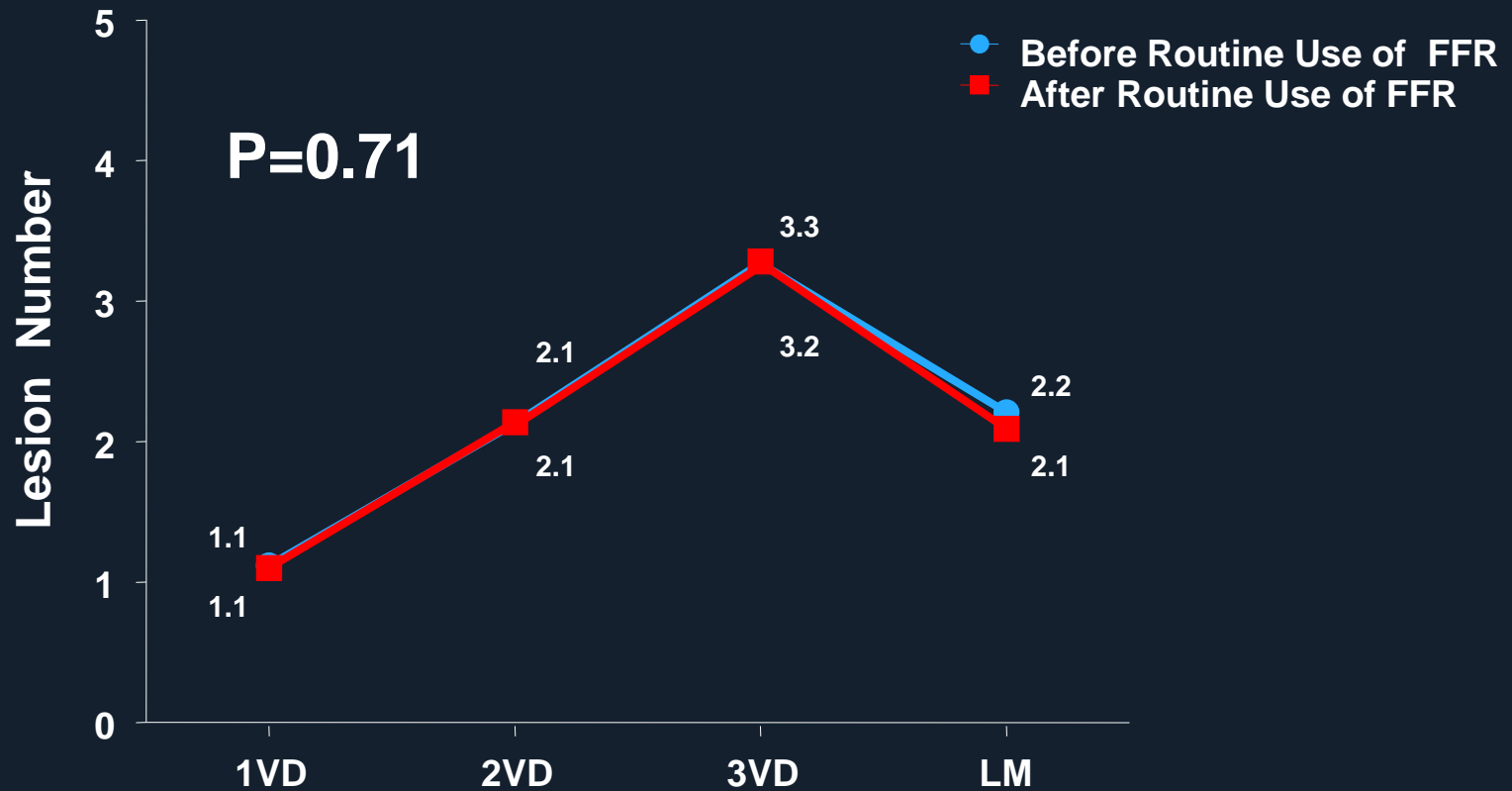
	Unadjusted Group			Propensity Matched Group		
	Before Routine FFR (N=2699)	After Routine FFR (N=2398)	P	Before Routine FFR (N=2178)	After Routine FFR (N=2178)	P
Previous CHF	20 (0.7)	26 (1.1)	0.20	19 (0.9)	22 (1.0)	0.76
Previous stroke	153 (5.7)	149 (6.2)	0.41	131 (6.0)	126 (5.8)	0.79
Peripheral vascular 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 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

