The clinical value of IVUS: data and its application in cath lab

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# Conflict of Interest

- **I have nothing to disclose**

ADAPT-DES substudy (n=8,583 pts, IVUS=3,349 pts and no IVUS=5,234 pts

Definite/Probable Stent Thrombosis

IVUS Use
No IVUS Use

HR: 0.50 [95% CI: 0.29, 0.86]
P = 0.01

1.04%
0.52%

Definite/Probable ST (%)

Time in Months
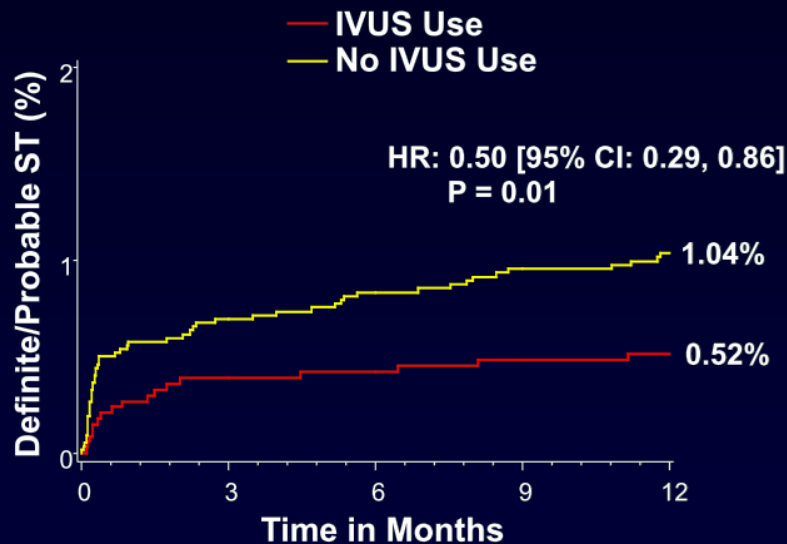
Number at risk:
IVUS Use	3349	3251	3221	3197	3023
No IVUS Use	5234	5015	4978	4938	4585

MI

IVUS Use
No IVUS Use

HR: 0.67 [95% CI: 0.51, 0.87]
P = 0.002

3.7%
2.5%

MI (%)

Time in Months
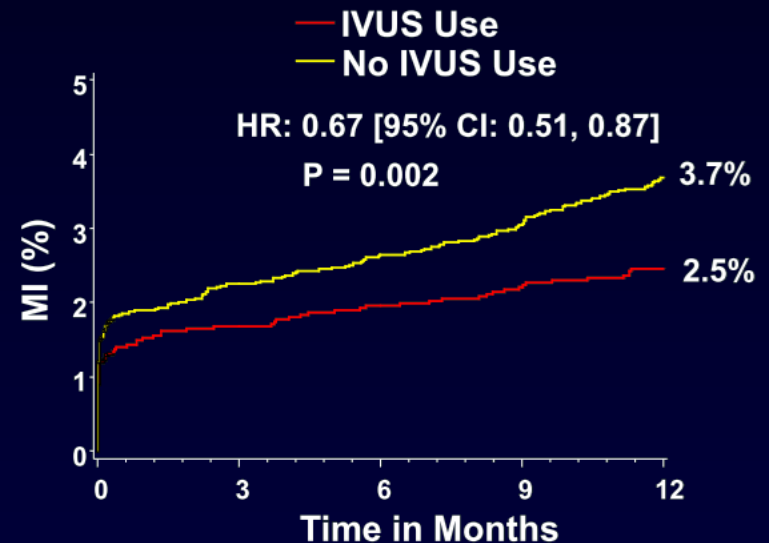
Number at risk:
IVUS Use	3349	3209	3171	3141	2969
No IVUS Use	5234	4932	4882	4830	4460

IVUS guidance during DES PCI may result in less stent thrombosis as well as fewer myocardial infarctions and MACEs

Witzenbichler B, et al. *Circulation* 2014;129: 463-470

MAIN-COMPARE registry: 3-year mortality
(145 propensity matched pairs)

