



PCI vs. CABG: The Debate Continues

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Disclosures

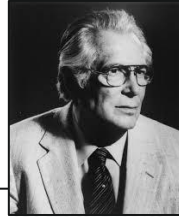
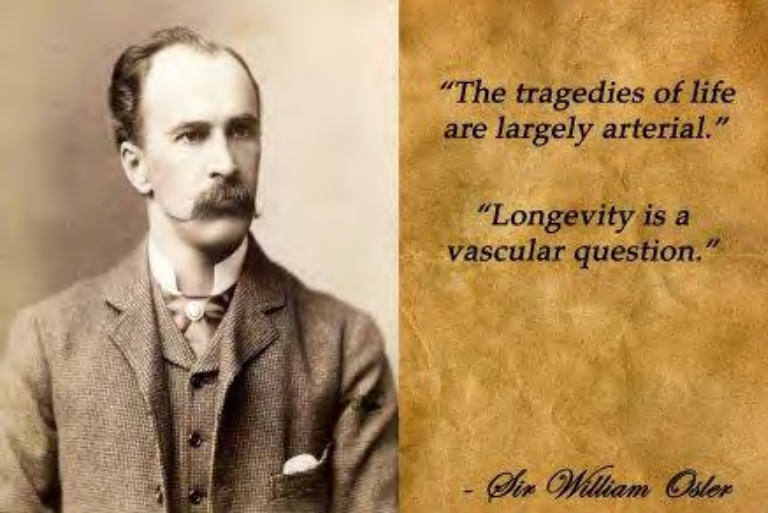
- None

A Brief History of Angina

- around 1500 BC, describes chest pain radiating down the arm and warns that the symptom often betokens imminent death.⁵ A thousand years later a famous Indian surgeon, Sushruta, discussed a symptom which he called 'hritshoola', pain above the heart aggravated by exertion and eased by rest.
- The doctor who called it angina pectoris (literally, 'choking of the breast') was William Heberden. In 1772 he described 'a disorder of the breast marked with strong and peculiar symptoms', which he had observed in over a hundred patients: They who are afflicted with it, are seized while they are walking (more especially if it be up hill, and soon after eating) with a painful and most disagreeable sensation in the breast, which seems as if it would extinguish life, if it were to increase or to continue; but the moment they stand still, all this uneasiness vanishes.



William Heberden
(1710 - 1801)



INTERNAL MAMMARY-CORONARY ARTERY ANASTOMOSIS A Nonsuture Method Employing Tantalum Rings

Robert H. Goetz, M.D., Michael Rohman, M.D.,* Jordan D. Haller, M.D.,
Ronald Dee, F.R.C.S., and Stephan S. Roizenak, M.D., New York, N.Y.

SURGICAL approaches to the treatment of occlusive coronary arteriosclerotic disease include (1) cardioplexy, using extracardiac structures to develop vascular adhesions to the myocardium, (2) arterialization of the coronary venous system, (3) implantation of the internal mammary artery into the myocardium, (4) ligation of the internal mammary artery to promote enlargement of pericardial branches communicating with cardiac branches at the base of the heart, and (5) coronary endarterectomy. None of these methods has been consistently successful.

Although it is generally true that systemic arteriosclerosis is a diffuse lesion, autopsy studies by Schlesinger and Zol¹ have shown that coronary arteriosclerosis frequently results in segmental occlusion of a main stem. They have shown that in 63 per cent of 193 hearts studied, the occlusion measured 5 mm. in length or less and in 69 per cent of 126 hearts the proximal extent of the lesion was within the first four centimeters of the main coronary trunks. At this level the coronary arteries have a lumen of approximately 2.5 to 3.5 mm., a diameter that might permit direct systemic coronary arterial bypass anastomoses as a method of improving distal coronary circulation.