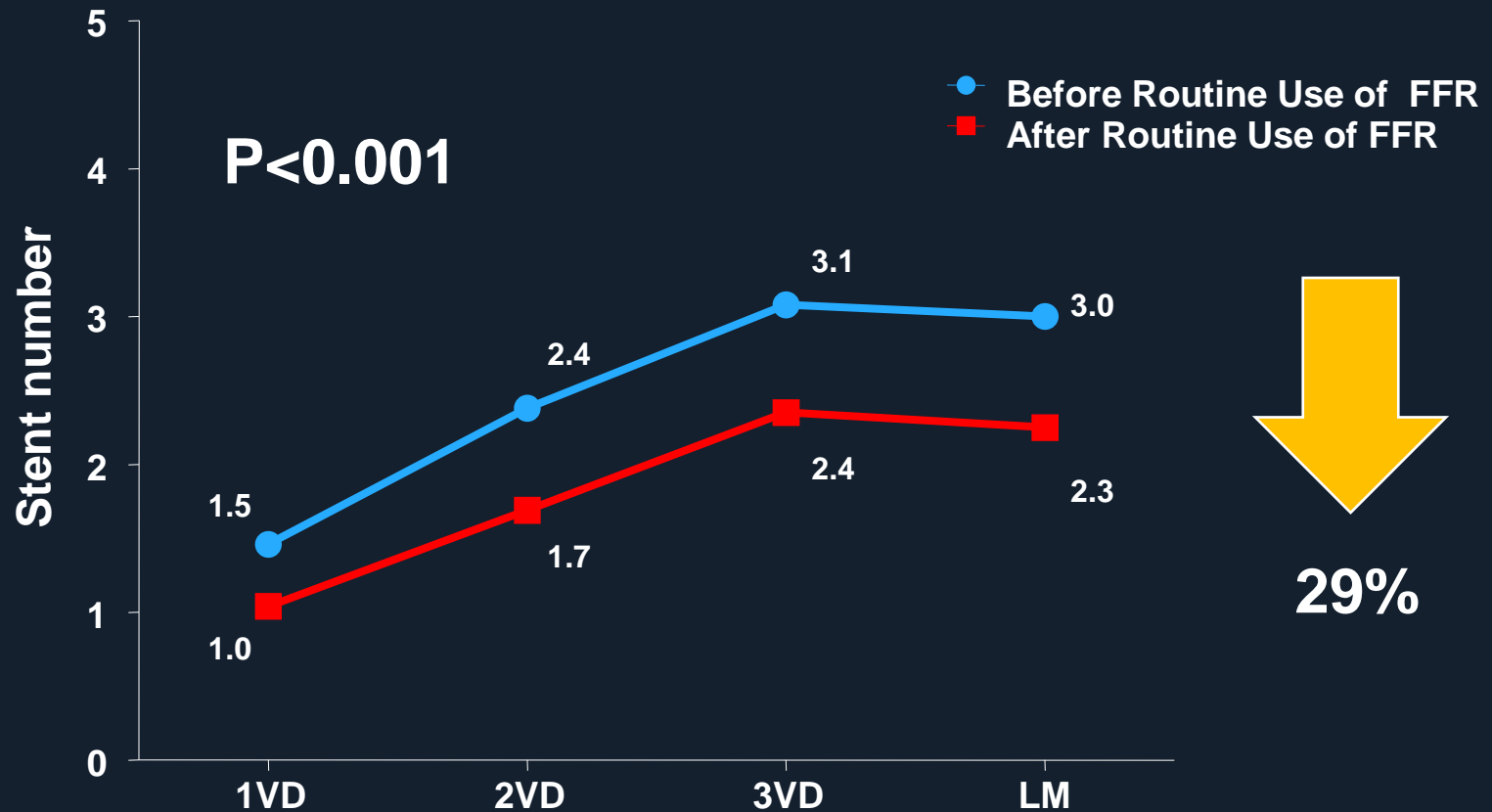
Changes in PCI procedure

Lesion Number



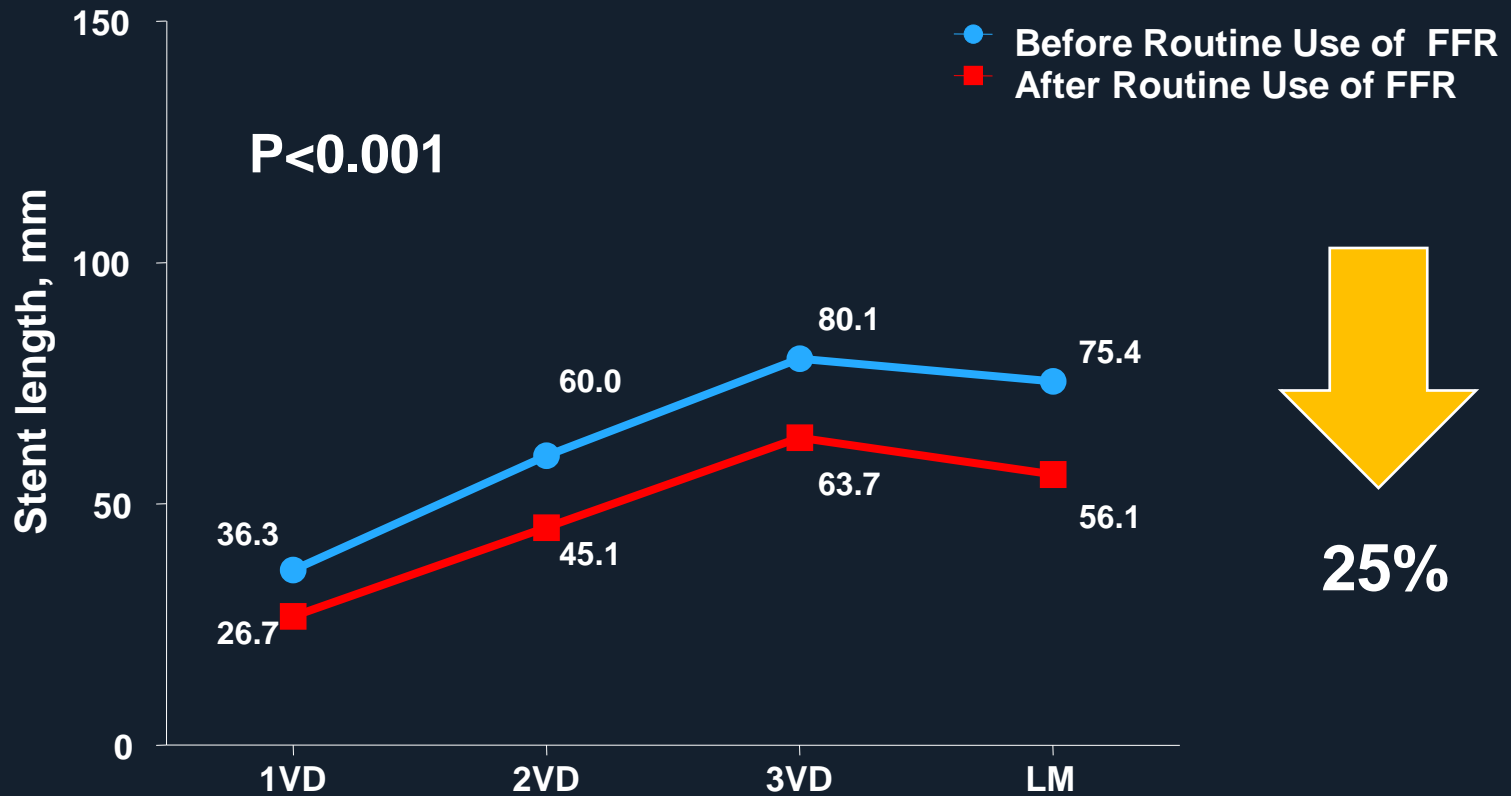
Changes in PCI procedure

Stent Number



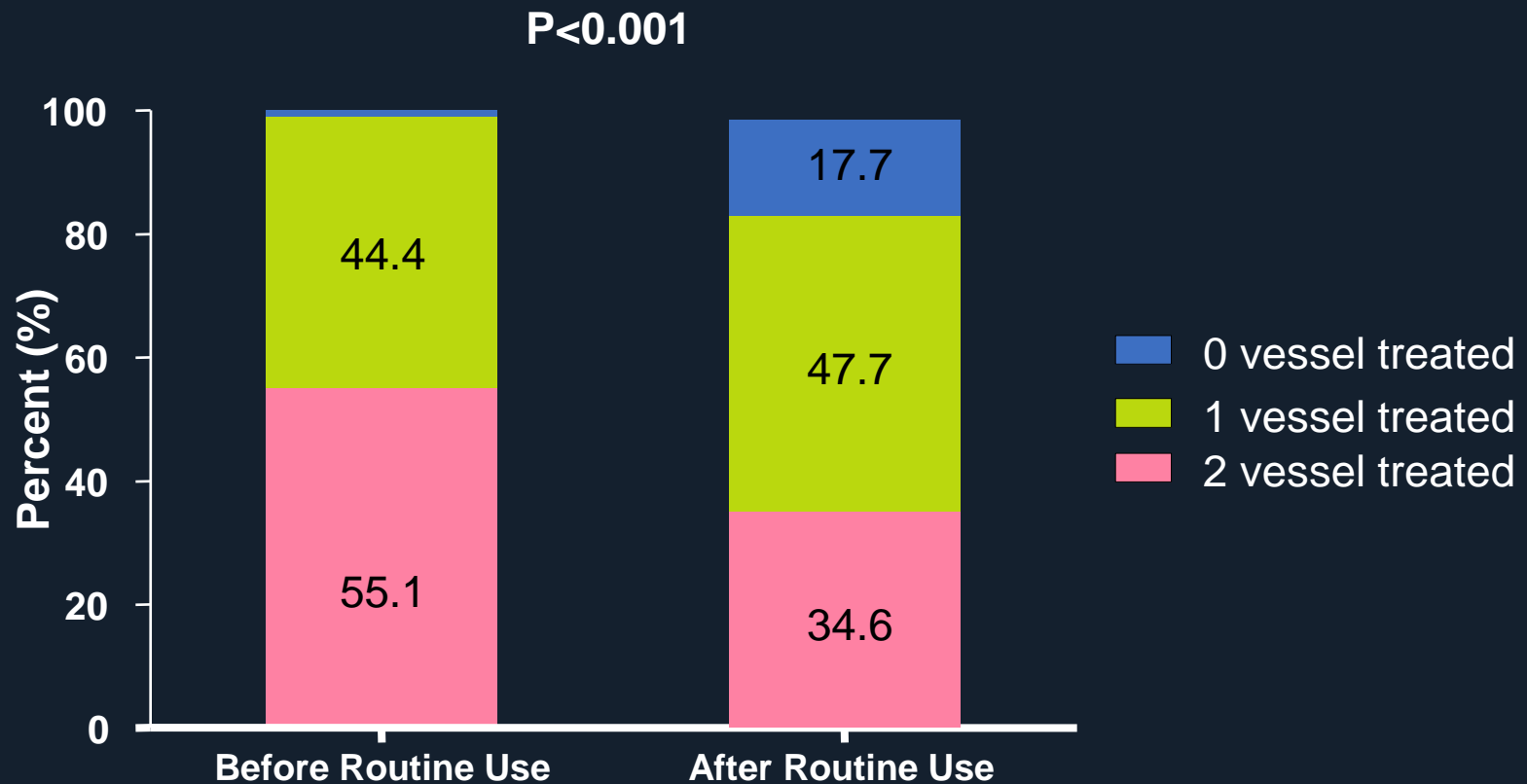
Changes in PCI procedure

Stent Length



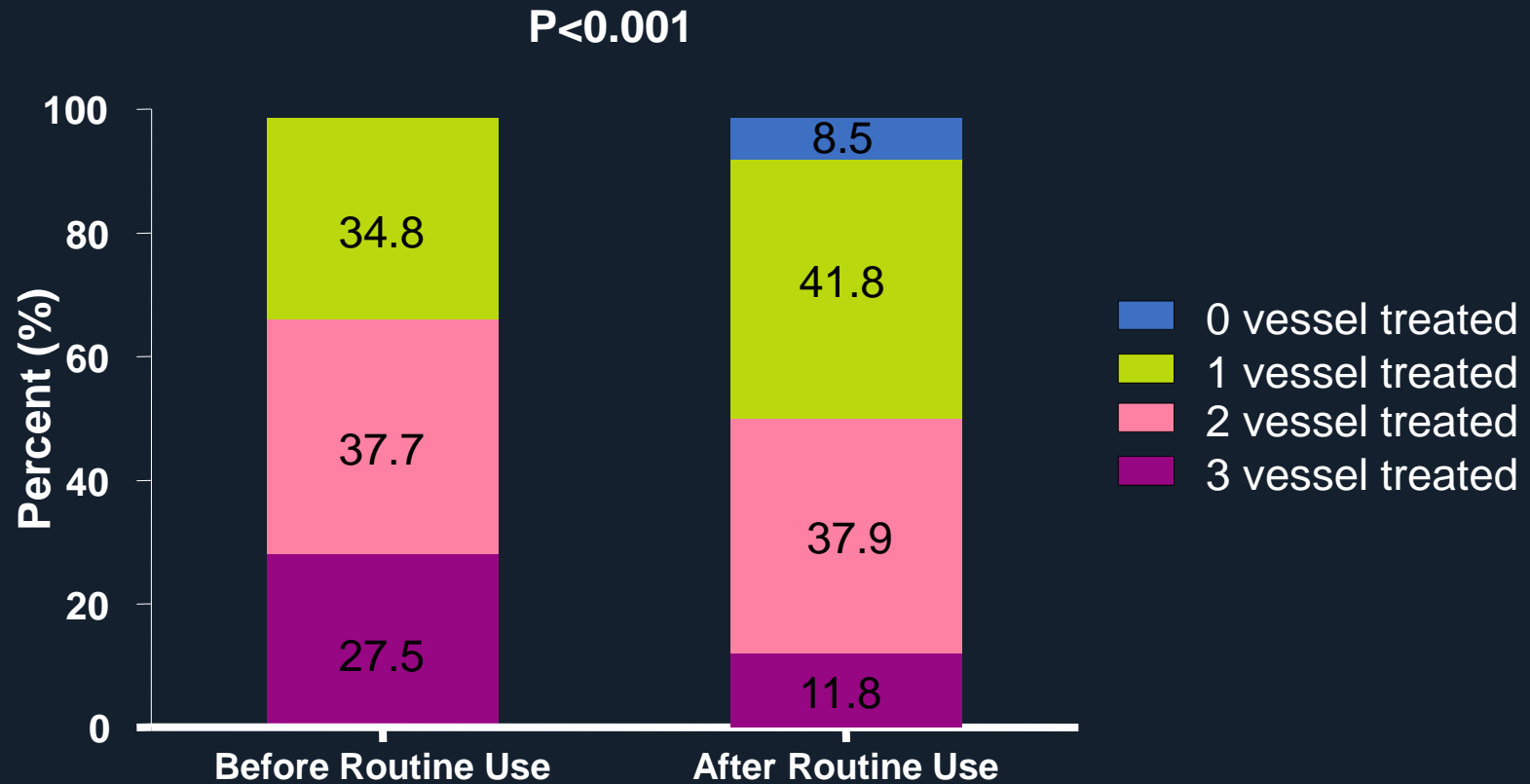
Changes in PCI procedure

Two Vessel Disease



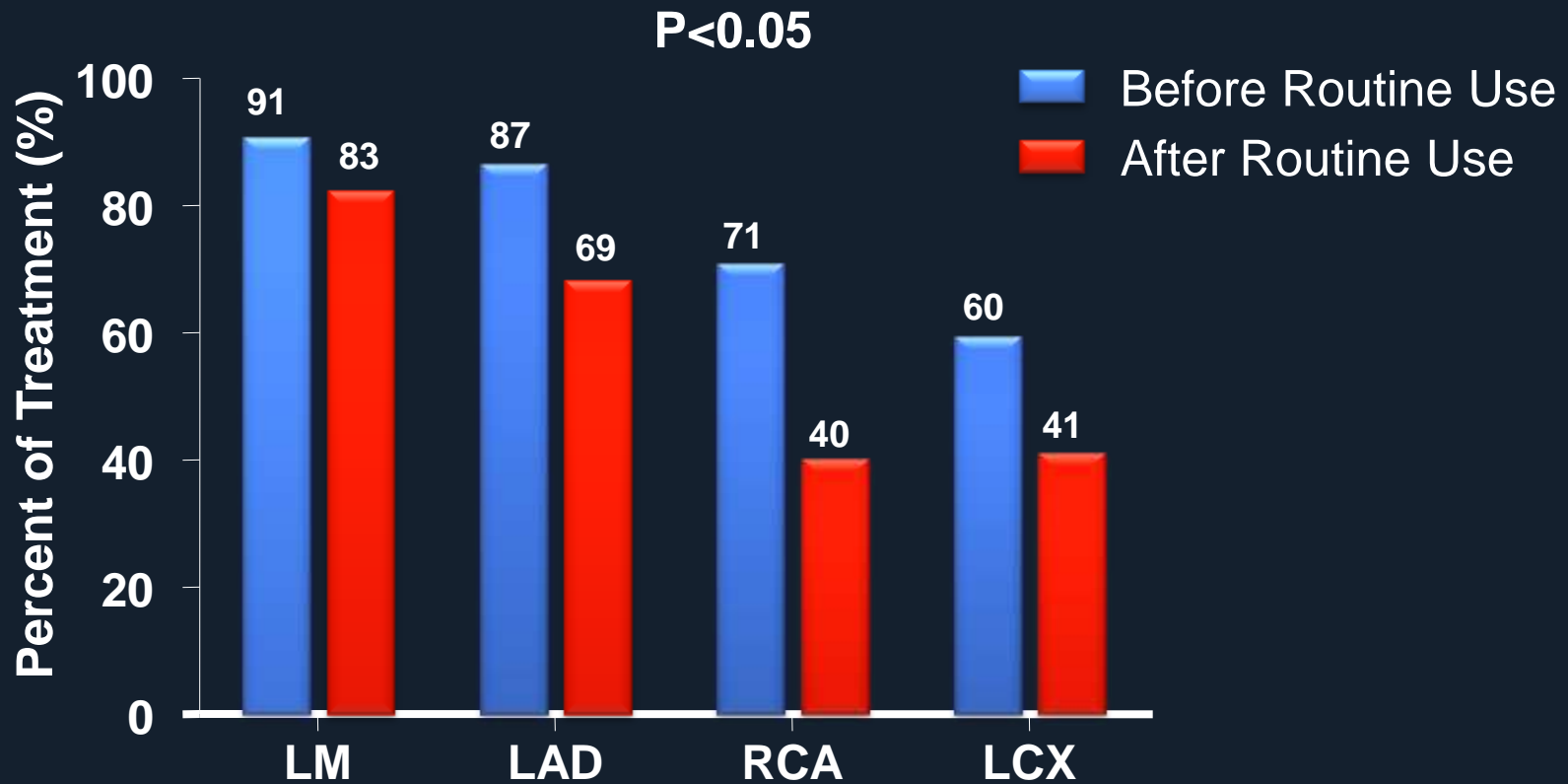
Changes in PCI procedure

Three Vessel Disease



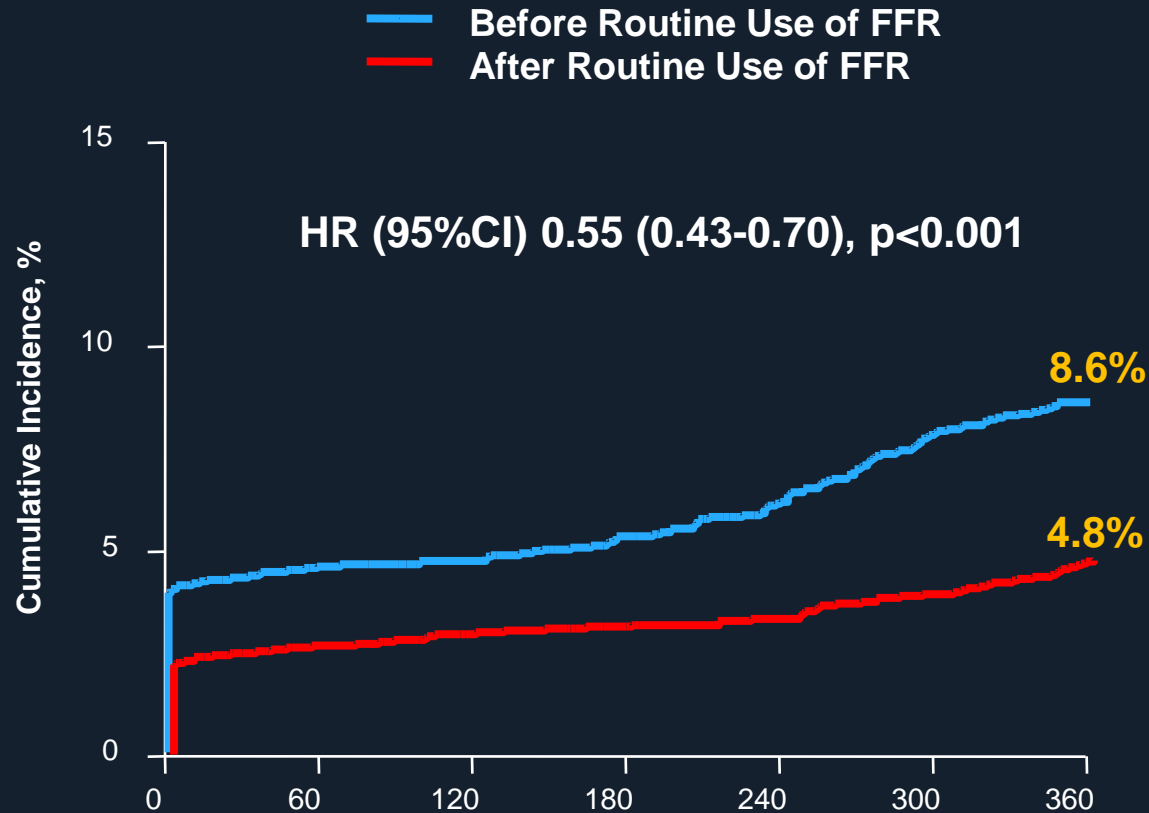
Changes in PCI procedure

Diseased Vessel Territory



Primary End Point