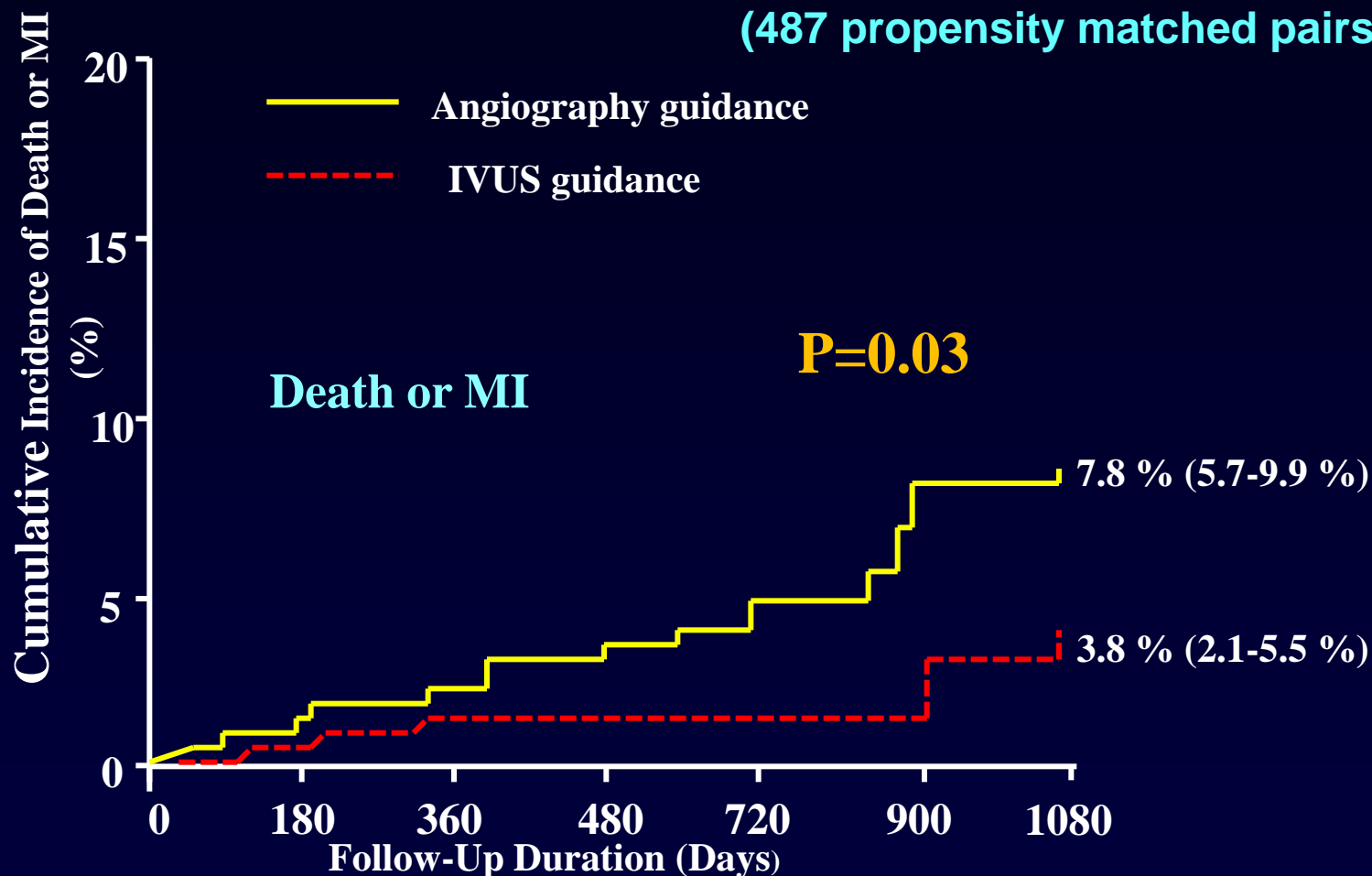Park SJ et al, *Circ Cardiovasc Intervent*. 2009;2:167-177

Cumulative Mortality(%)

—— Angiography guidance

---- IVUS guidance

P=0.048

Death

16.0 % (7.5-24.6%)

4.7 % (1.0-8.3 %)

Follow-Up Duration (Days)

Patients at risk	0	180	720	1080
IVUS-guidance	145	140	98	37
Angiography-guidance	145	137	88	29

Impact of IVUS-Guidance on 3-Year Clinical Outcomes: DES for Bifurcation Lesions from a Korean multi-center bifurcation registry

Kim JS, Hong MK, et al. *Am Heart J* 2011;161:180-187

2014 ESC/EACTS Guidelines on myocardial revascularization

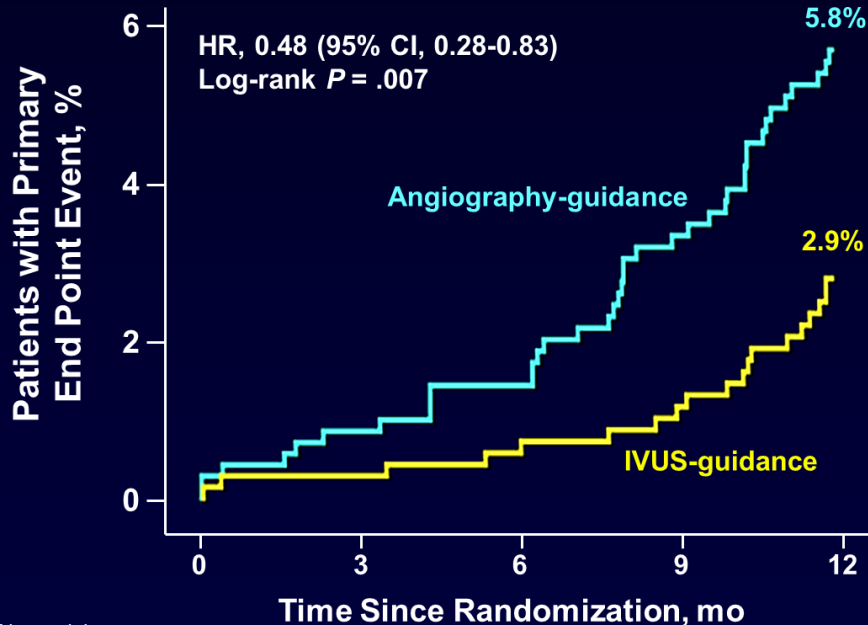| Recommendations	Class[a]	Level[b]	Ref.[c]
FFR to identify haemodynamically relevant coronary lesion(s) in stable patients when evidence of ischaemia is not available.	I	A	
FFR-guided PCI in patients with multivessel disease.	IIa	B	
IVUS in selected patients to optimize stent implantation.	IIa	B	702,703,706
IVUS to assess severity and optimize treatment of unprotected left main lesions.	IIa	B	705
IVUS or OCT to assess mechanisms of stent failure.	IIa	C	
OCT in selected patients to optimize stent implantation.	IIb	C	

