

국내외 관상동맥 우회술과 관상동맥 스텐트 삽입술의 비교

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CABG vs Stent in DES era

- 1. Evidences from Randomized Controlled Trials (RCTs)**
- 2. Evidences from large-volume registry data**
- 3. Yonsei data**
- 4. Cost-effectiveness**

Current US and European Guidelines

2011 ACCF/AHA guideline for coronary artery bypass graft surgery: Executive summary

Anatomic Setting	COR	LOE
UPLM or complex CAD		
CABG and PCI	I—Heart Team approach recommended	C
CABG and PCI	IIa—Calculation of the STS and SYNTAX scores	B
UPLM*		
CABG	I	B
PCI	IIa—For SIHD when <i>both</i> of the following are present: <ul style="list-style-type: none"> Anatomic conditions associated with a low risk of PCI procedural complications and a high likelihood of good long-term outcome (eg, a low SYNTAX score of ≤ 22, ostial or trunk left main CAD) Clinical characteristics that predict a significantly increased risk of adverse surgical outcomes (eg, STS-predicted risk of operative mortality $\geq 5\%$) IIa—For UA/NSTEMI if not a CABG candidate IIa—For STEMI when distal coronary flow is TIMI flow grade 3 and PCI can be performed more rapidly and safely than CABG IIb—For SIHD when <i>both</i> of the following are present: <ul style="list-style-type: none"> Anatomic conditions associated with a low to intermediate risk of PCI procedural complications and intermediate to high likelihood of good long-term outcome (eg, low-intermediate SYNTAX score of < 33, bifurcation left main CAD) Clinical characteristics that predict an increased risk of adverse surgical outcomes (eg, moderate-severe COPD, disability from prior stroke, or prior cardiac surgery; STS-predicted risk of operative mortality $> 2\%$) III: Harm—For SIHD in patients (versus performing CABG) with unfavorable anatomy and for PCI and who are good candidates for CABG	B
3-vessel disease with or without proximal LAD artery disease*		
CABG	I	B
	IIa—It is reasonable to choose CABG over PCI in patients with complex 3-vessel CAD (eg, SYNTAX > 22) who are good candidates for CABG	B
PCI	IIb—Of uncertain benefit	B
2-vessel disease with proximal LAD artery disease*		
CABG	I	B
PCI	IIb—Of uncertain benefit	B
2-vessel disease without proximal LAD artery disease*		
CABG	IIa—With extensive ischemia	B
	IIb—Of uncertain benefit without extensive ischemia	C
PCI	IIb—Of uncertain benefit	B

2014 ESC/EACTS Guidelines on myocardial revascularization

Recommendations according to extent of CAD	CABG		PCI	
	Class ^a	Level ^b	Class ^a	Level ^b
One or two-vessel disease without proximal LAD stenosis.	IIb	C	I	C
One-vessel disease with proximal LAD stenosis.	I	A	I	A
Two-vessel disease with proximal LAD stenosis.	I	B	I	C
Left main disease with a SYNTAX score ≤ 22 .	I	B	I	B
Left main disease with a SYNTAX score 23–32.	I	B	IIa	B
Left main disease with a SYNTAX score > 32 .	I	B	III	B
Three-vessel disease with a SYNTAX score ≤ 22 .	I	A	I	B
Three-vessel disease with a SYNTAX score 23–32.	I	A	III	B
Three-vessel disease with a SYNTAX score > 32 .	I	A	III	B

Higher class of recommendation with higher level of evidence in multi-vessel and left main subset

CABG vs Stent in DES era

Evidences from RCTs

- SYNTAX
- FREEDOM

Evidences from registry data

- New York registry data
- ACCF / STS data

Updated meta-analysis of CABG vs PCI (Sipahi, JAMA Int Med, 2014)

Coronary Artery Bypass Grafting vs Percutaneous Coronary Intervention and Long-term Mortality and Morbidity in Multivessel Disease

Meta-analysis of Randomized Clinical Trials of the Arterial Grafting and Stenting Era

1. CABG does not only lead to a dramatic reduction in repeat revascularization and MACCE but also leads to a **27% reduction in long-term all-cause mortality** and a **42% reduction in MIs** compared with PCI.
2. The benefits were not only observed in trials of **diabetic** patients but also in trials where the great majority of patients were **nondiabetic**.
3. Use of bare-metal or **drug-eluting stents did not alter** the mortality benefit.
4. Given these meaningful benefits, **CABG should be the preferred revascularization method for most patients with multivessel coronary artery disease.**

SYNTAX trial (The SYnergy between percutaneous coronary intervention with TAXus and cardiac surgery)

Coronary artery bypass graft surgery versus percutaneous coronary intervention in patients with three-vessel disease and left main coronary disease: 5-year follow-up of the randomised, clinical SYNTAX trial

(Mohr et al, Lancet, 2013)

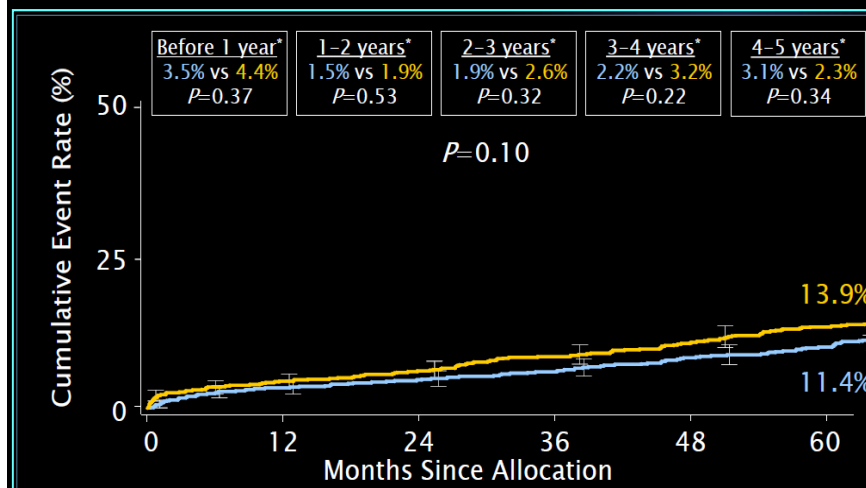
- 'All-comers' design trial
 - **Minimal exclusion criteria** ; previous PCI/CABG, AMI, concomitant procedures
 - " to determine the **best treatment option** for patients in a **real world population**..."
- **Heart team approach** (surgeon + interventional cardiologist)
- Randomized arms (N=1800) + Two registry arms (N=1275)
- SYNTAX score ; comprehensive anatomical consideration of coronary artery