Direct suture anastomosis between systemic and coronary arteries has been attempted by other investigators with disappointing results,²⁻⁴ even though the cannulated distal coronary arteries were perfused during the procedure to maintain coronary circulation. The incidence of early and late thromboses precludes clinical application of the method. Earlier work in this laboratory confirmed these findings and suture methods were abandoned. This report describes a nonsuture technique which employs a tantalum ring for the creation of internal mammary-coronary artery anastomoses.

MATERIALS AND METHOD

The rings used for the anastomosis are made of highly polished silicized tantalum, 0.25 mm. thick, and vary from 2.5 to 6 mm. in length and from 2.5

From the Department of Surgery, Albert Einstein College of Medicine, New York 61, N. Y.
*Alfred is part of a grant from the American Heart Association and Grant No. 5745 from the National Institutes of Health.

Received for publication Feb. 26, 1966.

*Fellow of American Tissue Society (1957-1959) and New York State Committee on Tuberculosis and Public Health (1957-1960).

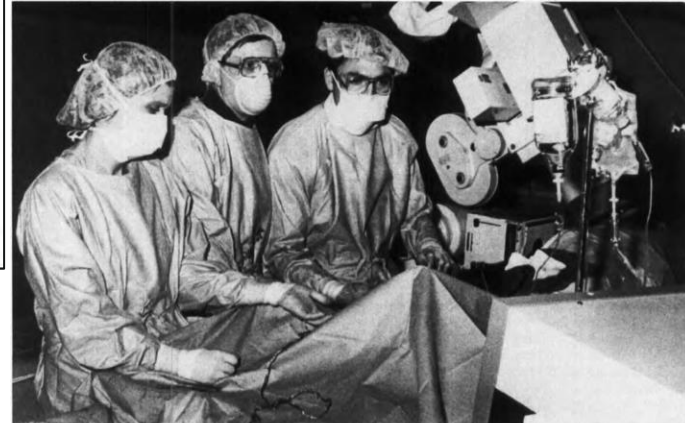
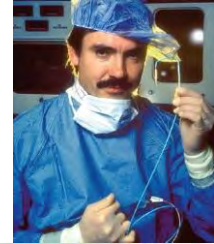
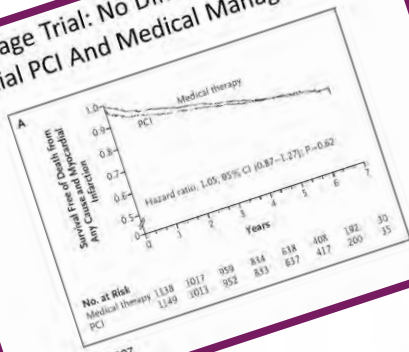


FIG. 1 Teaching, always teaching. Andreas Gruentzig, M.D. (right), Jay Hollman, M.D. (center), and Sally Deneen, R.T. (left).

Medical Therapy Works...