Level of Evidence is B
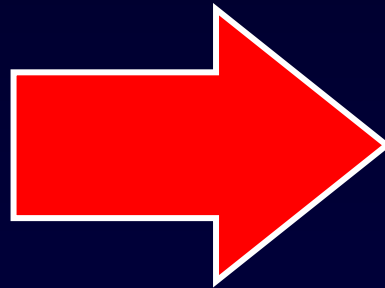
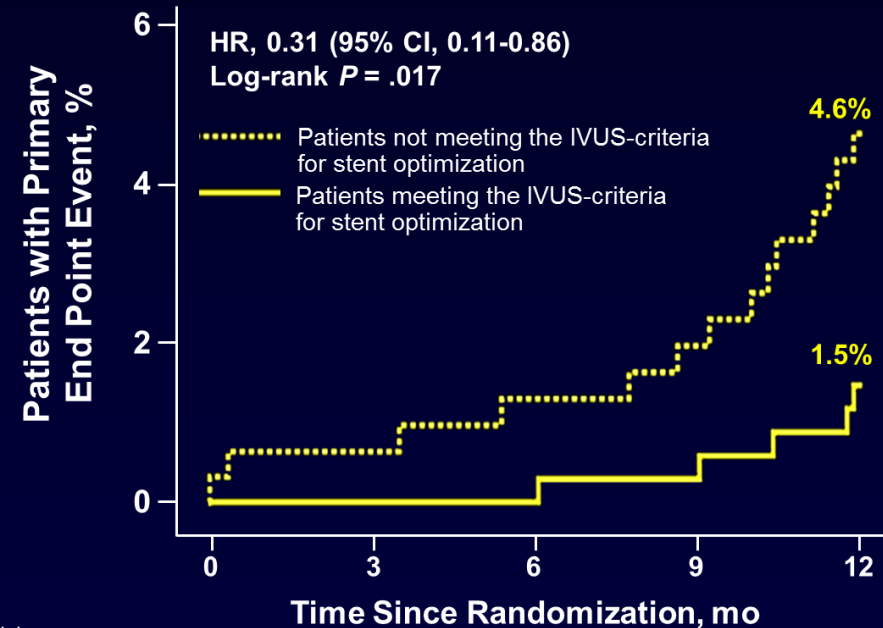# Chronic total occlusion: CTO-IVUS randomized trial
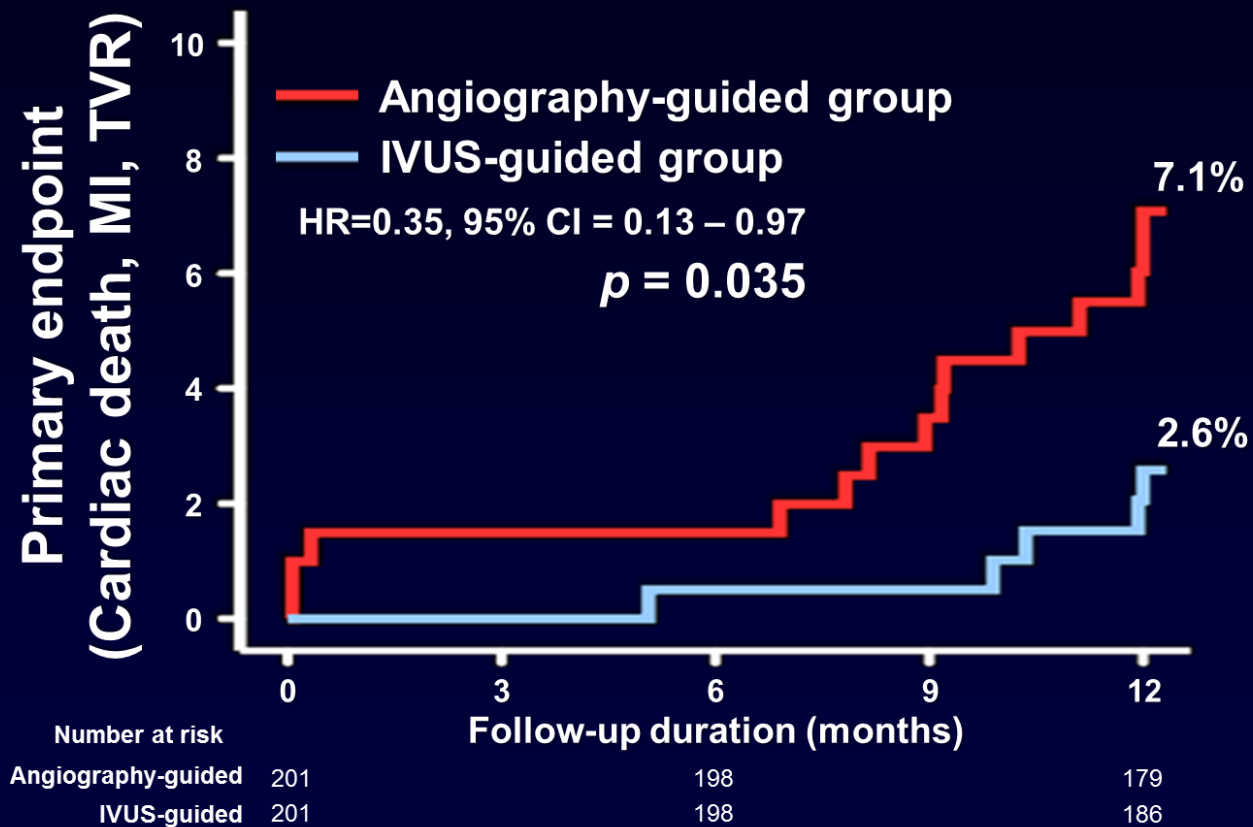
Kim BK, Jang Y et al, *Circ Cardiovasc Interv*. 2015;8:e002592