1. Most important and well-designed clinical trial of CABG vs PCI.

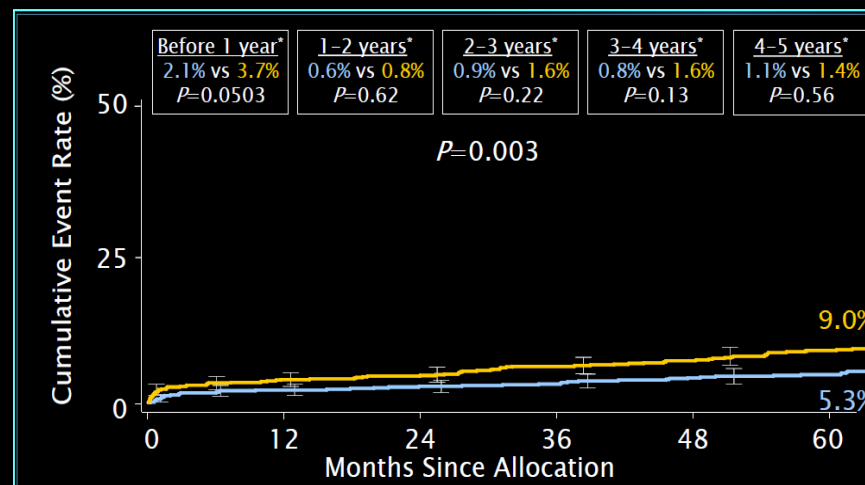
2. Real-world clinical practice was well reflected.

SYNTAX 5-year results; All-cause / cardiac mortality (Mohr et al, Lancet, 2013)

All-cause death



Cardiac death



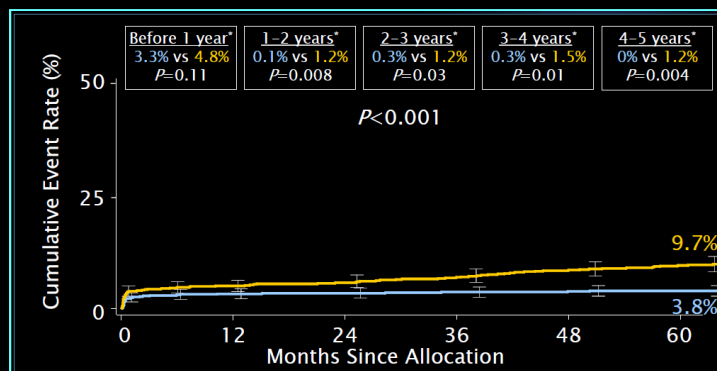
1. No difference in all-cause death at 5 years

2. Lower incidence of all-cause death from 4 year in 3VD

3. Lower incidence of cardiac death at 5 years

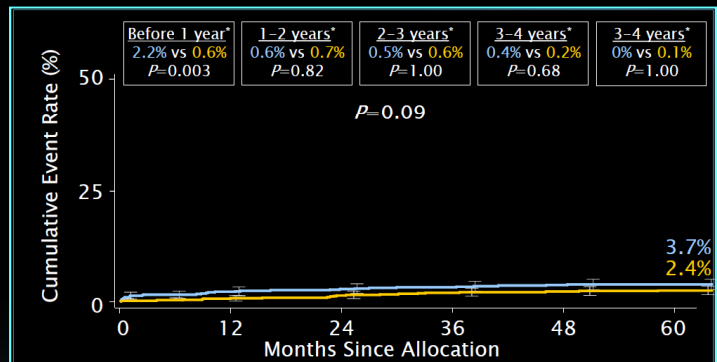
SYNTAX 5-year results; MI, CVA, repeat revascularization (Mohr et al, Lancet, 2013)

Non-fatal MI



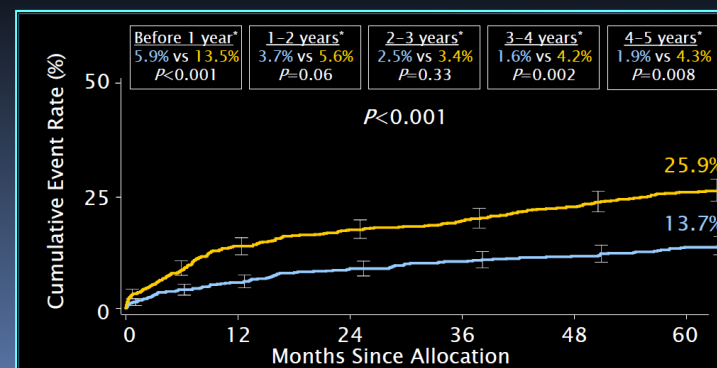
Lower non-fatal MI rate **from 1 year** in CABG group

CVA



No difference in CVA incidence at 5 years (higher in CABG group before 1 year)