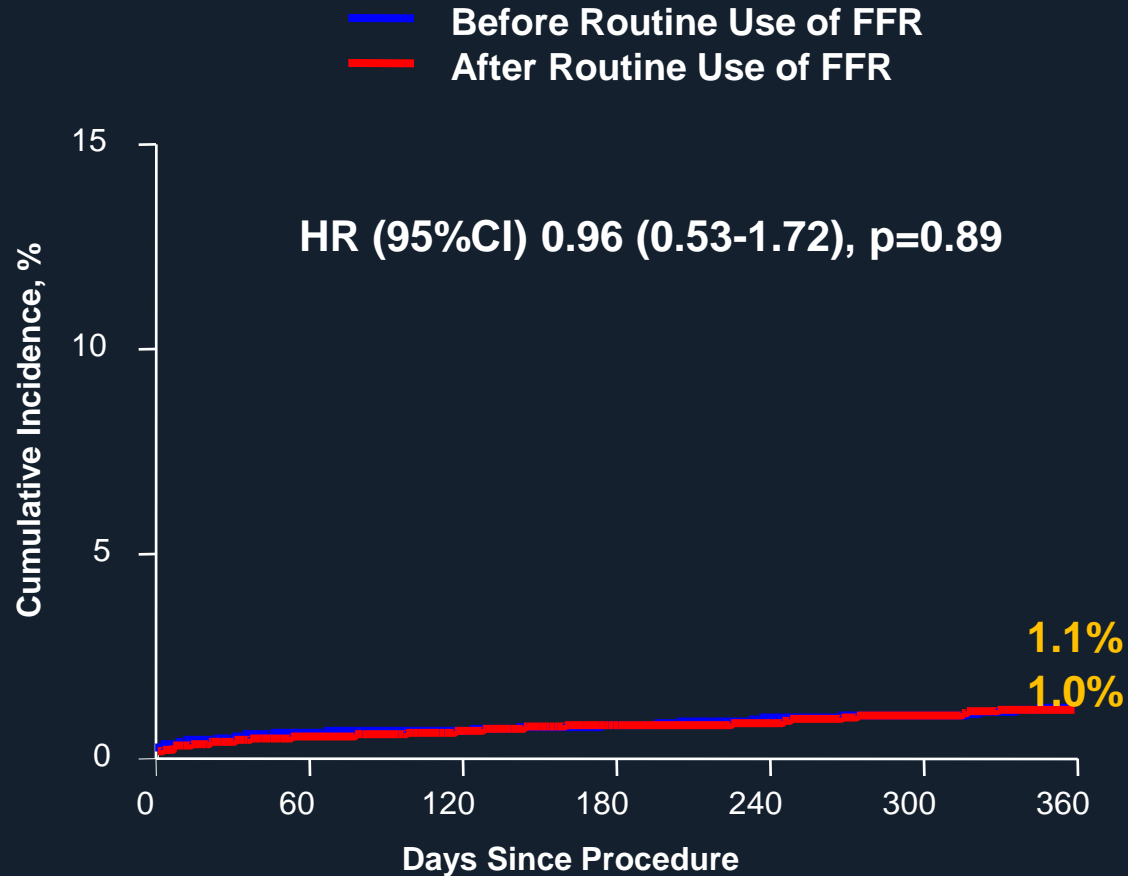
(Death, MI, or Repeat Revascularization)



No. at Risk

	0	60	120	180	240	300	360
Before Routine Use	2178	2066	2011	1960			
After Routine Use	2178	2092	2067	2037			

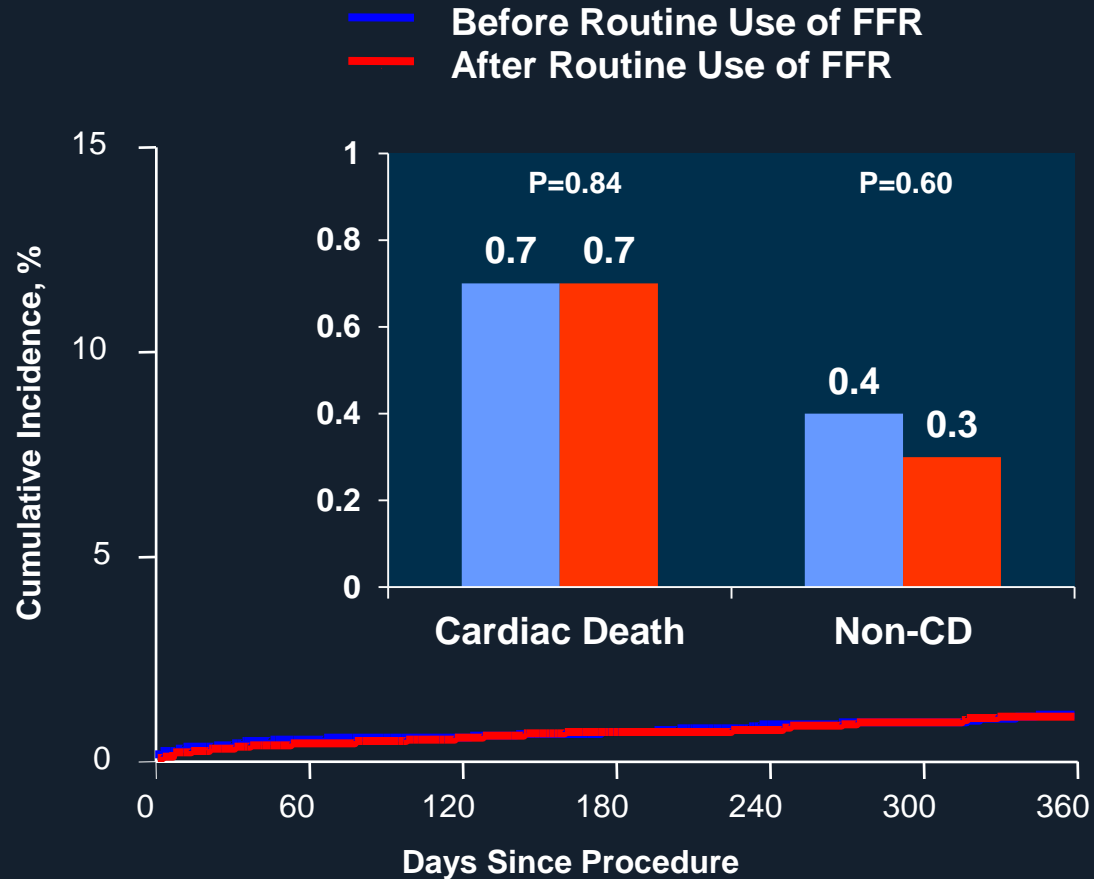
Death



No. at Risk

	0	60	120	180	240	300	360
Before Routine Use	2178	2156	2126	2126	2121	2121	2121
After Routine Use	2178	2143	2120	2120	2113	2113	2113

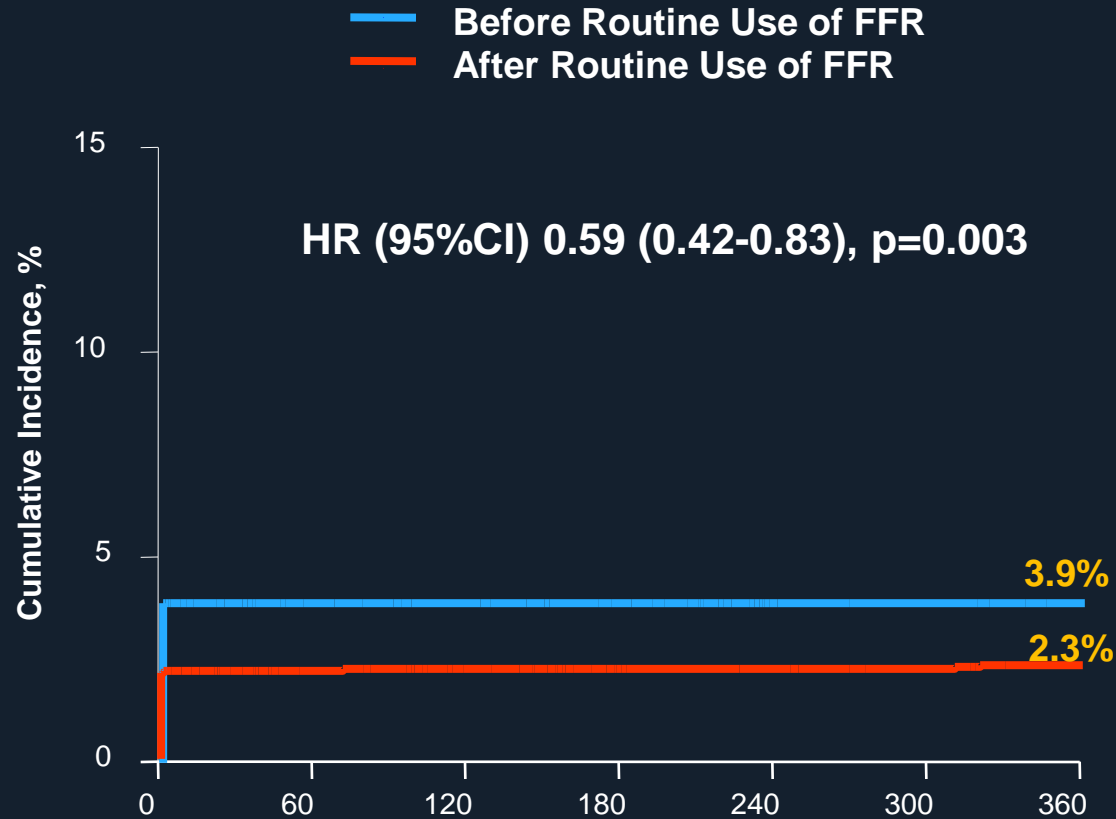
Death



No. at Risk

	0	60	120	180	240	300	360
Before Routine Use	2178		2156		2126		2121
After Routine Use	2178		2143		2120		2113