Diffuse long lesion: IVUS-XPL randomized trial

MACE: Cardiac death, MI, or TLR at 1 year

Left panel:

HR, 0.48 (95% CI, 0.28-0.83)
Log-rank *P* = .007

5.8% — Angiography-guidance
2.9% — IVUS-guidance

Y-axis: Patients with Primary End Point Event, %
X-axis: Time Since Randomization, mo

No. at risk

	0	3	6	9	12
Angiography arm	700	673	660	643	624
IVUS arm	700	671	665	654	641

Right panel:

HR, 0.31 (95% CI, 0.11-0.86)
Log-rank *P* = .017

Patients not meeting the IVUS-criteria for stent optimization
Patients meeting the IVUS-criteria for stent optimization

4.6%
1.5%

Y-axis: Patients with Primary End Point Event, %
X-axis: Time Since Randomization, mo

No. at risk

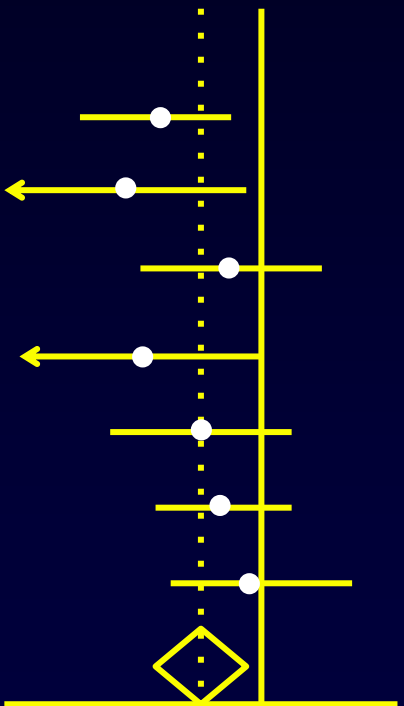|	0	3	6	9	12
Not meeting the criteria	315	299	297	394	285
Meeting the criteria	363	362	345	338	334

Hong SJ, Hong MK (corresponding author), et al. *JAMA* 2015;314:2155-63

Meta-analysis of 7 randomized trials: IVUS vs. angio -guided (first and next-generation) DES implantation

Event: cardiac death, MI, TLR

Study-level meta-analysis

Study	Year	OR	Events: IVUS	Events: Angio
IVUS-XPL	2015	0.49	19/700	39/700
CTO-IVUS	2015	0.37	5/201	14/201
AIR-CTO	2015	0.82	25/115	29/115
Tan et al	2015	0.42	8/61	17/62
Kim et al (RESET)	2013	0.60	12/269	20/274
AVIO	2013	0.67	24/142	33/142
HOME DES IVUS	2010	0.91	11/105	12/105
Overall		0.60	104/1593	164/1599

IVUS better   Angio better

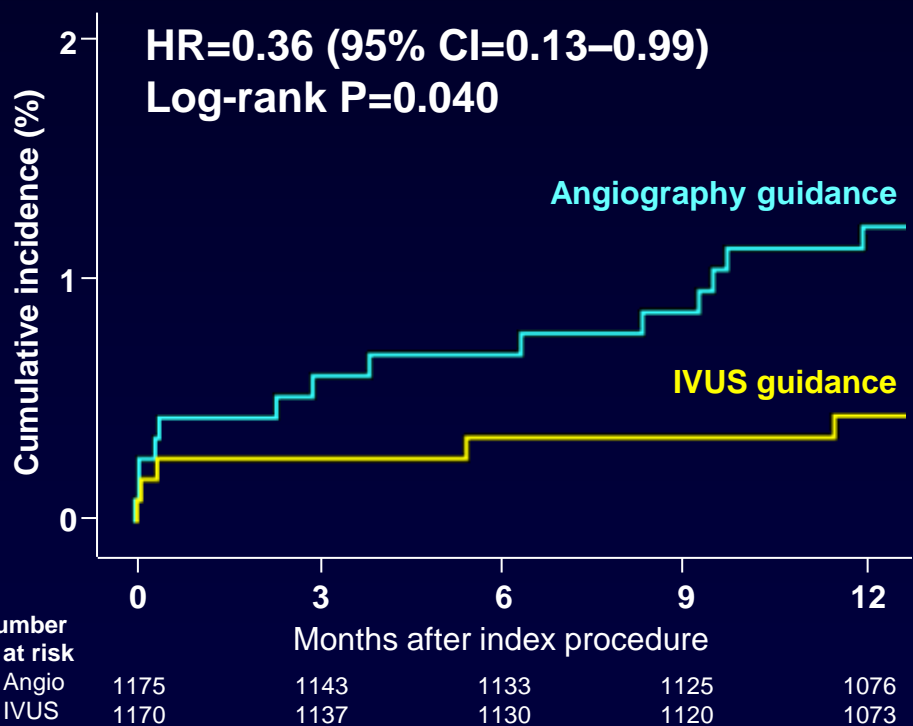Islam Y. Elgendy et al. *Circ Cardiovasc Interv.* 2016;9:e003700