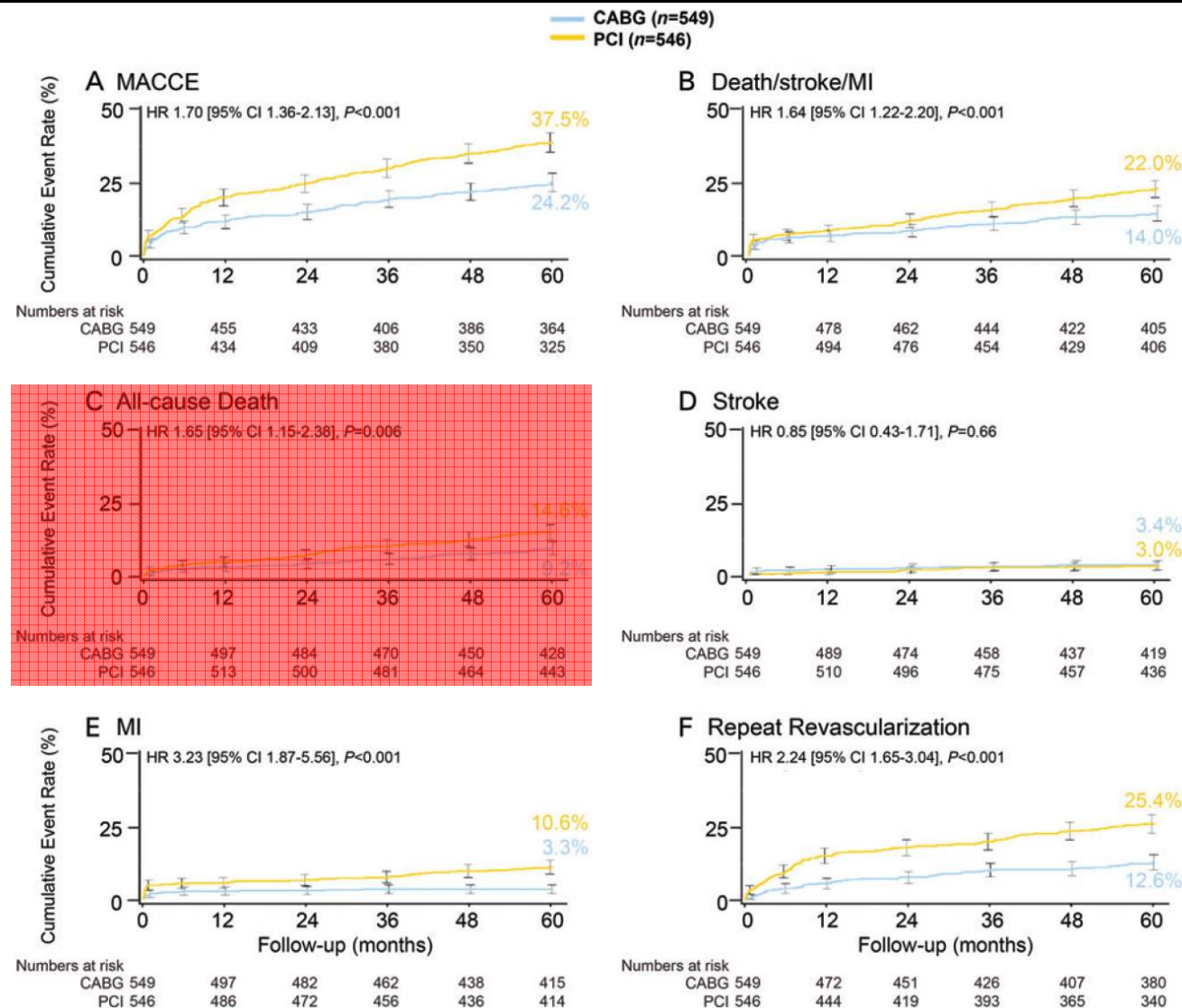
Repeat revascularization



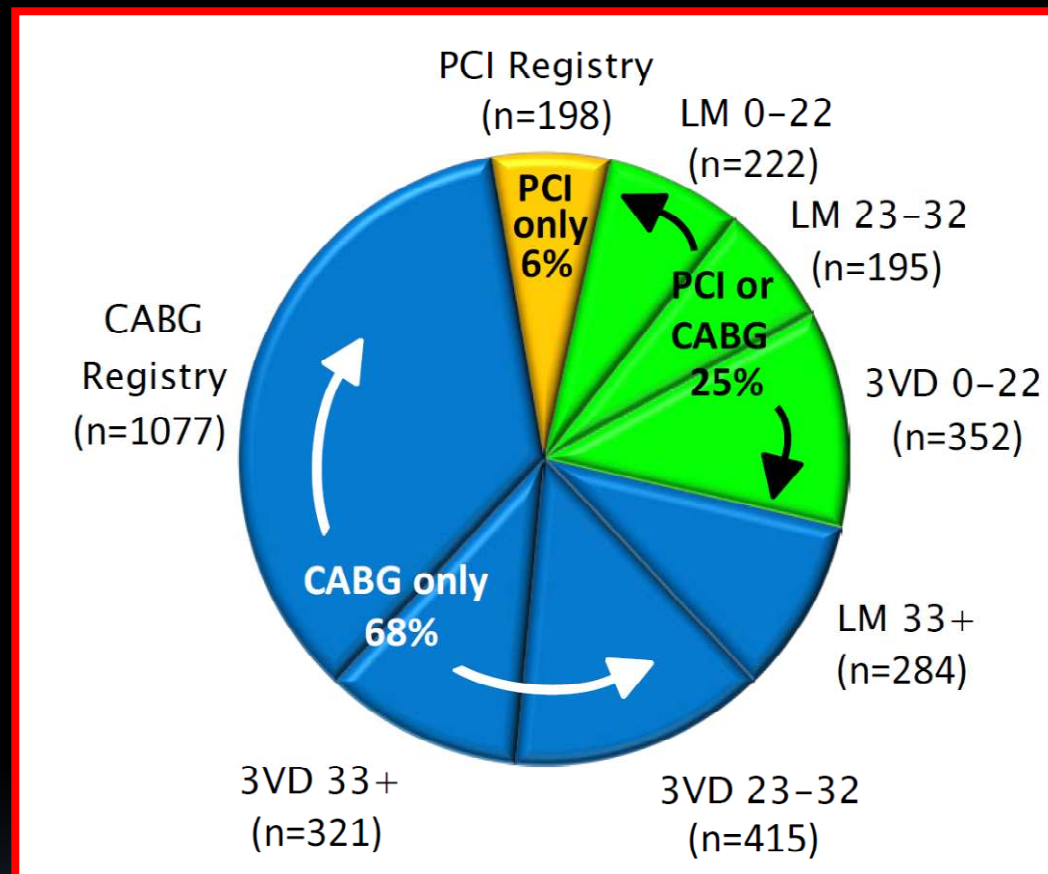
Lower incidence of repeat revascularization in CABG group **from the first year**

SYNTAX subgroup analysis; 3-VD 5-year results (Head et al, European Heart J, 2013)

Coronary artery bypass grafting vs. percutaneous coronary intervention for patients with three-vessel disease: final five-year follow-up of the SYNTAX trial



SYNTAX 5-year results; SYNTAX score (Mohr et al, Lancet, 2013)