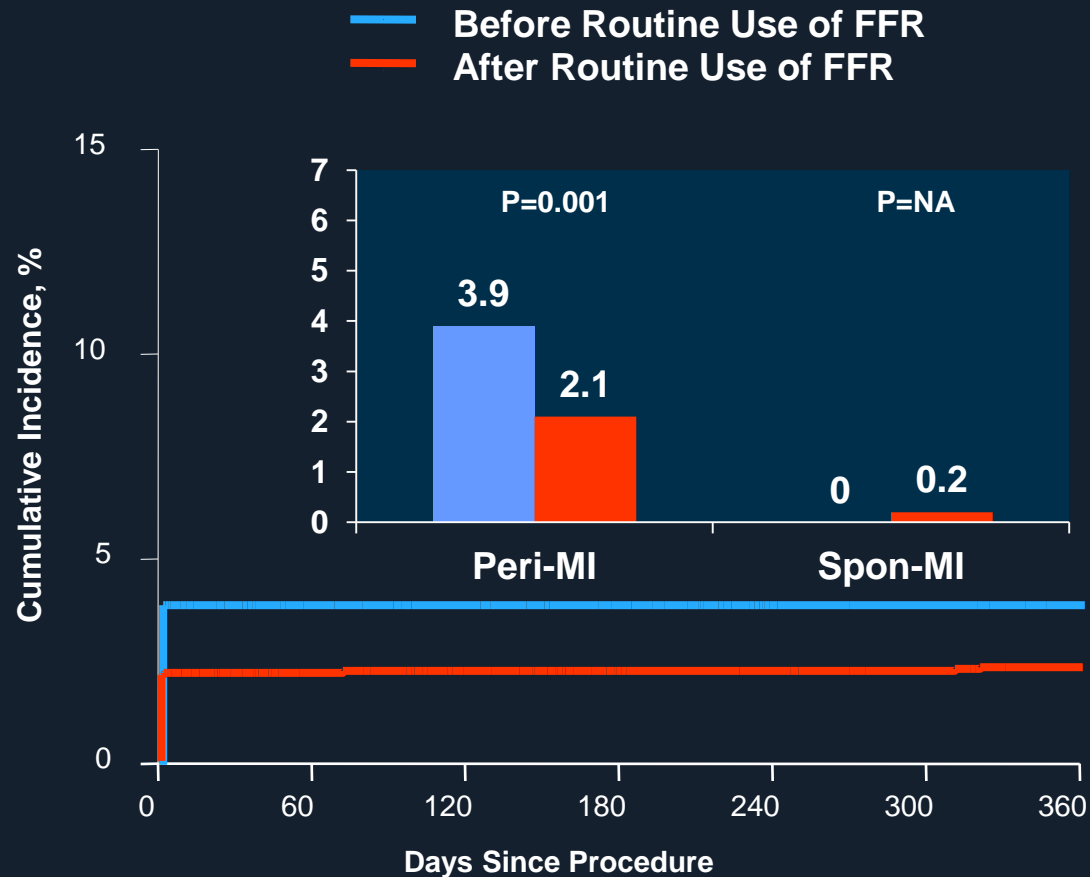
Myocardial Infarction



No. at Risk

	0	60	120	180	240	300	360
Before Routine Use	2178	2071	2041	2036			
After Routine Use	2178	2098	2075	2066			

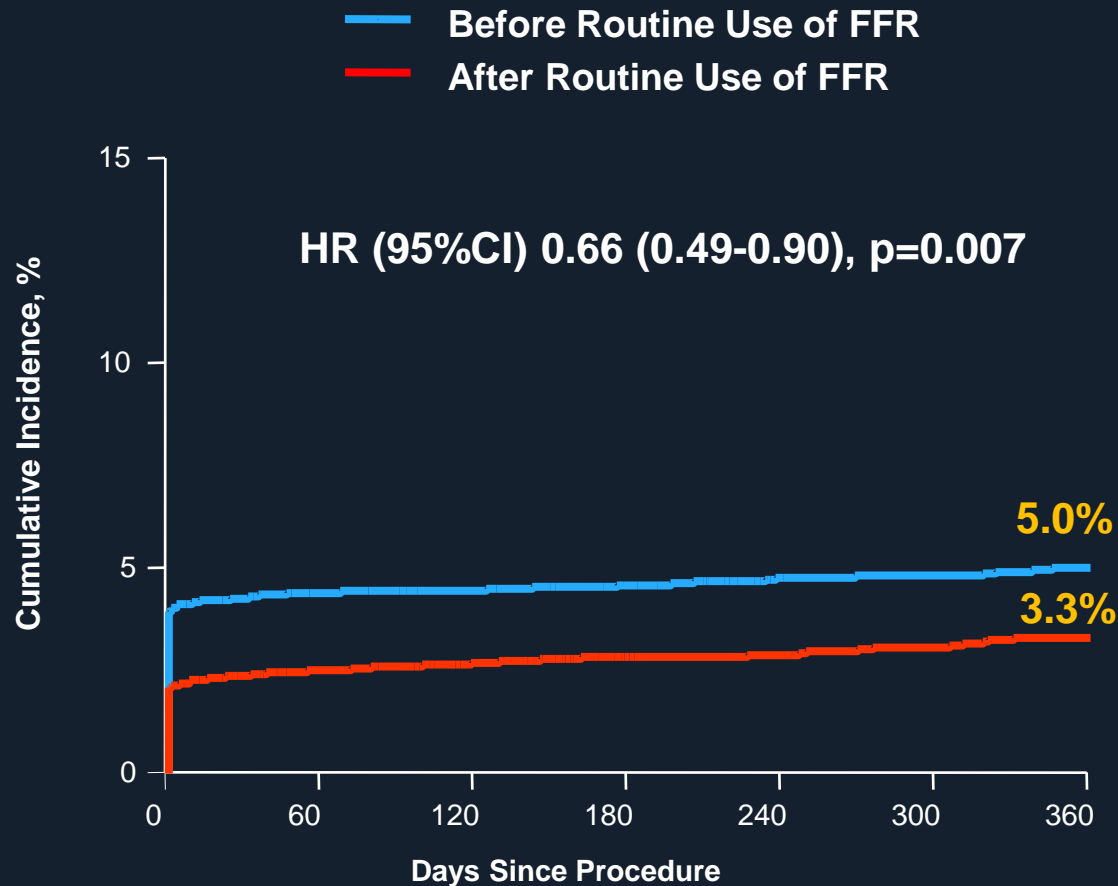
Myocardial Infarction



No. at Risk

	0	60	120	180	240	300	360
Before Routine Use	2178	2071	2041	2036			
After Routine Use	2178	2098	2075	2066			

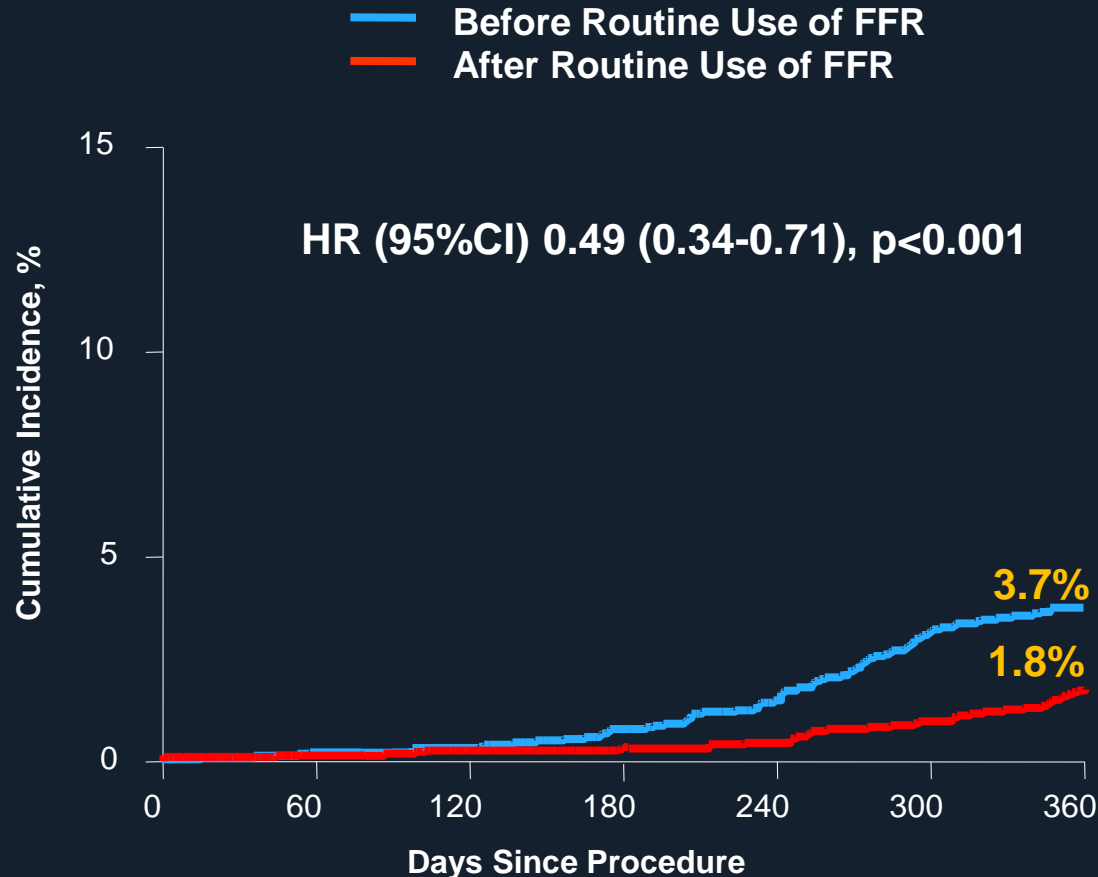
Death or Myocardial Infarction



No. at Risk

	0	60	180	360
Before Routine Use	2178	2071	2041	2036
After Routine Use	2178	2098	2075	2066

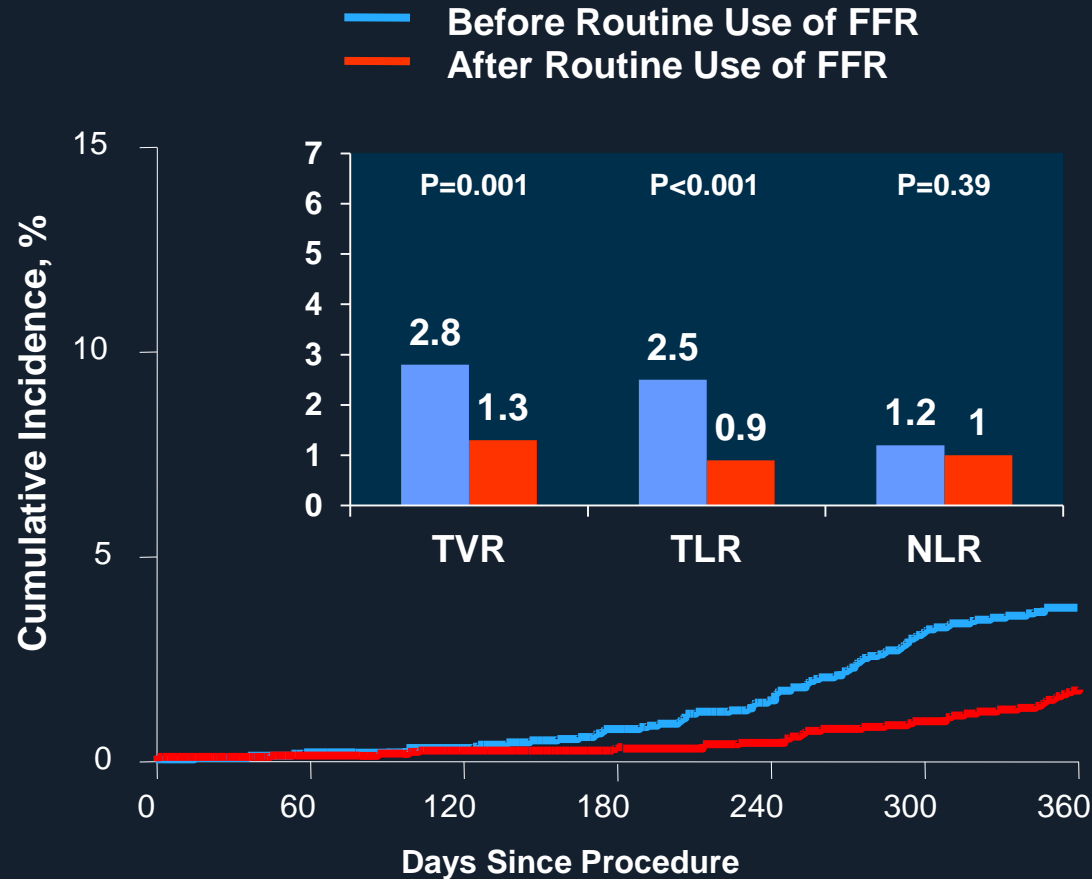
Repeat Revascularization



No. at Risk

	0	60	120	180	240	300	360
Before Routine Use	2178	2151	2095	2048			
After Routine Use	2178	2136	2110	2083			