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IVUS-XPL: Randomized Trial

	IVUS-guidance (n=700)	Angiography-guidance (n=700)	Hazard ratio (95% CI)	Log-Rank *P* value
Primary End Point				
MACE	19 (2.9%)	39 (5.8%)	0.48 (0.28–0.83)	.007
Secondary End Point				
Cardiac death	3 (0.4%)	5 (0.7%)	0.60 (0.14-2.52)	.48
Target lesion related MI	0	1 (0.1%)	-	.32
Ischemia-driven TLR	17 (2.5%)	33 (5.0%)	0.51 (0.28-0.91)	.02
Stent thrombosis	2 (0.3%)	2 (0.3%)	1.00 (0.14-7.10)	1.00
Acute	1 (0.1%)	1 (0.1%)	-	-
Sub-acute	1 (0.1%)	0	-	-
Late	0	1 (0.1%)	-	-

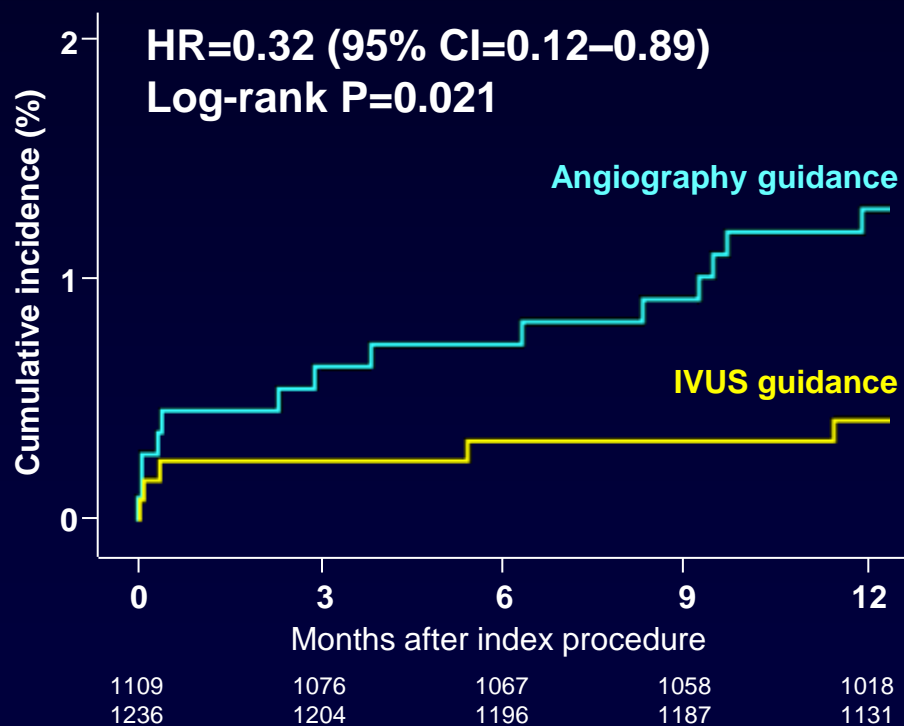Hong SJ, Kim BK, Hong MK, et al. JAMA 2015;314:2155-63

Meta-analysis with Individual Patient-Level Data from 2,345 Randomized Patients with second-generation DES (RESET Long, CTO IVUS and IVUS XPL)

Hard events of MACE (cardiac death, MI, or stent thrombosis)


Intention-to treat analysis

HR=0.36 (95% CI=0.13–0.99)
Log-rank P=0.040

Angiography guidance

IVUS guidance

Per-protocol analysis

HR=0.32 (95% CI=0.12–0.89)
Log-rank P=0.021

Angiography guidance

IVUS guidance

Cumulative incidence (%)

Months after index procedure

Number at risk	0	3	6	9	12
Angio	1175	1143	1133	1125	1076
IVUS	1170	1137	1130	1120	1073