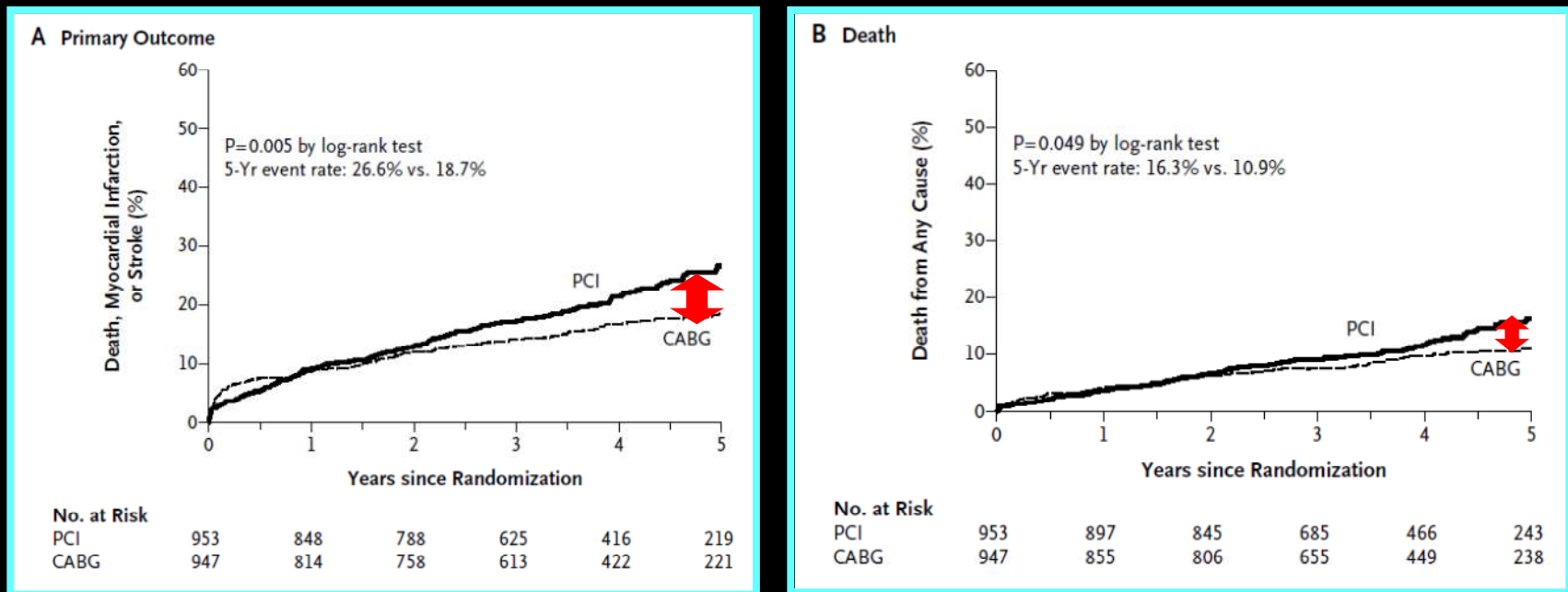


SYNTAX 5-year results suggest that about 70% of all patients (3VD and/or LMD) are still best treated with CABG.

Strategies for Multivessel Revascularization in Patients with Diabetes

- 2VD or 3VD with diabetes
- Primary outcome ; Composite of all-cause death, nonfatal MI, or nonfatal stroke
- 1900 patients enrolled (947 CABG vs 953 PCI)
- 2005-2010, 140 centers involved
- 83% had 3VD
- 18.5% underwent off-pump surgery
- Minimum follow-up of 2 years (median; 3.8 years)

FREEDOM trial (Farkouh et al, NEJM, 2012)



1. The rate of **primary outcome (death, MI, stroke)** was lower in the **CABG group** ($p=0.005$) with divergence of the curves starting at **2 years**.
2. Incidences of **death** ($p=0.049$) and **MI** ($p>0.001$) were lower in the **CABG group**.
3. Stroke incidence was higher in the CABG group ($p=0.03$)
("evident only early in the **postprocedural period**")

CABG vs Stent in DES era

Evidences from RCTs

- SYNTAX
- FREEDOM

Evidences from registry data

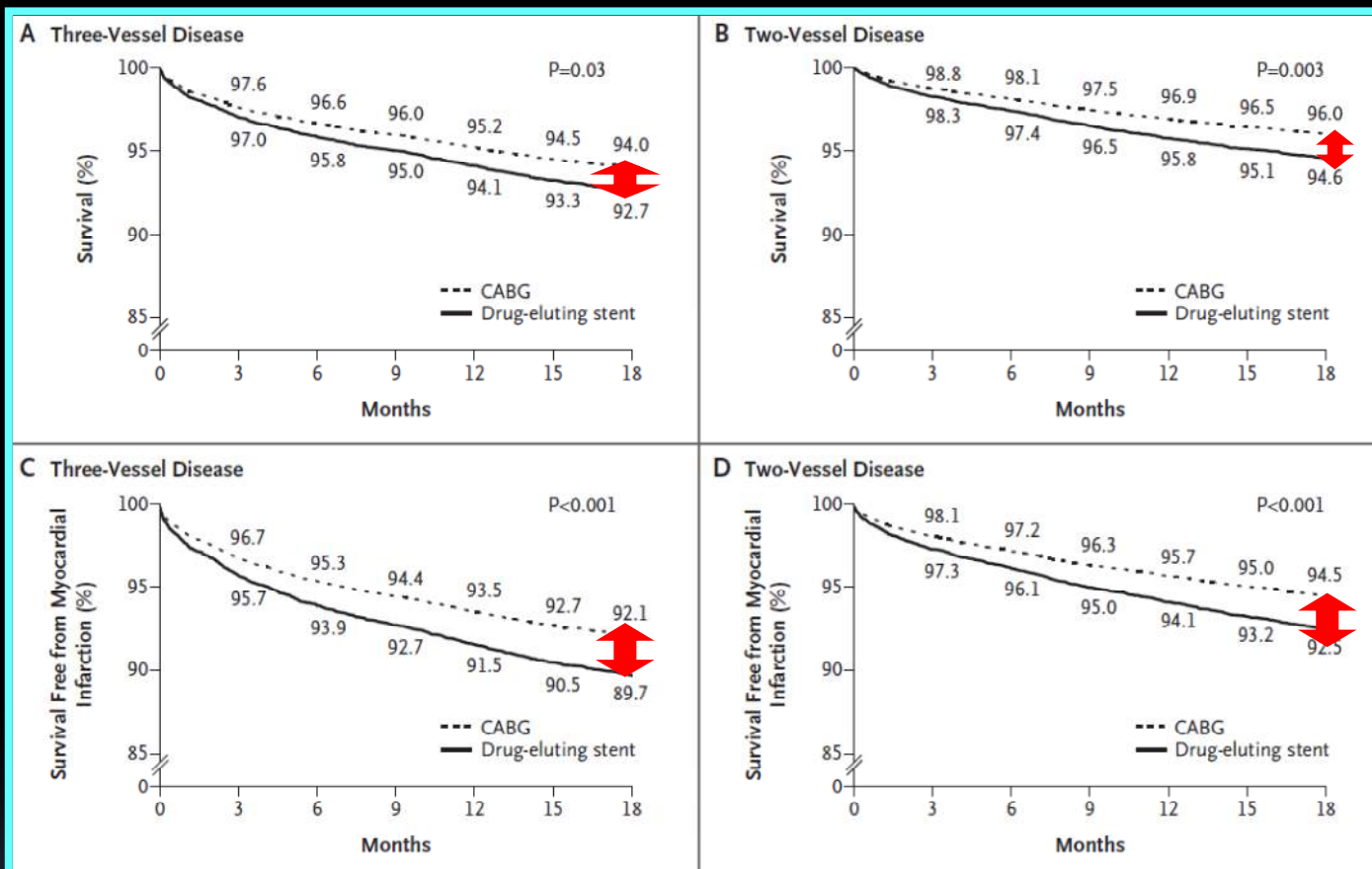
- New York registry data
- ACCF / STS data

NY Cardiac registry data, 9963 CABG patients and 7437 PCI patients (Hannan et al, NEJM, 2008)

Survival

3VD

2VD



MI

CABG showed lower mortality, lower MI rate, and lower repeat revascularization rate compared with stent implantation in 2VD and in 3VD regardless of LAD involvement.