Courage Trial: No Difference Between Initial PCI And Medical Management



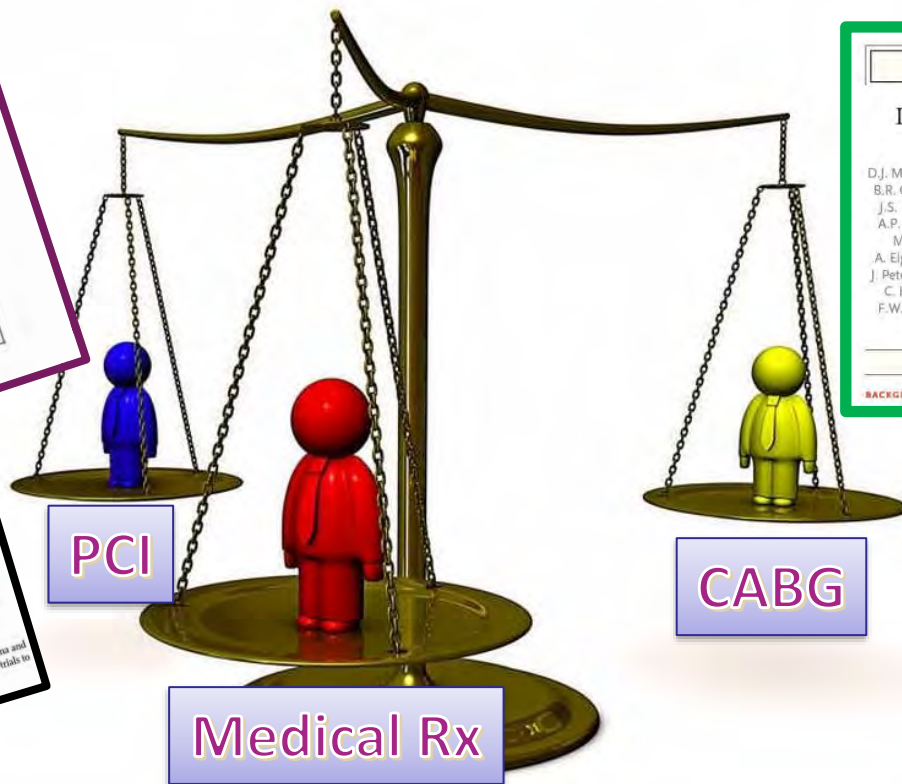
Boden, NEJM, 2007

Percutaneous coronary intervention in stable angina (ORBITA): a double-blind, randomised controlled trial

Abdulla Al-Lamee, David Thompson, Helen Morley-Deeks, Simon Sin, Kuan Tze, John Davies, Thomas Korte, Michael Madhwal, Nigel Knapton, Nigel S. Malik, Sudhakar S. Nigam, Riccardo Petronio, Christopher Cook, Yusef Ahmed, James Howard, Christopher Baker, Matthew Olney, Robert Gifford, Samuel Latham, Ross Alexander, James Mayet, Robert Wrenn, David Collier, Matthew Shaw, John, Simon A. Thom, Jordan C. Davies, David P. Francis, on behalf of the ORBITA Investigators

Summary
Background Symptomatic relief is the primary goal of percutaneous coronary intervention (PCI) in stable angina and is commonly observed clinically. However, there is no evidence from blinded, placebo-controlled randomised trials to show its efficacy.

Al-Lamee R et al. Lancet. 2017.



ORIGINAL ARTICLE

Initial Invasive or Conservative Strategy for Stable Coronary Disease

D.J. Maron, J.S. Hochman, H.R. Reynolds, S. Bangalore, S.M. O'Brien, W.E. Boden, B.R. Chaitman, R. Senior, J. López-Sendón, K.P. Alexander, R.D. Lopes, L.J. Shaw, J.S. Berger, J.D. Newman, M.S. Sidhu, S.G. Goodman, W. Ruzyllo, G. Gosselin, A.P. Maggioni, H.D. White, B. Bhargava, J.K. Min, G.B.J. Mancini, D.S. Berman, M.H. Picard, R.Y. Kwong, Z.A. Ali, D.B. Mark, J.A. Spertus, M.N. Krishnan, A. Elghamraz, N. Moorthy, W.A. Hueb, M. Demkow, K. Mavromatis, O. Bockeria, J. Peteiro, T.D. Miller, H. Szwed, R. Doerr, M. Keltai, J.B. Selvanayagam, P.G. Steg, C. Held, S. Kohsaka, S. Mavromichalis, R. Kirby, N.O. Jeffries, F.E. Harrell, Jr., F.W. Rockhold, S. Broderick, T.B. Ferguson, Jr., D.O. Williams, R.A. Harrington, G.W. Stone, and Y. Rosenberg, for the ISCHEMIA Research Group^a

ABSTRACT

BACKGROUND

Five-Year Follow-Up of the Medicine, Angioplasty, or

A Random

Mortality after coronary artery bypass grafting versus

Original Investigation

Coronary Artery Bypass Grafting vs Percutaneous Coronary

Intervention

in Patients With Multivessel Coronary Artery Disease: A Collaborative Analysis of Individual Patient Data From Ten Randomised Trials