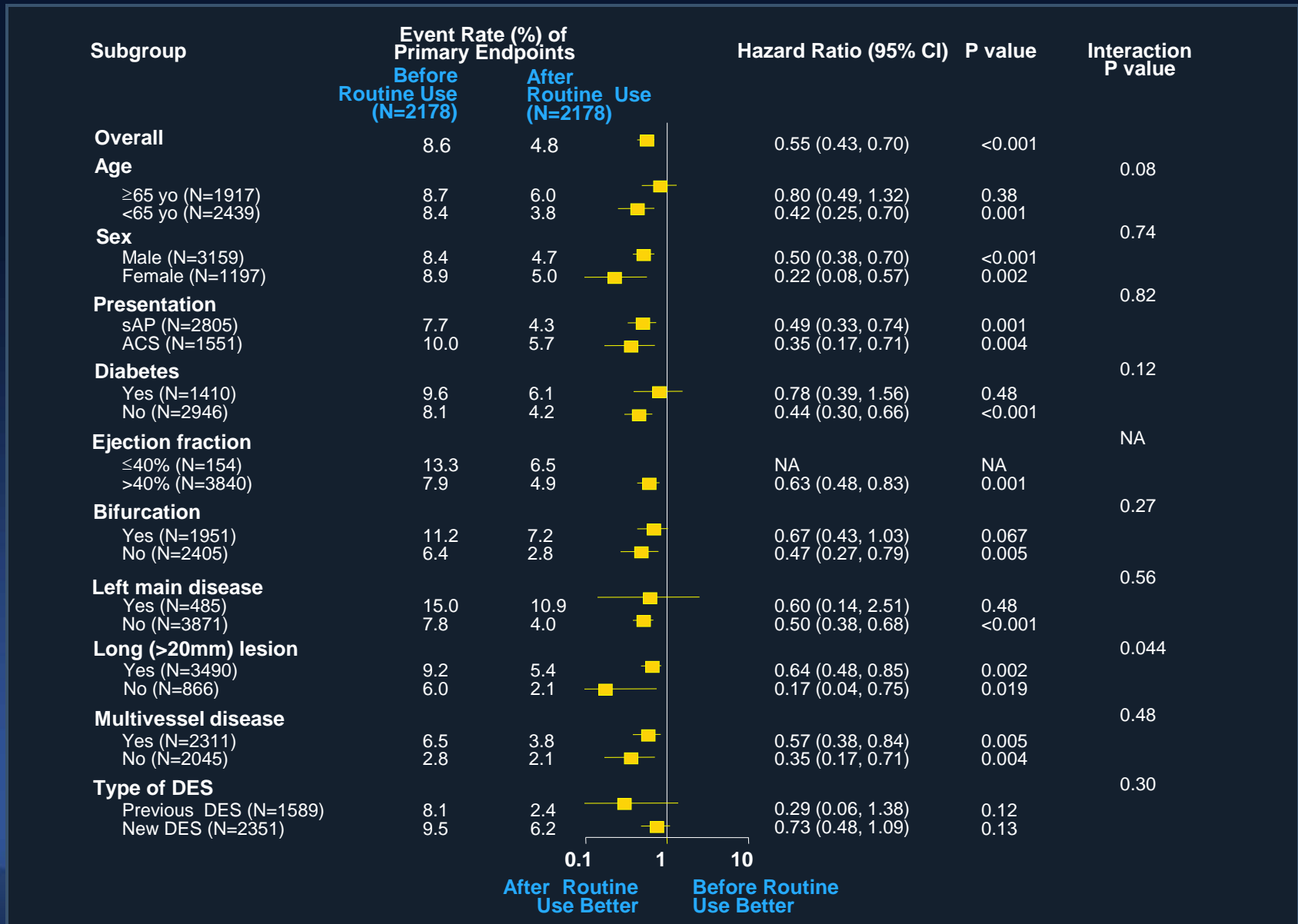
Repeat Revascularization



No. at Risk

	0	60	120	180	240	300	360
Before Routine Use	2178		2151		2095		2048
After Routine Use	2178		2136		2110		2083

Subgroup Analysis



Conclusion

- The current study demonstrated the benefit of FFR-guided PCI in a real-world patient population.
- Temporal comparison of two cohorts using propensity-score matching showed that the risks of death, MI, or repeat revascularization at 1 year were significantly reduced when FFR is used routinely.
- The benefit is primarily due to a reduced number of stents used per patients and a subsequent decreased risk of periprocedural MI and repeat revascularization.

ASAN MV & LM Registry

PCI: 1229 Patients

CABG: 1264 Patients

Medication: 119 Patients

Baseline Clinical Characteristics

Before Routine FFR
(Year 2008-2009)

After Routine FFR
(Year 2010-2011)

	CABG (N=770)	PCI (N=663)	DEFER (N=34)	CABG (N=494)	PCI (N=566)	DEFER (N=85)
Age, year	63.8±9.4	64.0±10.1	64.3±9.9	63.9±9.2	63.7±10.0	63.9±9.8
Male sex	570 (74.0)	487 (73.5)	28 (82.4)	387 (78.3)	435 (76.9)	57 (67.1)
BMI	24.7±2.9	24.8±3.0	25.1±2.9	24.5±2.9	25.0±2.9	25.6±3.8
Hypertension	480 (62.3)	425 (64.1)	21 (61.8)	226 (45.7)*	369 (65.2)	59 (69.4)
DM	323 (41.9)	239 (36.0)	15 (44.1)	173 (35.0)	226 (39.9)	29 (34.1)
Current smoker	199 (25.8)	192 (29.0)	9 (26.5)	125 (25.3)	158 (27.9)	20 (23.5)
Hyperlipidemia	370 (48.1)	365 (55.1)	15 (44.1)	320 (64.8)	375 (66.3)	52 (61.2)
Previous MI	44 (5.7)	35 (5.3)	4 (11.8)	47 (9.5)	36 (6.4)	6 (7.1)
Previous PCI	109 (14.2)*	115 (17.3)	15 (44.1)	83 (16.8)	90 (15.9)	19 (22.4)

* p<0.05

Baseline Clinical Characteristics

Before Routine FFR
(Year 2008-2009)

After Routine FFR
(Year 2010-2011)

	CABG (N=770)	PCI (N=663)	DEFER (N=34)	CABG (N=494)	PCI (N=566)	DEFER (N=85)
Previous CHF	10 (1.3)	10 (1.5)	0	20 (4.0)	4 (0.7)	4 (4.7)
Previous stroke	81 (10.5)	48 (7.2)	3 (8.8)	54 (10.9)	52 (9.2)	7 (8.2)
Peripheral VDz	17 (2.2)	13 (2.0)	3 (8.8)	43 (8.7)	11 (1.9)	3 (3.5)
CRF	46 (6.0)	26 (3.9)	1 (2.9)	33 (6.7)	27 (4.8)	8 (9.4)
COPD	20 (2.6)	14 (2.1)	1 (2.9)	8 (1.6)	10 (1.8)	1 (1.2)
LVEF, %	56.6±10.7*	58.2±8.7	56.6±9.9	55.8±10.3*	58.6±8.1	59.7±7.9
Clinical presentation						
Stable angina	513 (66.6)*	422 (63.7)	27 (79.4)	365 (73.9)*	355 (62.7)	59 (69.4)
Unstable angina	220 (28.6)	173 (26.1)	3 (8.8)	96 (19.4)	160 (28.3)	24 (28.2)
AMI	37 (4.8)	68 (10.3)	4 (11.8)	33 (6.7)	51 (9.0)	2 (2.4)

Baseline Angiographic Characteristics

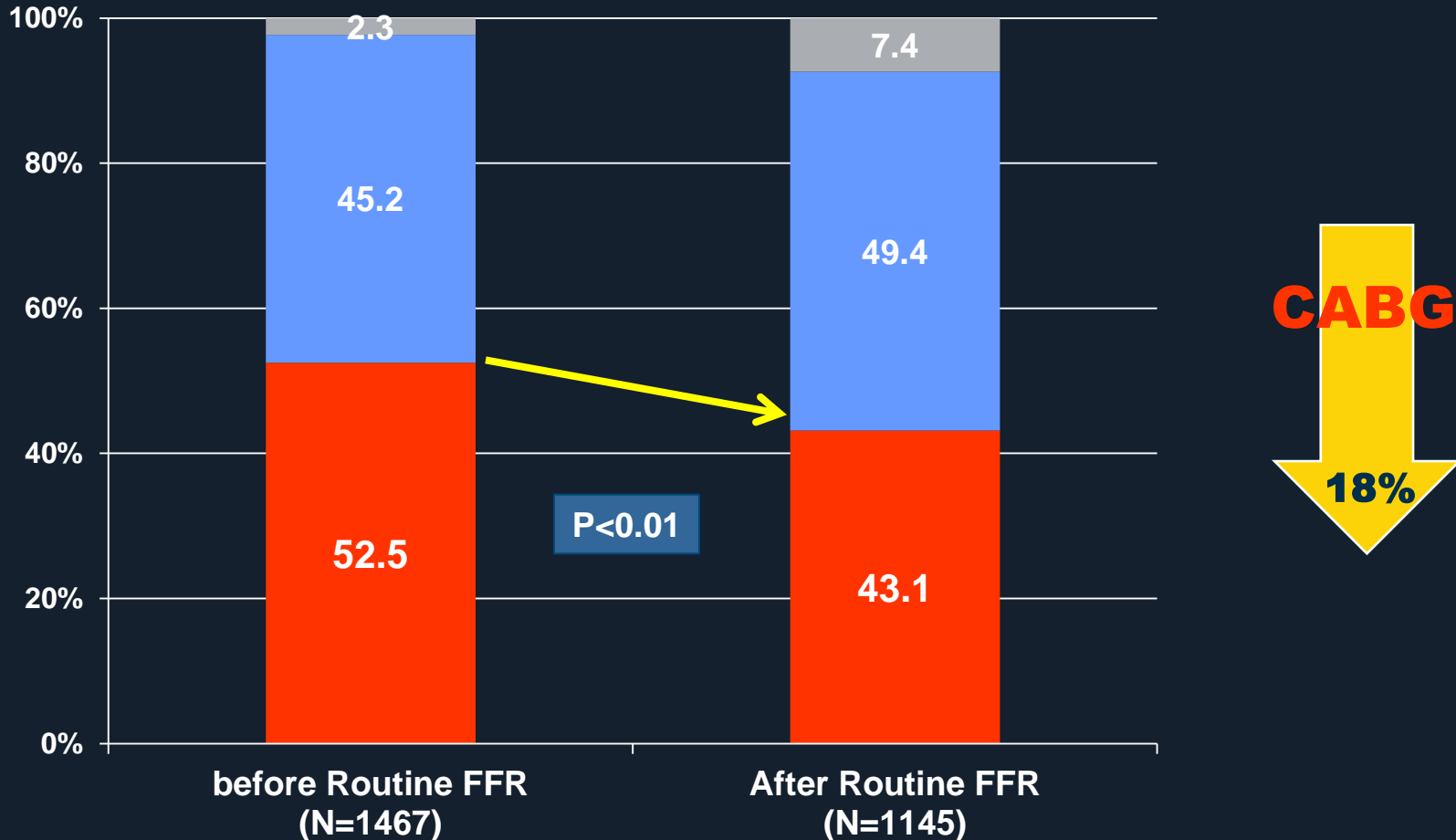
Before Routine FFR
(Year 2008-2009)

After Routine FFR
(Year 2010-2011)

	CABG (N=770)	PCI (N=663)	DEFER (N=34)	CABG (N=494)	PCI (N=566)	DEFER (N=85)
Extent						
Three-Vessel Dz	467 (60.6)*	368 (55.5)	27 (79.4)	344 (69.6)*	320 (56.5)	57 (67.1)
Left main disease	303 (39.4)	295 (44.5)	7 (20.6)	150 (30.4)	246 (43.5)	28 (32.9)
Isolated LM	3 (1.0)	26 (8.8)	0	2 (1.3)	22 (8.9)	1 (3.6)
LM + 1VD	22 (7.3)	73 (24.7)	2 (28.6)	5 (3.3)	64 (26.0)	17 (60.7)
LM + 2VD	62 (20.5)	117 (39.7)	0	22 (14.7)	97 (39.4)	4 (14.3)
LM + 3VD	216 (71.3)*	79 (26.8)	5 (71.4)	121 (80.7)*	63 (25.6)	6 (21.4)
LAD involvement	749 (97.3)*	615 (92.8)	33 (97.1)	487 (98.6)*	524 (92.6)	73 (85.9)
RCA involvement	709 (92.1)*	498 (75.1)	32 (94.1)	471 (95.3)*	425 (75.1)	66 (77.6)
Total occlusion ≥1	284 (36.9)*	29 (4.4)	0	214 (43.3)*	36 (6.4)	19 (22.4)