	0	3	6	9	12
Angio	1109	1076	1067	1058	1018
IVUS	1236	1204	1196	1187	1131

Shin DH, Hong MK (corresponding author), et al. *JACC Intv* 2016;9:2232-2239

How the IVUS information influenced the procedure? From ADAPT-DES Study

When IVUS was used, the operator was required to report the timing of IVUS imaging (eg, before intervention, after DES, after adjunct balloon inflation) and how the IVUS information influenced the procedure.
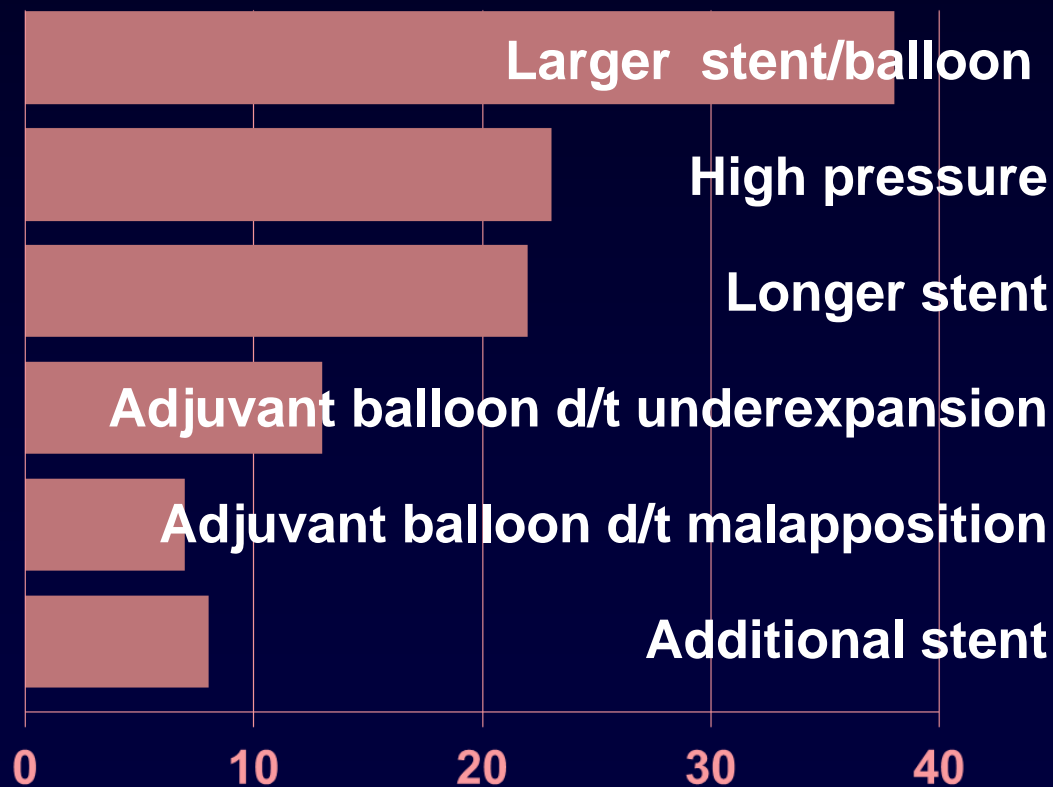
Witzenbichler B et al. Circulation. 2014;129:463-470

Table 2 Recommendations on the adjunctive use of intravascular imaging for diagnostic evaluation of coronary artery disease, guidance and optimization of PCIs

- **Diagnostic assessment of coronary lesions**

Consensus opinion

Angiographically unclear/ambiguous findings (e.g. dissection, thrombus, calcified nodule)

Assessment of left main stenosis

Complex bifurcation lesions

Suspected culprit lesion of ACS

- **PCI guidance and optimization**

RCT evidence

Long lesions

Chronic total occlusions

Consensus opinion

Patients with acute coronary syndromes

Left main coronary artery lesions

Two stents bifurcation

Implantation of bioresorbable scaffolds

Patients with renal dysfunction (IVUS)

- **Identification of mechanism of stent failure**

Restenosis

Stent thrombosis

Eur Heart J 2018;39:3281-3300

2018 ESC/EACTS Guidelines on myocardial revascularization

Recommendations on intravascular imaging for procedural optimization

Recommendations	Class[a]	Level[b]
IVUS or OCT should be considered in selected patients to optimize stent implantation.[603,612,651–653]	IIa	B
IVUS should be considered to optimize treatment of unprotected left main lesions.[35]	IIa	B

IVUS = intravascular ultrasound; OCT = optical coherence tomography.
[a]Class of recommendation.
[b]Level of evidence.

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Eur Heart J 2018 (in press)

2014 ESC/EACTS Guidelines

IVUS in selected patients to optimize stent implantation.	IIa	B
IVUS to assess severity and optimize treatment of unprotected left main lesions.	IIa	B
IVUS or OCT to assess mechanisms of stent failure.	IIa	C