ACCF/STS Registry data (Weintraub et al, NEJM, 2012)

Comparative Effectiveness of Revascularization Strategies

ASCERT trial

ACCF and STS database

86,244 CABG patients and 103,549 PCI patients

Age over 65, 2VD or 3VD (AMI excluded), 2004-2008

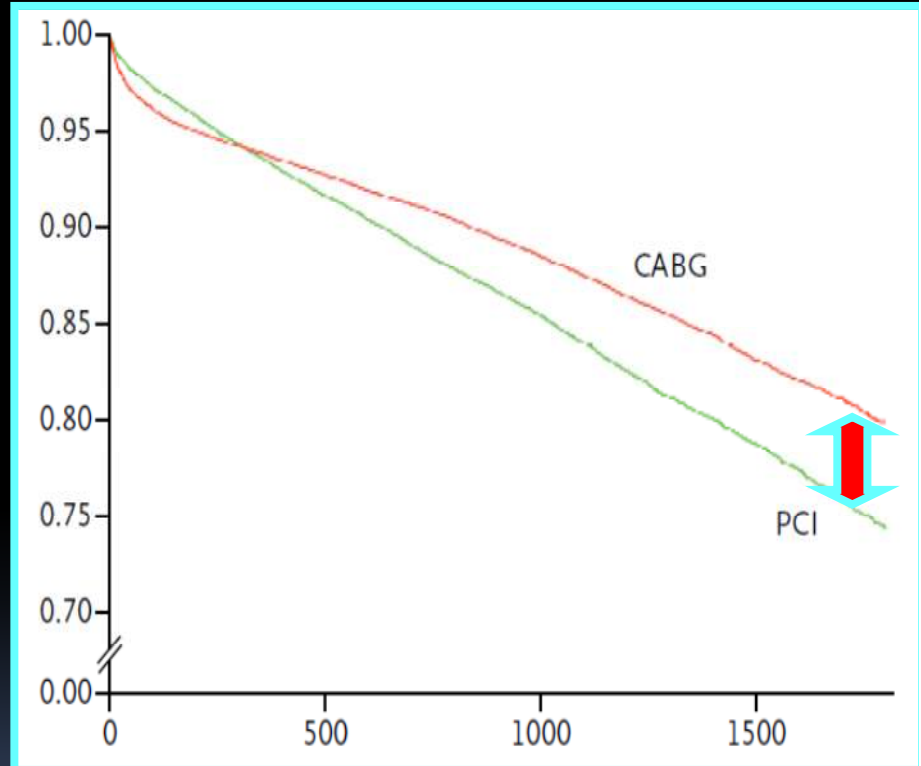
Median follow-up; 2.7 years

Primary endpoint; mortality

Propensity score and inverse-probability weighting adjustment

Angiographic variables ; not considered

78% of PCI ; DES used



Survival benefit of CABG of 4.4% at 4 years (HR 0.79 (0.76-0.82))

CABG vs Stenting in DES era

- The two most important randomized controlled trial (SYNTAX, FREEDOM) showed benefit of CABG regarding survival as well as MI and repeat revascularization.

SYNTAX ; better cardiac survival at 5 years

better overall survival from 4 years in 3VD

FREEDOM ; better overall survival at 4 years in diabetes

- Large volume registry data showed survival benefit of CABG (NY registry, ASCERT trial).
- Majority of patients with multivessel or LMD are still best treated with CABG in the DES era.

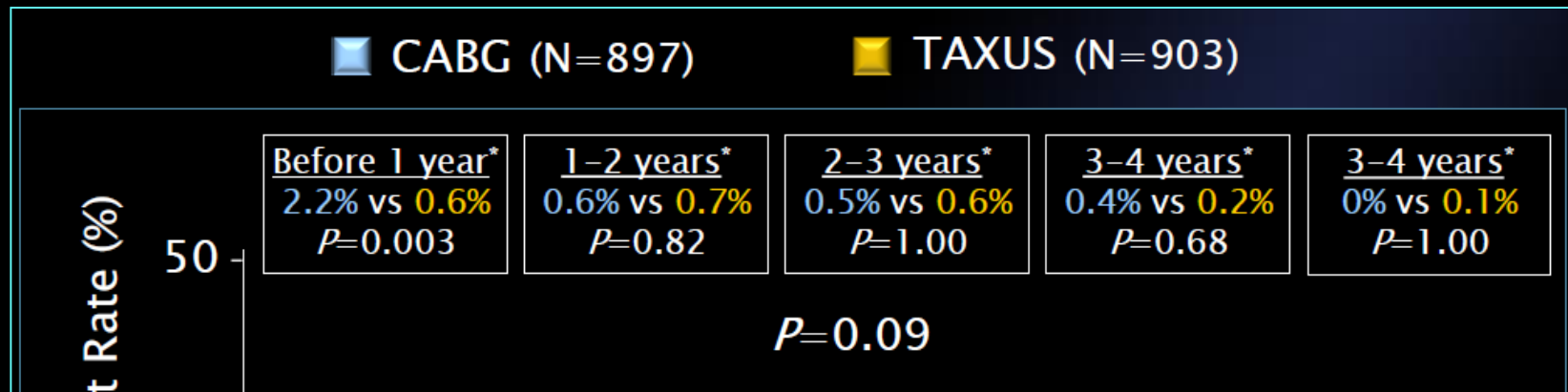
OPCAB vs Stent in DES era

Yonsei Experience

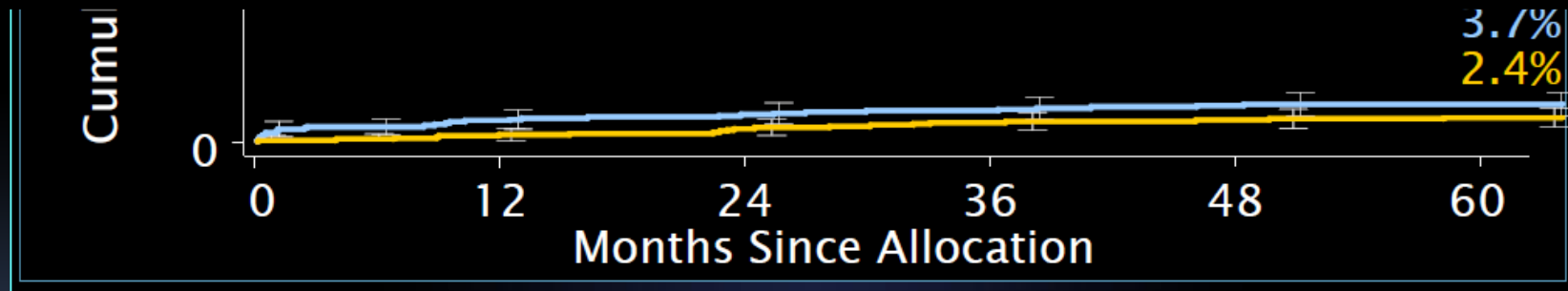
- OPCAB vs DES in 3VD
- OPCAB vs DES in left main disease
- OPCAB vs second generation DES