Treatment Strategy

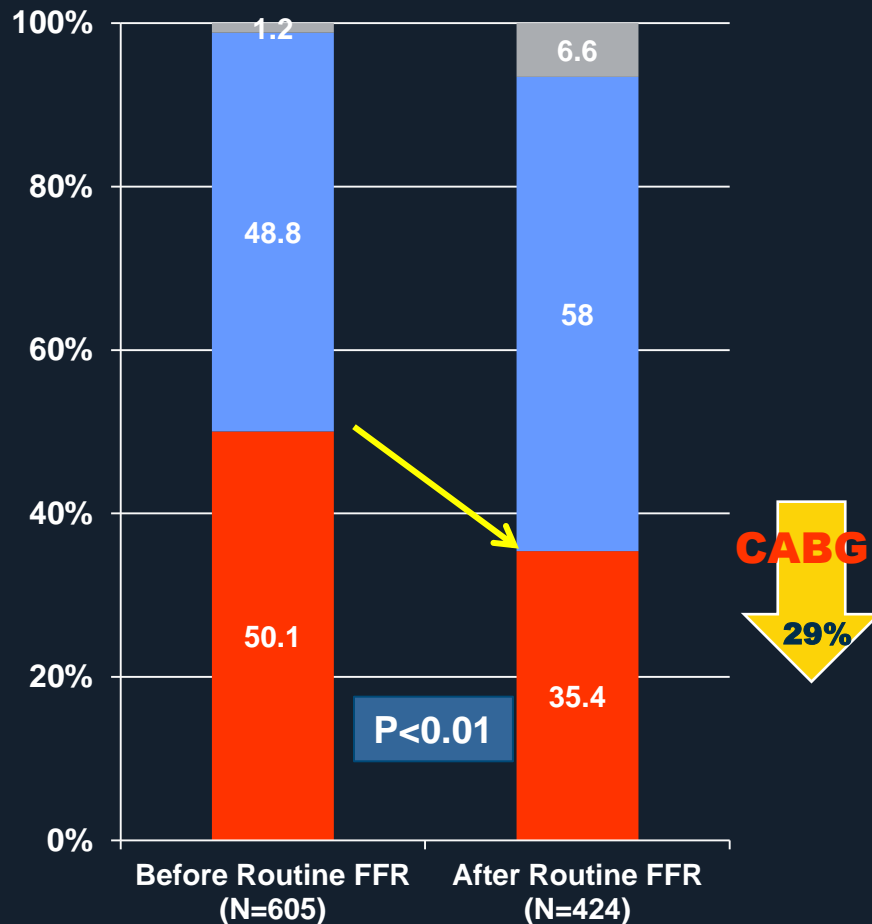
CABG **PCI** **DEFER**



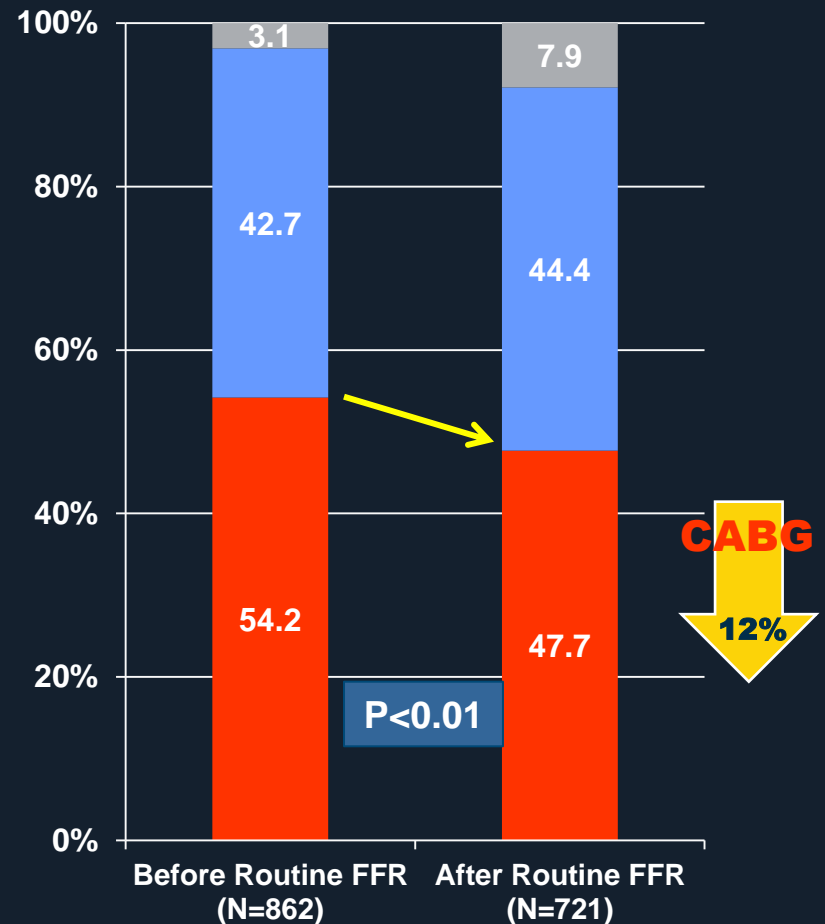
Treatment Strategy

CABG **PCI** **DEFER**

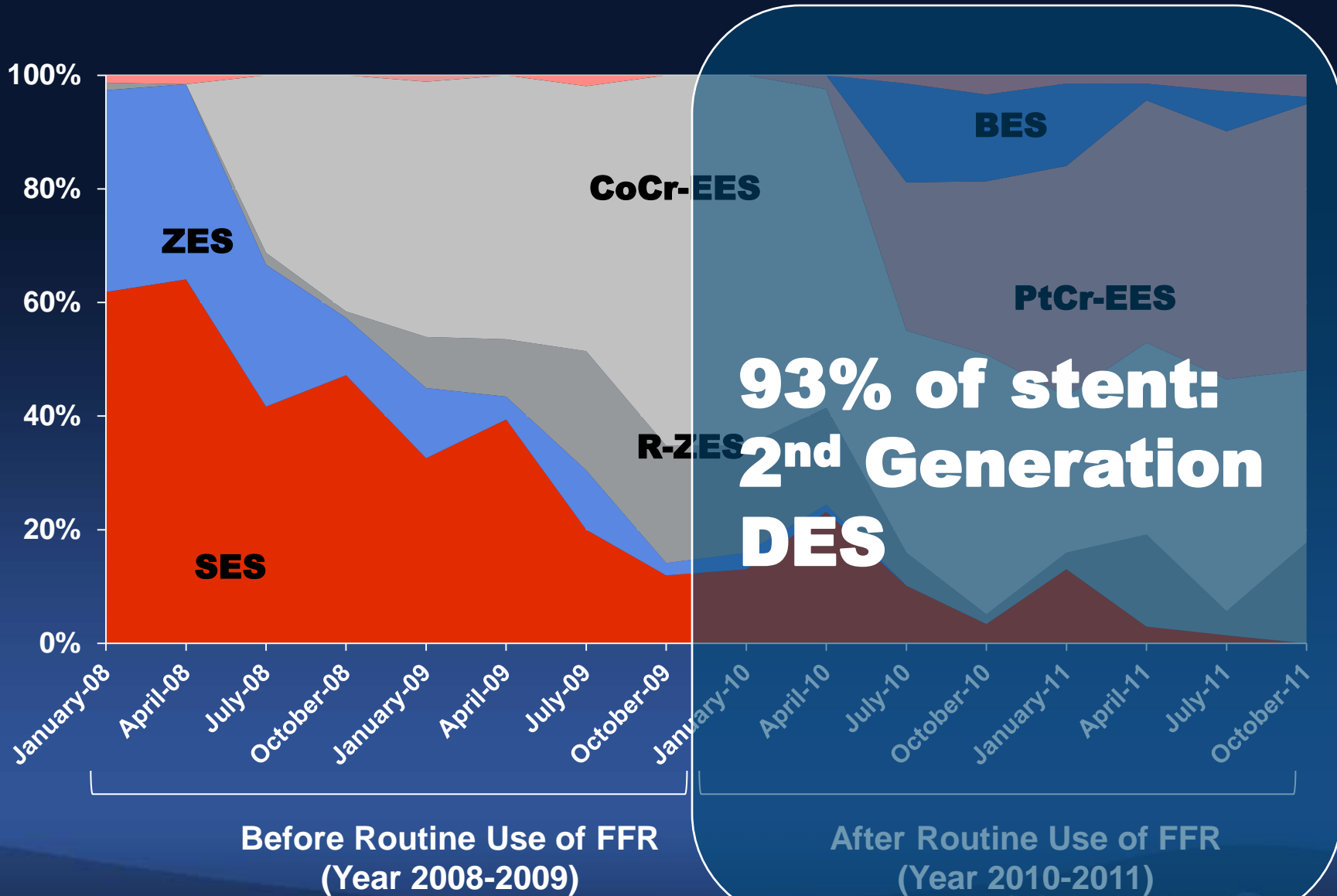
(A) Left Main Disease



(B) Three Vessel Disease



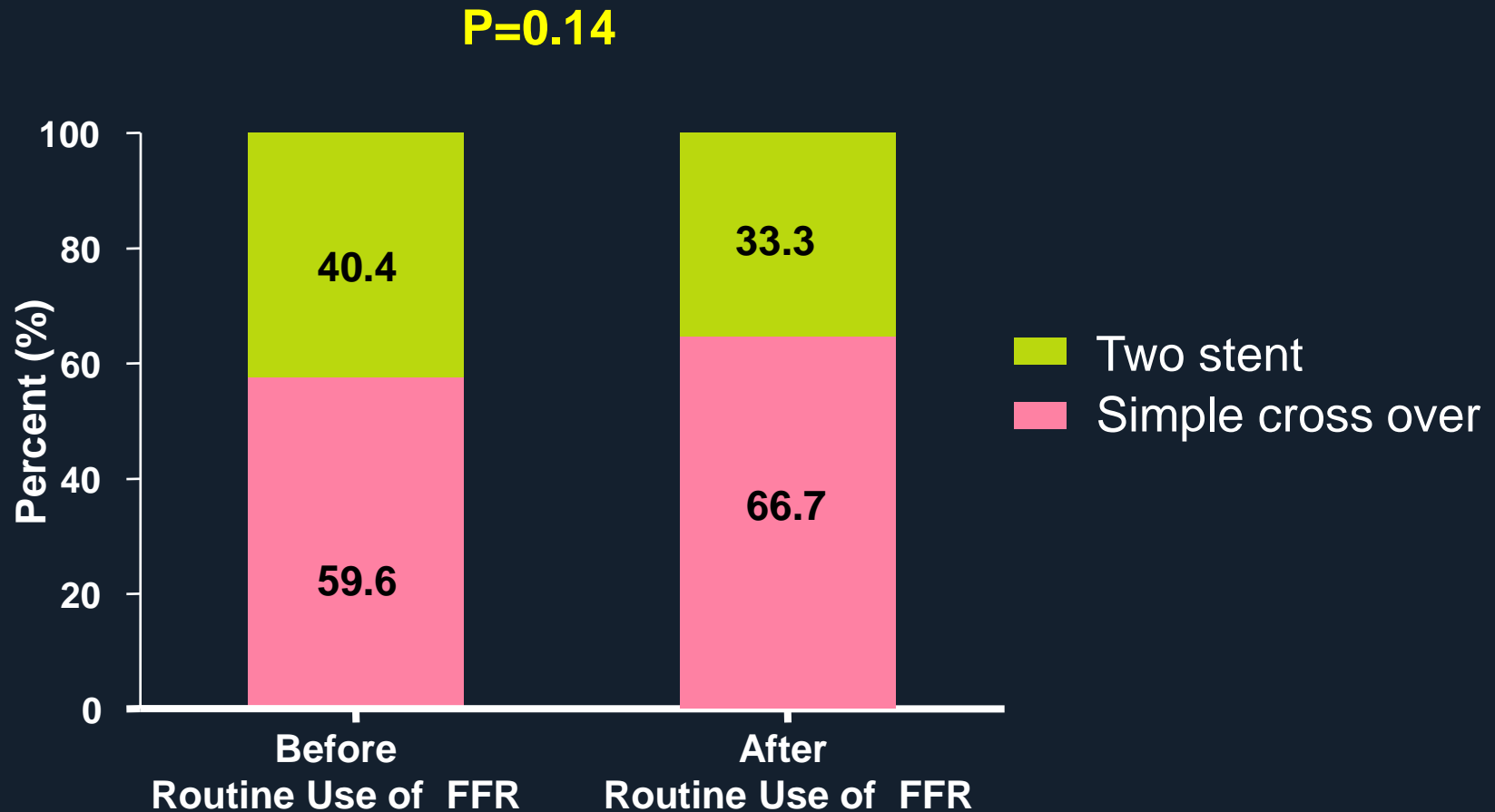
Type of DES



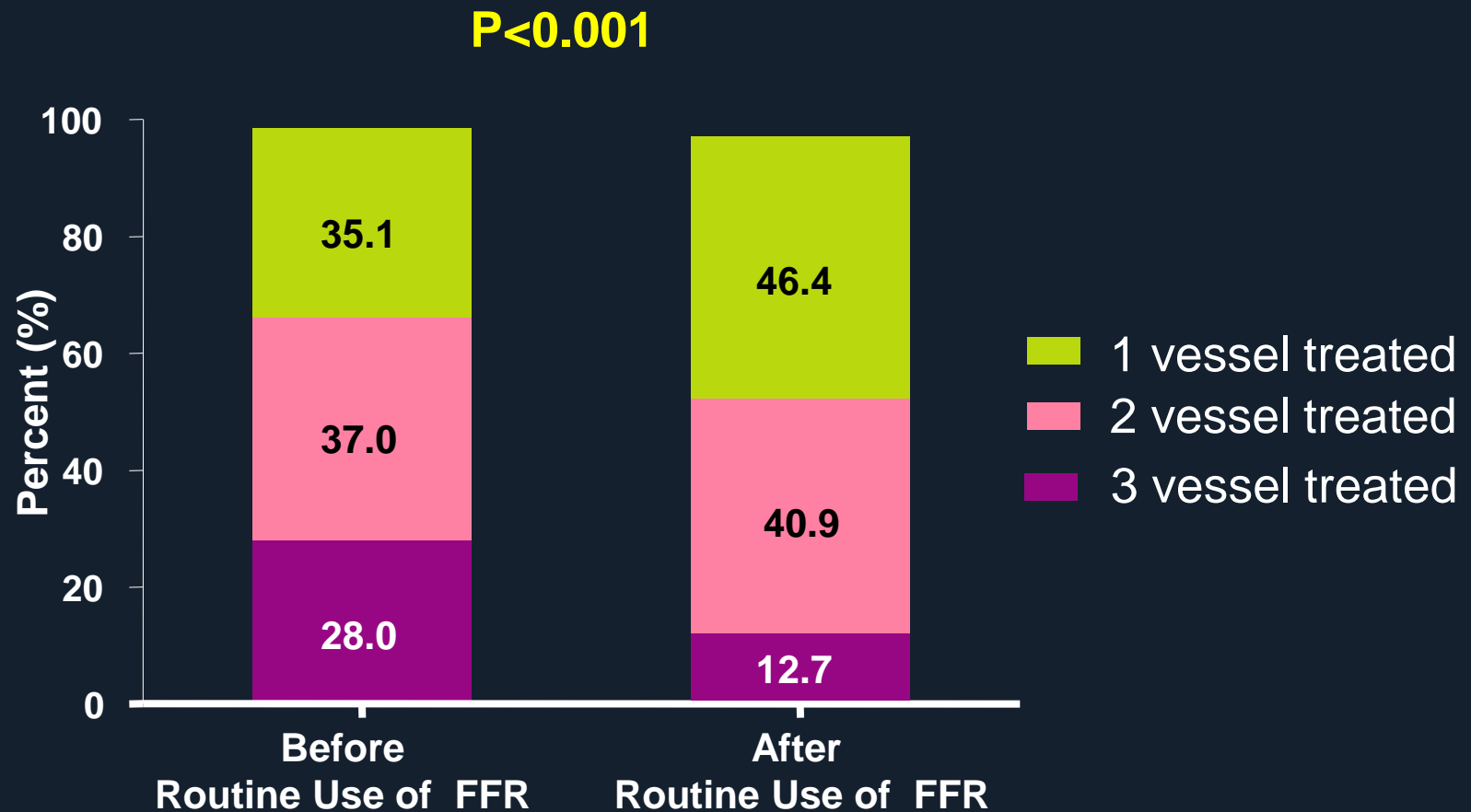
**93% of stent:
2nd Generation
DES**

Procedural Change in PCI

Distal LM Treatment in LM Subset



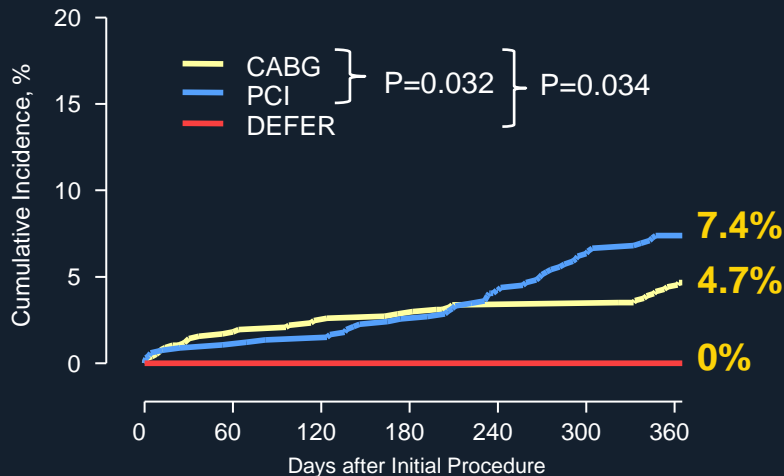
Procedural Change in PCI Three Vessel Subset



Primary End Point

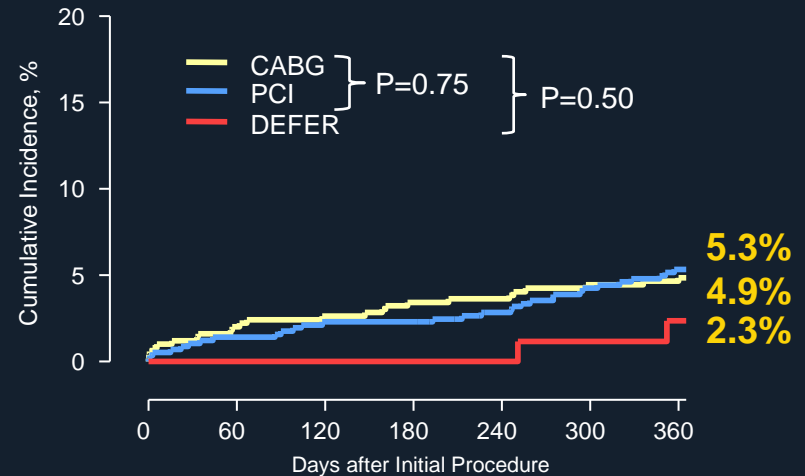
(Death, MI, Stroke or Repeat Revascularization)

Before Routine FFR (2008-2009)



CABG	770	751	743	734
PCI	663	655	634	612
DEFER	34	34	34	34

After Routine FFR (2010-2011)



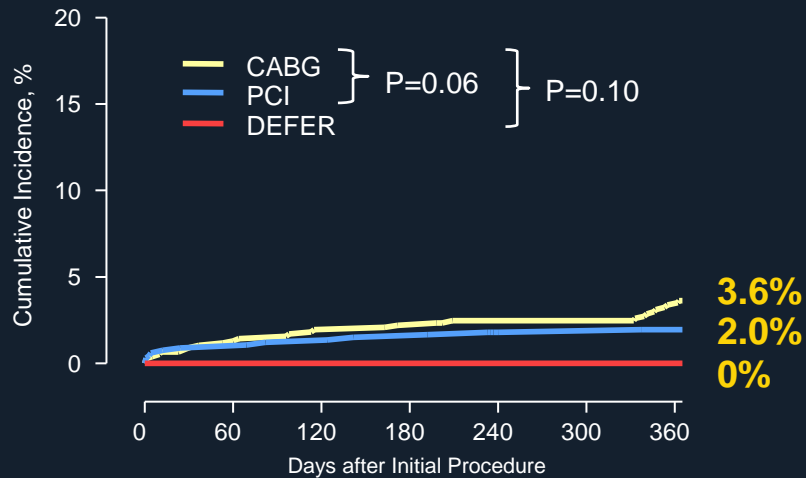
CABG	494	482	477	471
PCI	566	553	545	531