2018 ESC/EACTS Guidelines

Recommendations on intravascular imaging for procedural optimization

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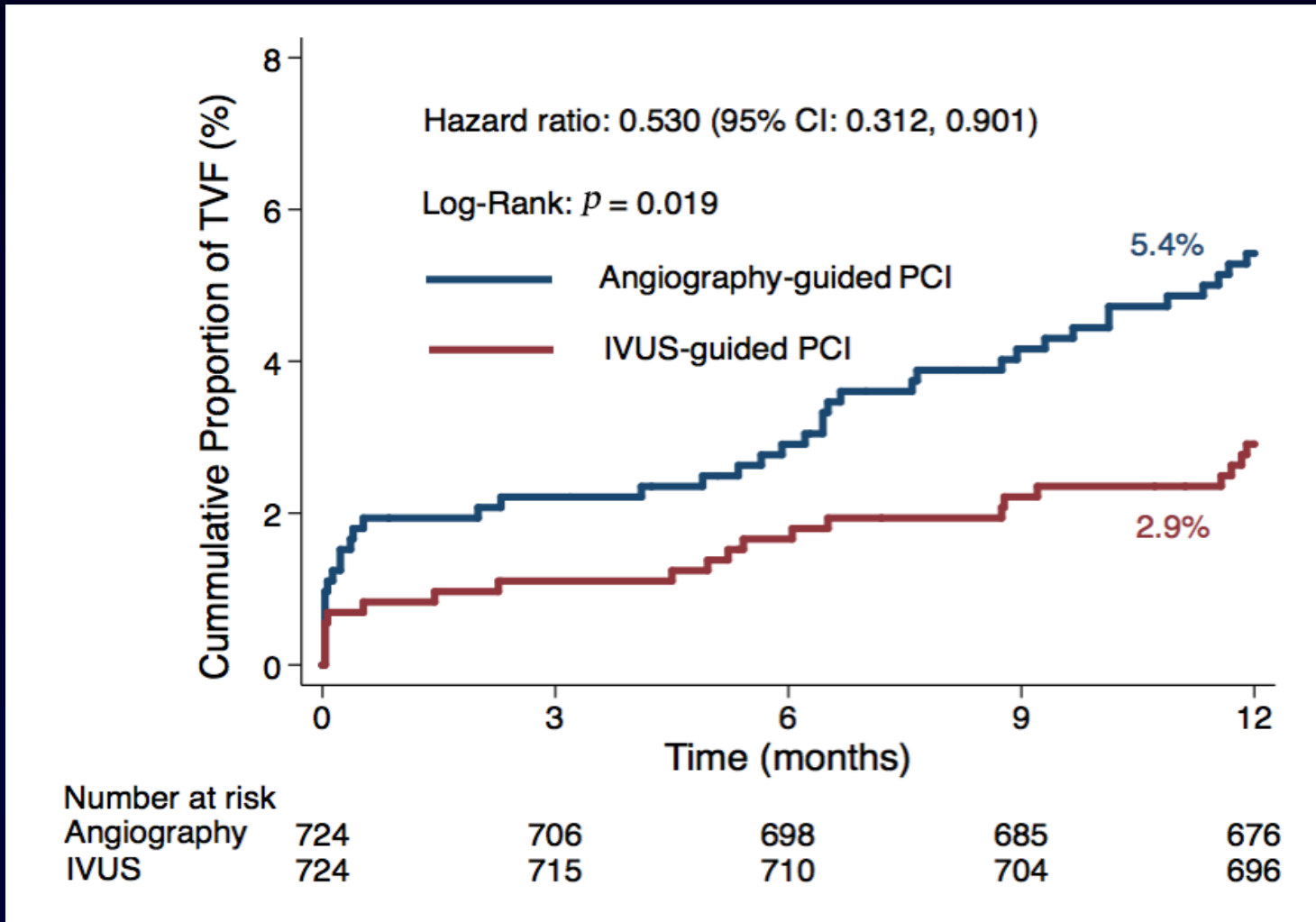IVUS = intravascular ultrasound; OCT = optical coherence tomography.
[a]Class of recommendation.
[b]Level of evidence.

No change of recommendation to use IVUS in guideline

ULTIMATE trial

Primary Endpoint: TVF at 12 months

Zhang J, et al. *J Am Coll Cardiol* 2018;72:3126-37

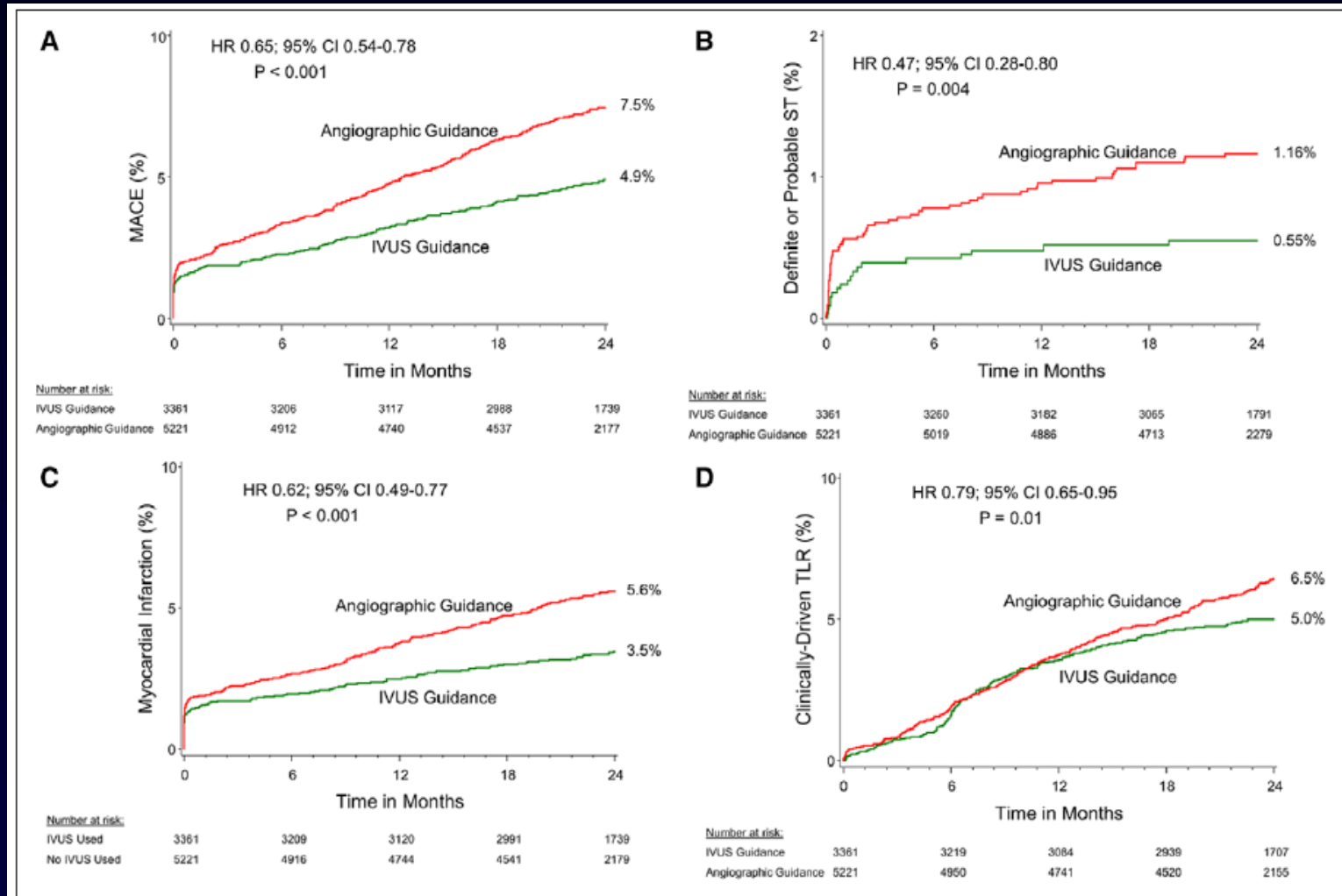# Two-year follow-up of the ADAPT DES study