Stroke rate in the SYNTAX trial

slide from 2012 EACTS presentation by SYNTAX Investigators



"the low rate of stroke among patients who underwent PCI may have resulted from the use of **highly effective dual-antiplatelet** therapy, which prevents thromboembolic events..." (Serruys et al, NEJM, 2009)



Off-pump CABG was performed in **15%** of patients in the CABG group.

Yonsei experience

OPCAB vs 1st generation DES in 3VD (Am J Cardiol 2012)

Comparison of Long-Term Outcome of Off-Pump Coronary Artery Bypass Grafting Versus Drug-Eluting Stents in Triple-Vessel Coronary Artery Disease

Gijong Yi, MD, PhD^a, Young-Nam Youn, MD, PhD^b, Soonchang Hong, MD^a,
Suk-Won Song, MD, PhD^a, and Kyung-Jong Yoo, MD, PhD^{b,*}

OPCAB vs 1st generation DES in left main disease (ATS 2012)

Midterm Outcome of Off-Pump Bypass Procedures Versus Drug-Eluting Stent for Unprotected Left Main Coronary Artery Disease

Gijong Yi, MD, PhD, Young-Nam Youn, MD, PhD, Soonchang Hong, MD,
Suk-Won Song, MD, PhD, and Kyung-Jong Yoo, MD, PhD

OPCAB vs second generation DES in 3VD and/or LMD (ATS 2013)

Stent Versus Off-Pump Coronary Bypass Grafting in the Second-Generation Drug-Eluting Stent Era

Gijong Yi, MD, PhD, Hyun-Chel Joo, MD, Young-Nam Youn, MD, PhD,
Soonchang Hong, MD, and Kyung-Jong Yoo, MD, PhD

- Better MACCE rate in OPCAB group.
- No difference in stroke rate
- Determining factors ; Nonfatal MI, Target vessel revascularization
- Survival advantage?

Long-term survival advantage of OPCAB over PCI with 1st generation DES

Study design ;

2498 triple-vessel disease patients from 2003-2008

OPCAB group ; 981

PCI group ; 1517



Propensity score matching

OPCAB group ; 718

PCI group ; 718



Follow-up; 6.7 years, Follow-up rate ; 97.4%

Survival

MACCE

Age

Gender

Hypertension

Diabetes mellitus

Smoking history

Acute coronary
syndrome

LVEF (%)

Left main disease

COPD

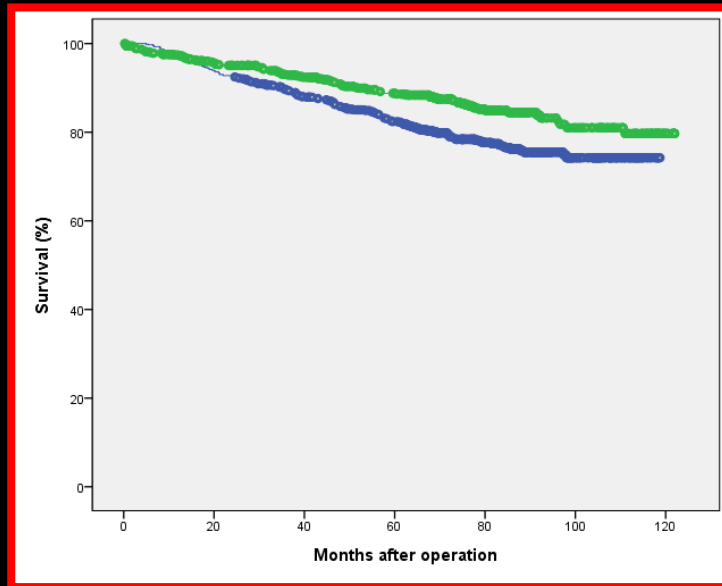
Chronic renal failure

CVA history

Low EF (<35%)

Long-term survival advantage of OPCAB over PCI with 1st generation DES

Survival and MACCE (N=1436)

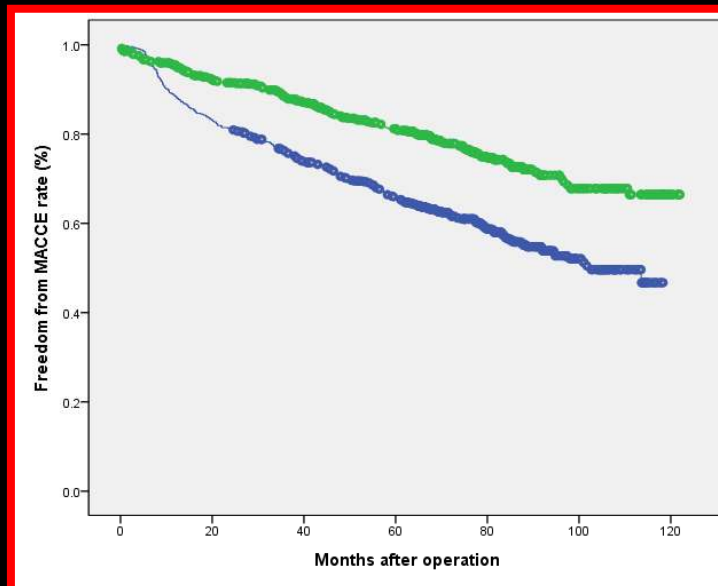


10-year Survival rate

OPCAB group ; $80.1 \pm 2.5\%$

PCI group ; $74.5 \pm 2.0\%$

P=0.001 by log-rank test



10-year Freedom from MACCE rate

OPCAB group ; $66.4 \pm 2.9\%$

PCI group ; $46.7 \pm 3.8\%$

P<0.001 by log-rank test

5.6% survival benefit at 10 years

OPCAB vs Stenting in DES era

- OPCAB showed better MACCE rate compared with PCI with DES.
- Repeat revascularization and nonfatal MI were two determining factors in most of analyses.
- OPCAB, compared with PCI, showed similar incidence of stroke even in the early postoperative period.
- OPCAB showed consistently superior outcomes compared with PCI regarding MACCE rate for the treatment of 3VD and/or LMD in the second generation DES era.