DEFER	85	85	85	84

Unadjusted K-M curve

CardioVascular Research Foundation

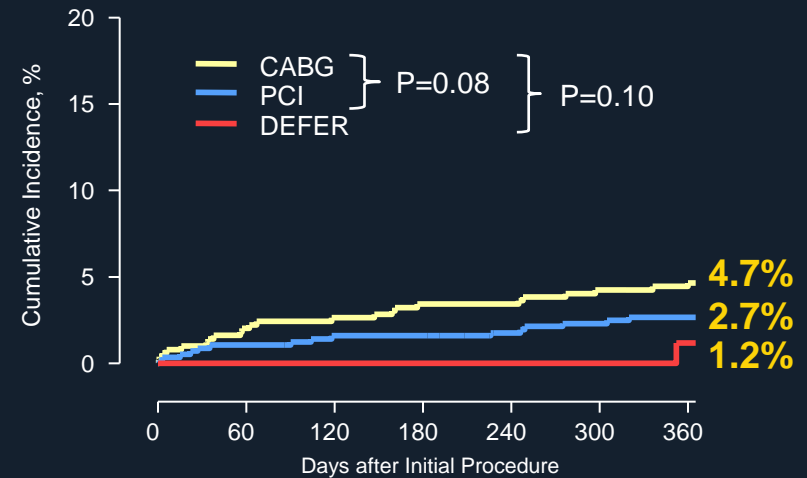
Death, MI or Stroke

Before Routine FFR (2008-2009)



CABG	770	755	750	742
PCI	663	656	650	648
DEFER	34	34	34	34

After Routine FFR (2010-2011)



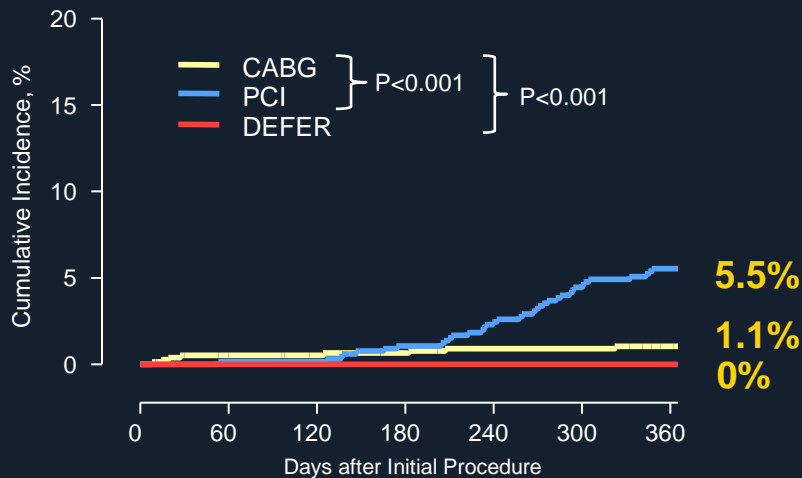
CABG	494	482	478	472
PCI	566	556	550	545
DEFER	85	85	85	85

Unadjusted K-M curve

CardioVascular Research Foundation

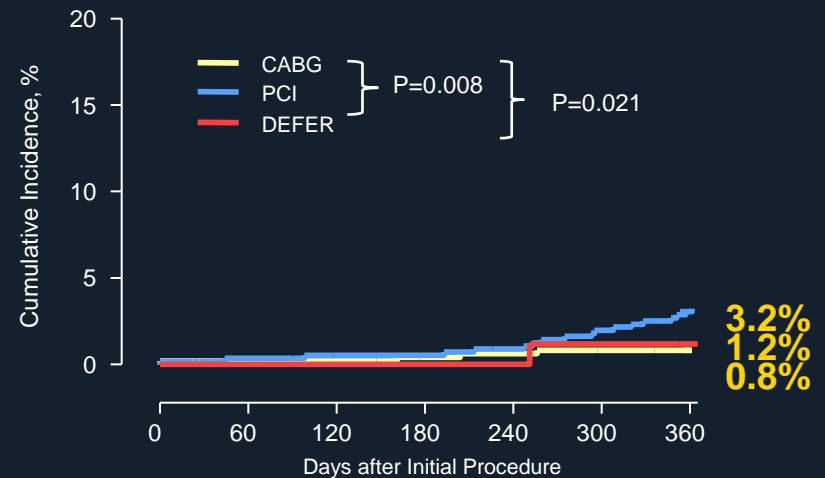
Repeat Revascularization

Before Routine FFR (2008-2009)



CABG	770	756	749	742
PCI	663	656	634	613
DEFER	34	34	34	34

After Routine FFR (2010-2011)



CABG	494	486	481	476
PCI	566	555	552	540
DEFER	85	85	85	84

Unadjusted K-M curve

CardioVascular Research Foundation

Propensity Matched Population

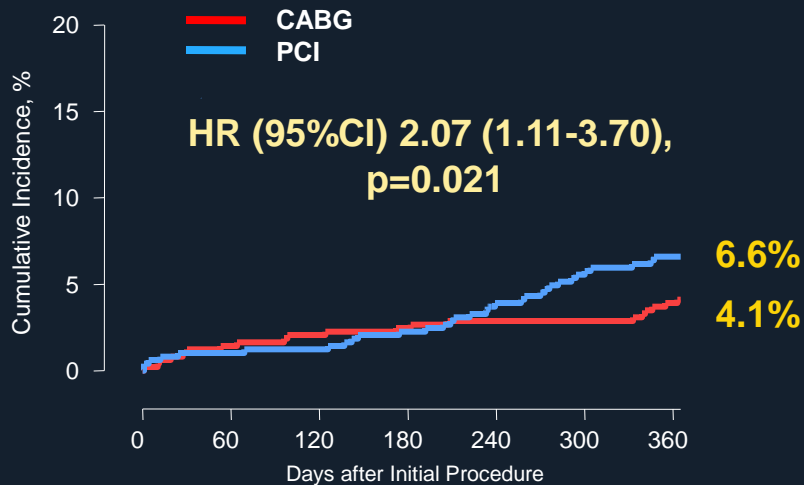
Before Routine Use of FFR: CABG versus PCI (486 pairs)