Figure 1. Time-to-event curves according to intravascular ultrasound (IVUS) guidance vs angiography guidance.
Kaplan-Meier survival curves through 2 y for (**A**) major adverse cardiac events (MACE), (**B**) definite or probable stent thrombosis (ST), (**C**) myocardial infarction, and (**D**) clinically driven target lesion revascularization (TLR) according to IVUS guidance vs angiography guidance. HR indicates hazard ratio.

Maehara A, et al. *Circ Cardiovasc Interv*. 2018;11:e006243

Use of IVUS in complex lesions: median 64 months FU

IVUS guidance= 1,674 patients; angiography guidance=4,331 patients
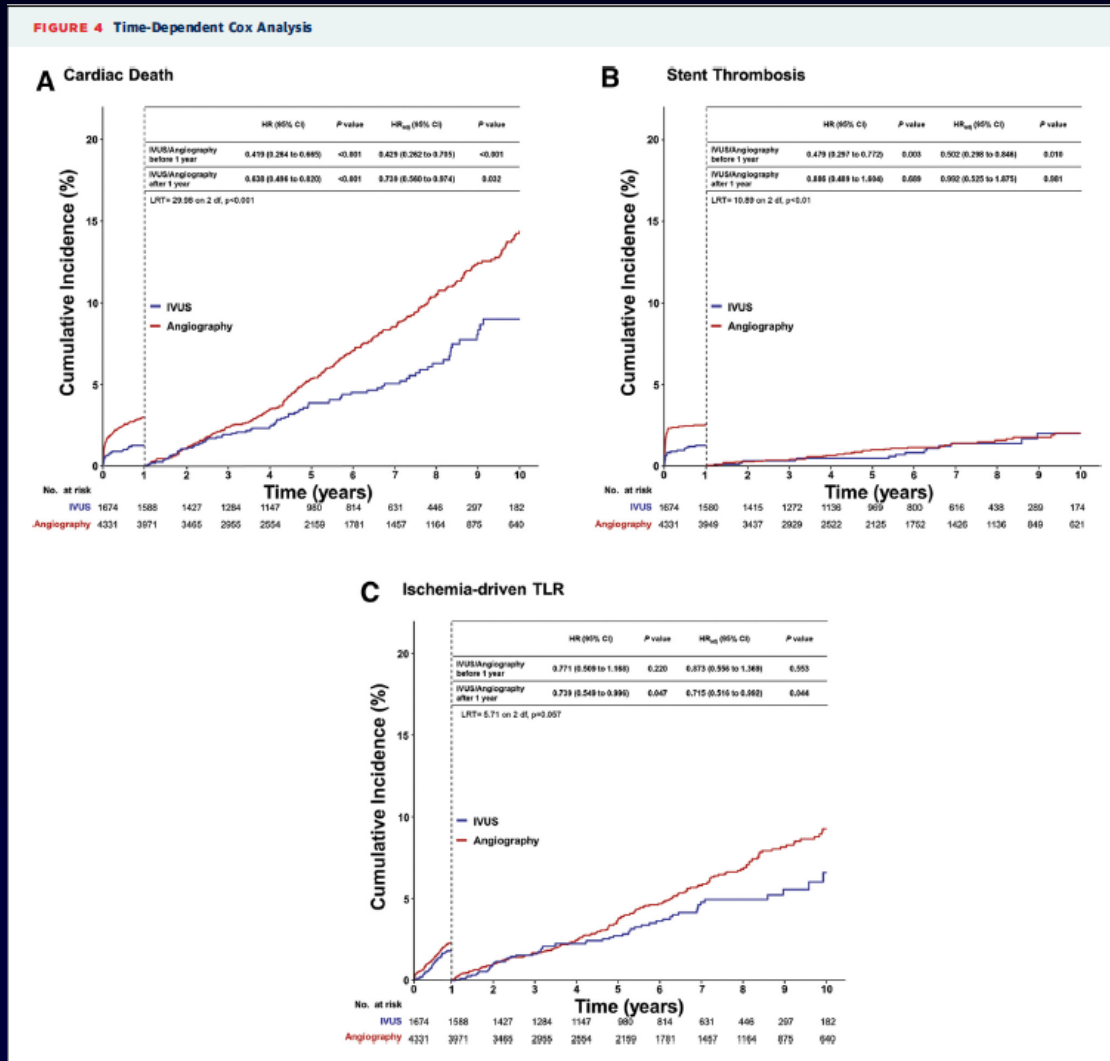
Conclusion

Just do IVUS in PCI for complex lesions in the cath lab.

Dreams will come true

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