Cost effectiveness of CABG vs PCI-DES

Cost-Effectiveness of Percutaneous Coronary Intervention With Drug-Eluting Stents Versus Bypass Surgery for Patients With 3-Vessel or Left Main Coronary Artery Disease

Final Results From the Synergy Between Percutaneous Coronary Intervention With TAXUS and Cardiac Surgery (SYNTAX) Trial

(Cohen et al, Circulation, 2014)

Cost-Effectiveness of Percutaneous Coronary Intervention with Drug Eluting Stents versus Bypass Surgery for Patients with Diabetes and Multivessel Coronary Artery Disease: Results from the FREEDOM Trial

(Magnuson et al, Circulation, 2014)

Cost-effectiveness of PCI versus CABG; SYNTAX (Cohen et al, Circulation, 2014)

Cost-Effectiveness of Percutaneous Coronary Intervention With Drug-Eluting Stents Versus Bypass Surgery for Patients With 3-Vessel or Left Main Coronary Artery Disease

Final Results From the Synergy Between Percutaneous Coronary Intervention With TAXUS and Cardiac Surgery (SYNTAX) Trial

Index hospitalization costs

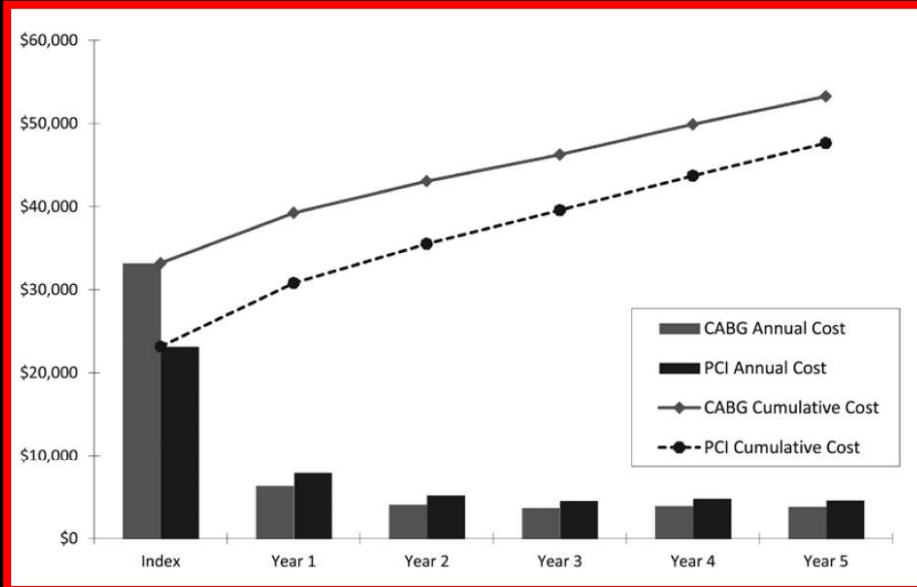
	CABG (n=870)	PCI (n=896)	Difference (95% CI)	<i>P</i> Value
Initial hospitalization costs, \$				
Revascularization procedures	8580±2231 [8340]	12 054±6287 [8340]	−3474 (−3917 to −3032)	< 0.001
Hospital stay plus ancillary services	19 511±6655 [16 669]	8785±5464 [6216]	10 726 (10 159 to 11 294)	< 0.001
Physician fees	5100±853 [4956]	2315±954.8 [1942]	2785 (2700 to 2869)	< 0.001
Total	33 190±7938 [30 903]	23 154±10 379 [20 279]	10 036 (9172 to 10 901)	< 0.001

Cost-effectiveness of PCI versus CABG; SYNTAX (Cohen et al, Circulation, 2014)

	Year 1		Year 2		Year 3		Year 4		Year 5		5-y Cumulative		
	CABG (n=870)	PCI (n=896)	CABG (n=813)	PCI (n=851)	CABG (n=791)	PCI (n=832)	CABG (n=767)	PCI (n=805)	CABG (n=733)	PCI (n=771)	CABG (n=870)	PCI (n=896)	P Value
Clinical outcomes, %													
Death	1.8	2.6	1.5	2.0	1.9	2.6	2.2	3.2	2.9	2.3	10.7	13.6	0.06
MI	0.9	2.2	0.1	1.2	0.3	1.2	0.3	1.7	0.0	1.2	3.7	9.3	<0.001
Stroke	1.0	0.6	0.7	0.7	0.5	0.6	0.4	0.2	0.0	0.1	3.4	2.2	0.12
Resource use, n events/100 patients													
Repeat revascularization (any)	4.8	14.1	3.9	6.6	2.5	3.7	2.2	5.5	2.6	4.3	16.6	35.2	<0.001
PCI procedures	4.7	11.9	3.9	5.6	2.5	2.8	2.2	4.8	2.6	3.1	15.3	28.9	<0.001
CABG procedures	0.1	2.1	0.0	0.9	0.0	1.0	0.0	0.6	0.0	1.2	1.3	6.3	<0.001
Diagnostic catheterization	3.8	11.6	2.3	6.5	1.9	4.1	0.1	0.2	1.4	3.4	10.1	22.3	<0.001
Rehospitalization	27.7	41.1	16.6	20.9	12.9	15.6	14.5	18.3	11.5	13.5	77.5	103.6	<0.001
Cost per patient, \$													
Rehospitalizations	2435	3964	1570	2044	1200	1485	1240	1664	1178	1471	...	...	...
Outpatient services	323	333	91	167	83	110	141	171	118	165	...	...	...
Rehabilitation/ skilled nursing stays	900	186	27	14	28	15	30	47	31	49	...	...	...
Medications	1578	2136	1787	2186	1837	2236	1866	2204	1952	2300	...	...	...
Physician fees	724	1027	439	558	348	421	384	446	321	381	...	...	...
Total	5959	7646	3914	4970	3495	4266	3661	4532	3601	4366	...	...	...

CABG indicates coronary artery bypass grafting; MI, myocardial infarction; mITT, modified intention to treat; and PCI, percutaneous coronary intervention.

Cost-effectiveness of PCI versus CABG; SYNTAX (Cohen et al, Circulation, 2014)



Life-time cost-effectiveness estimation

CABG was associated with

1. Lifetime incremental costs of \$5081
2. Gain in life-expectancy of 0.412 years
3. Gain in quality-adjusted life expectancy of 0.307 QALYs

For most patients with 3-vessel or left main coronary artery disease, CABG is a clinically and economically attractive revascularization strategy compared with DES-PCI.