After Routine Use of FFR: CABG versus PCI (316 pairs)

Primary End Point

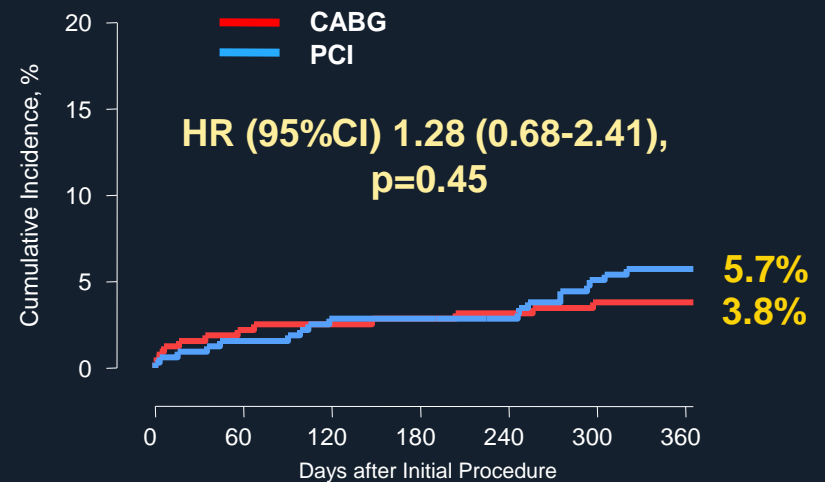
(Death, MI, Stroke or Repeat Revascularization)

Before Routine FFR (2008-2009)



CABG	486	477	472	467
PCI	486	481	466	453

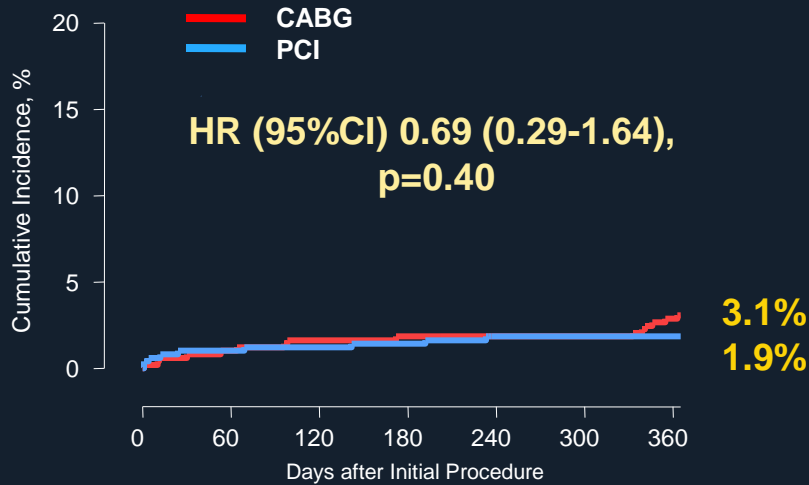
After Routine FFR (2010-2011)



CABG	315	308	306	304
PCI	315	307	304	295

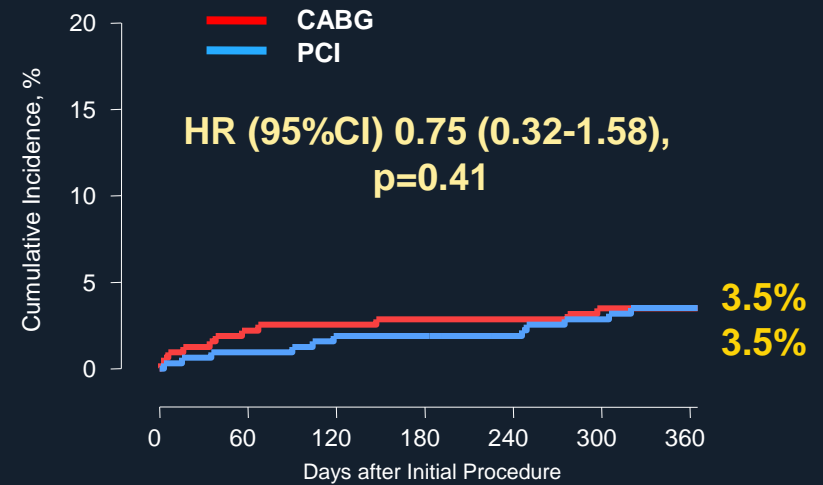
Death, MI or Stroke

Before Routine FFR (2008-2009)



CABG	486	479	477	472
PCI	486	481	476	476

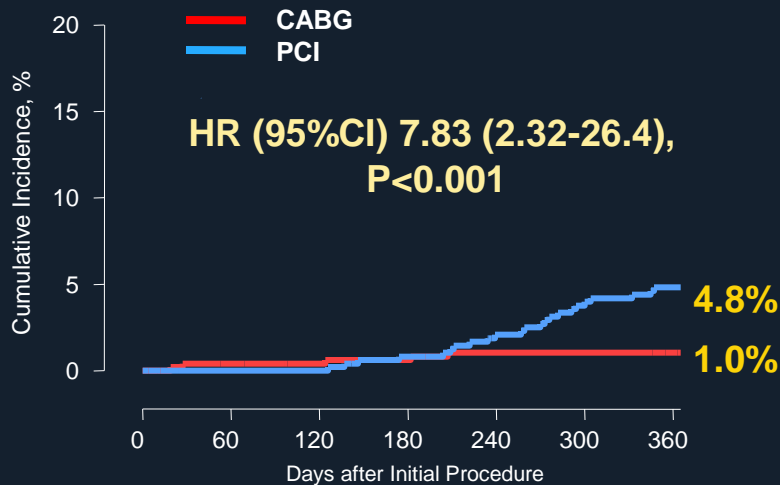
After Routine FFR (2010-2011)



CABG	315	308	307	305
PCI	315	310	307	302

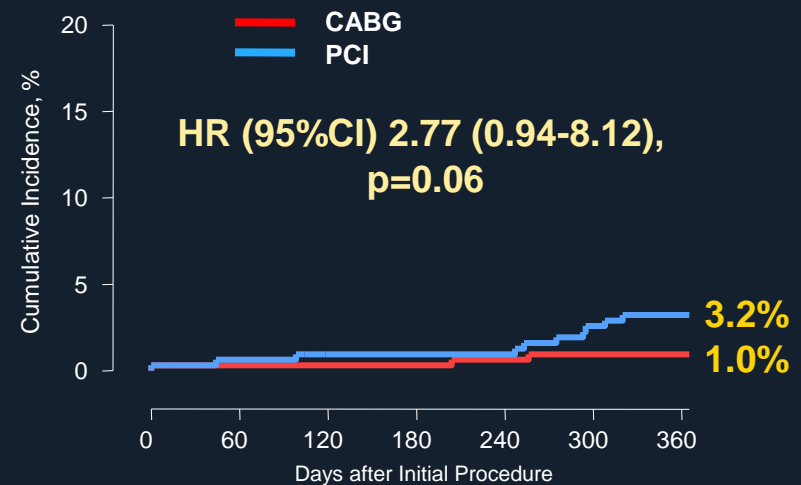
Repeat Revascularization

Before Routine FFR (2008-2009)



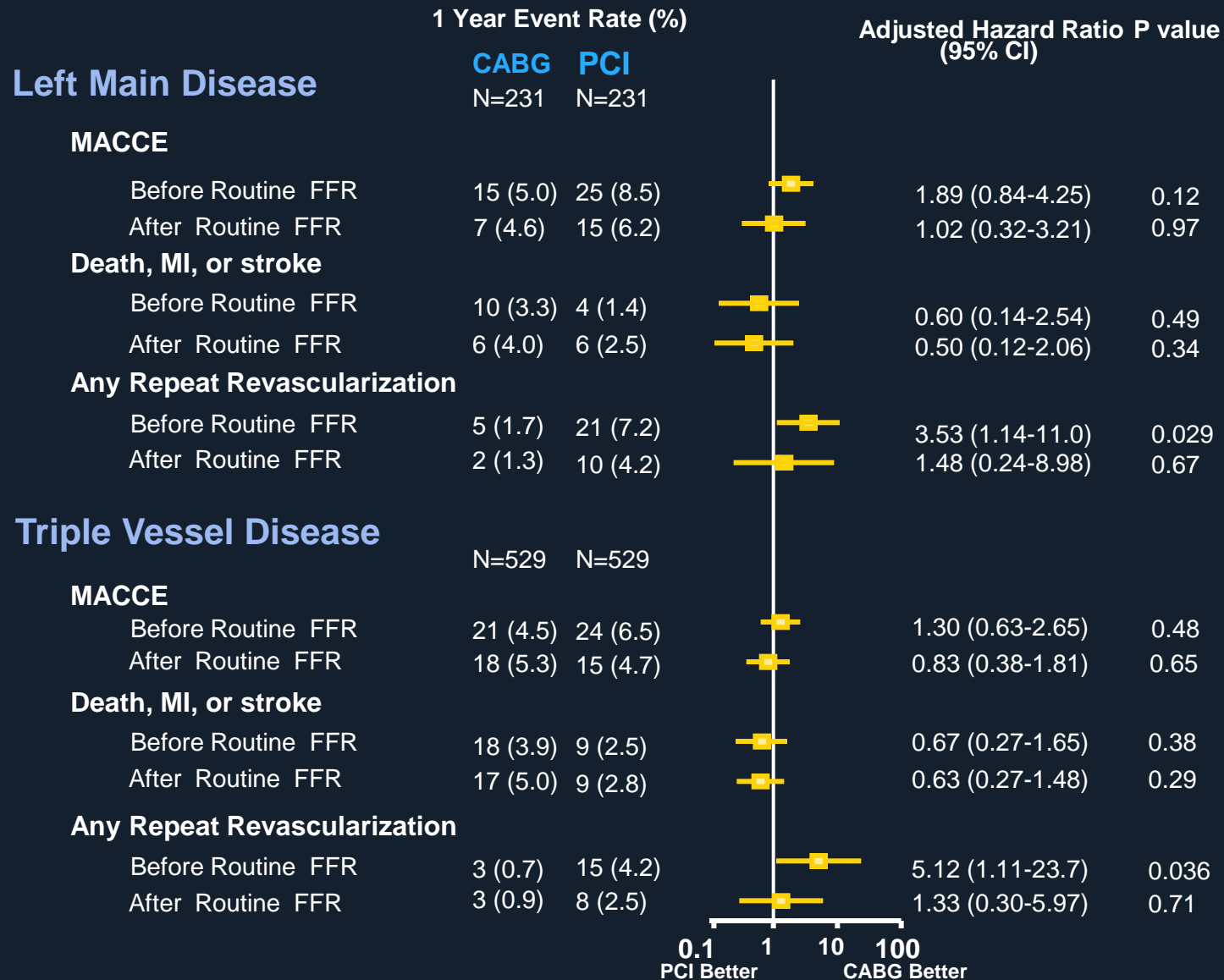
CABG	486	479	475	472
PCI	486	482	466	453

After Routine FFR (2010-2011)



CABG	315	311	309	307
PCI	315	307	307	300

Subgroup Analysis



Conclusion

1. The routine incorporation of FFR in the decision making for revascularization has extended role of PCI, while it reduced role of CABG as the primary revascularization strategies.
2. PCI with second generation DES, guided by FFR showed similar clinical outcomes with concurrent CABG at 1 year in patients with left main or three vessel disease.



Thank You !!

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One-Year Outcomes of Patients and FFR-Assessed Lesions

FFR was measured in 1267 patients (1551 lesions) during study period

Deferred of PCI

475 patients (575 lesions)

Performed PCI at any lesion

792 patients (976 lesions)

412 lesions deferred
564 lesions stented

1 year clinical outcomes

Non-cardiac death: 1 patient
Repeat revascularization: 2 patients (3 lesions)

Cardiac death: 1 patient
Non-cardiac death: 2 patients
Repeat revascularization: 19 patients (21 lesions*)

3 revascularizations were associated with deferred lesions.

Reasons for Deferral of Revascularization

	Before Routine FFR (N = 34)	After Routine FFR (N = 85)
Negative non-invasive functional study	10	12
FFR >0.80	1	59
Angiographic intermediate or small vessel disease	23	14

Reasons for Deferral of Revascularization

	Before Routine FFR (N=34)	After Routine FFR (N=85)
TMT/Thallium (-)	10	12
FFR (-)	1	59
Angiographic Intermediate or Small Vessel Disease	23	14

Procedural Characteristics 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 Characteristics 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 arterial conduit	1.80±0.87	1.78±0.90	0.69
Number of vein conduit	1.17±0.90	1.30±0.85	0.009
Internal thoracic artery	757 (98.3)	481 (97.4)	0.25
Off-pump	499 (64.8)	433 (87.7)	<0.001