Cost-effectiveness of PCI versus CABG; FREEDOM (Magnuson et al, Circulation, 2014)

Cost-Effectiveness of Percutaneous Coronary Intervention with Drug Eluting Stents versus Bypass Surgery for Patients with Diabetes and Multivessel Coronary Artery Disease: Results from the FREEDOM Trial

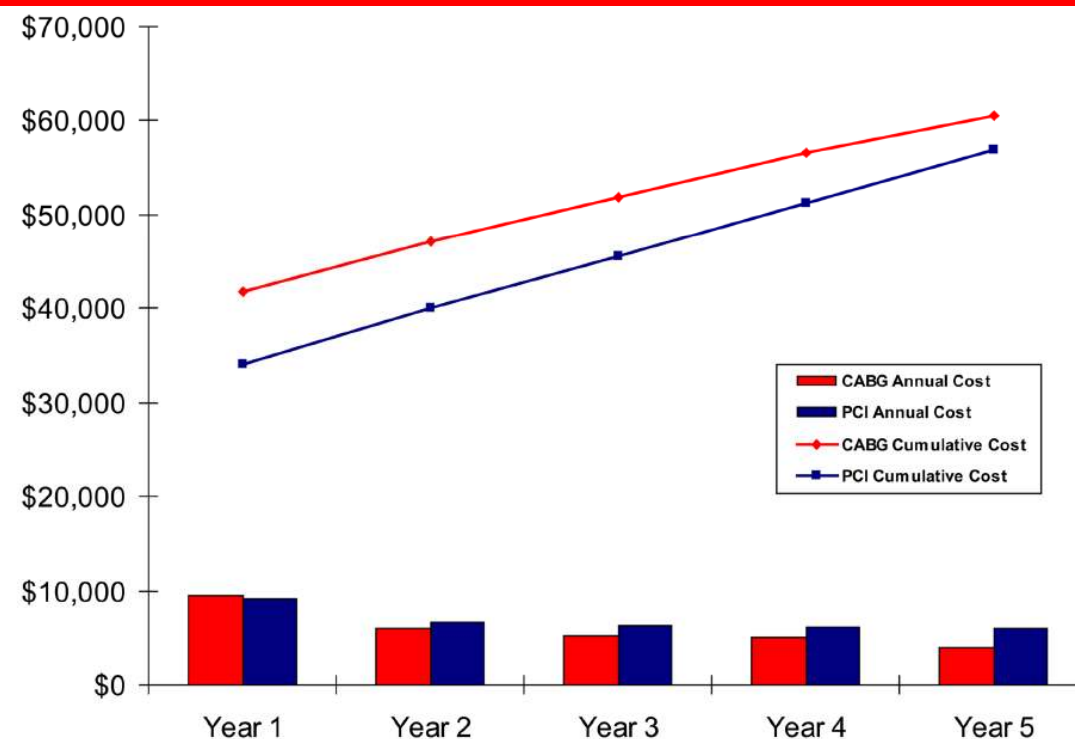


Figure 2.
Mean cumulative medical costs (lines) and mean annual follow-up costs (bars) in 2010 dollars, for the PCI and CABG groups.

Cost-effectiveness of PCI versus CABG; FREEDOM (Magnuson et al, Circulation, 2014)

	Year 1		Year 2		Year 3		Year 4		Year 5		5-Year Cumulative*		
	CABG N=911	PCI N=944	CABG N=897	PCI N=845	CABG N=824	PCI N=784	CABG N=628	PCI N=659	CABG N=428	PCI N=419	CABG N=911	PCI N=944	p-value*
Clinical Outcomes													
Death, %	4.1	3.4	2.1	3.0	1.3	2.4	1.8	2.3	1.0	4.0	10.7	16.0	0.06
MI, %	3.7	5.8	0.8	1.0	0.4	1.9	0.3	2.1	0.5	3.0	6.0	13.9	<0.001
Stroke, %	1.9	0.8	0.7	0.7	0.8	0.5	0.8	0.3	0.7	0.2	5.1	2.4	0.04
Resource Utilization (events/100 pts)													
Repeat Revascularization													
PCI procedures	4.6	8.4	3.8	6.0	2.3	5.3	0.8	4.6	2.4	5.1	3.3	6.8	<0.001
CABG procedures	0.0	2.4	0.0	1.4	0.0	1.1	0.0	1.2	0.0	1.4	0.0	1.7	0.99
Total procedures	4.6	10.8	3.8	7.5	2.3	6.4	0.8	5.8	2.4	6.5	3.3	8.5	<0.001
Diagnostic catheterization													
Re-hospitalization	1.6	2.9	2.4	2.8	1.4	3.0	1.3	2.3	1.0	1.9			
Cardiovascular													
Cardiovascular	18.8	22.2	10.3	14.6	6.0	12.5	3.3	14.1	5.3	10.7	10.8	17.2	<0.001
Non-cardiovascular													
Non-cardiovascular	19.1	13.9	12.0	11.6	11.1	11.5	11.6	9.6	7.9	9.3	14.6	12.8	0.052
Costs per patient, \$													
Cardiovascular hospitalizations	2377	2991	1208	1749	581	1587	211	1782	461	1598	---	---	---
Non-cardiovascular hospitalizations	2380	1567	1356	1224	1050	1413	1437	1022	697	1104	---	---	---
Outpatient services	1200	1041	1061	831	954	848	856	885	839	754	---	---	---
Rehab/skilled nursing stays	1606	1229	339	486	714	240	529	454	264	787	---	---	---
Medications	1928	2275	1988	2323	1846	2172	2018	2053	1660	1719	---	---	---
Total	9491	9102	5952	6613	5145	6259	5051	6196	3921	5963	---	---	---

Higher costs in DES-PCI group throughout 1-5 years due to

Higher incidence of repeat revascularization procedures, diagnostic catheterization and cardiovascular re-hospitalization

Conclusions—Despite higher initial costs, CABG is a highly cost-effective revascularization strategy compared with DES-PCI for patients with diabetes and multivessel CAD.

CABG vs Stent in DES era

1. The two most important randomized controlled trial (SYNTAX, FREEDOM) showed benefit of CABG regarding survival as well as MI and repeat revascularization.
2. Large volume registry data showed survival benefit of CABG (NY registry, ASCERT trial).
3. Evidences from RCTs showed that CABG is highly cost-effective revascularization strategy throughout life-time compared with PCI-DES.



THANK YOU FOR YOUR ATTENTION.



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