Me

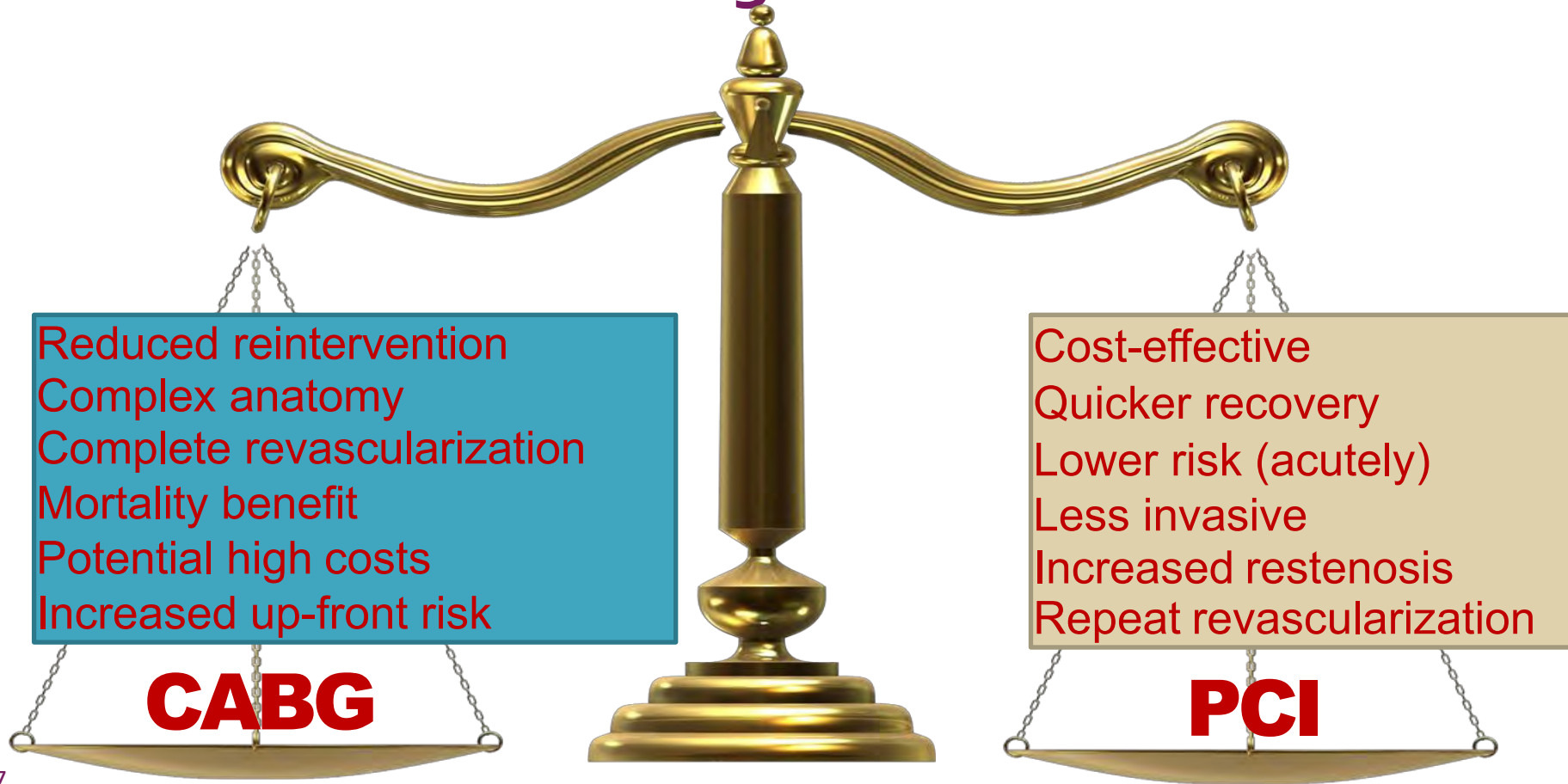
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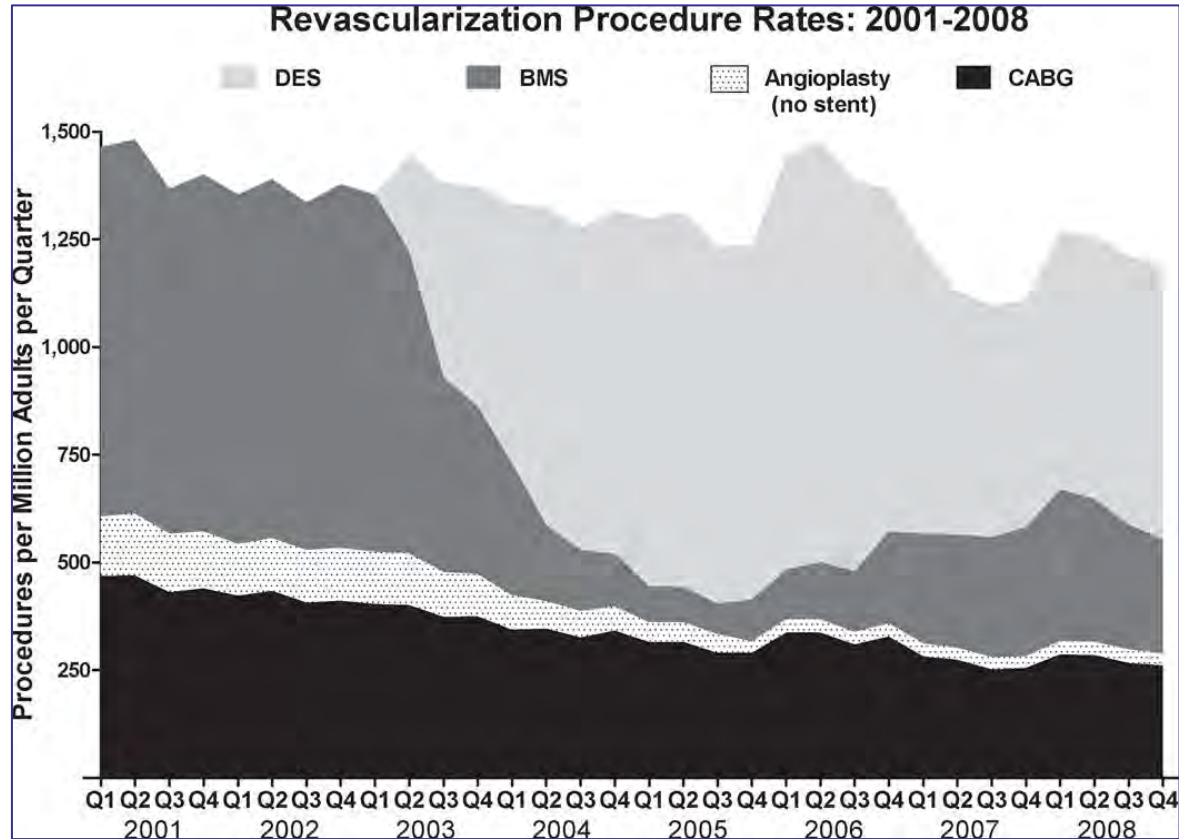
Consensus: CABG > PCI in MVCAD

Mark A Hlatky, Derek B Boothroyd, Dena M Bravata, Eric Boersma, Jean Booth, Maria M Brooks, Didier Carrié, Tim C Clayton, Nicolas Danchin, Marcus Flather, Christian W Hamm, Whady A Hueb, Jan Kähler, Sheryl F Kelsey, Spencer B King, Andrzej S Kosinski, Neuza Lopes, Kathryn M McDonald, Alfredo Rodriguez, Patrick Serruys, Ulrich Sigwart, Rodney H Stables, Douglas K Owens, Stuart J Pocock

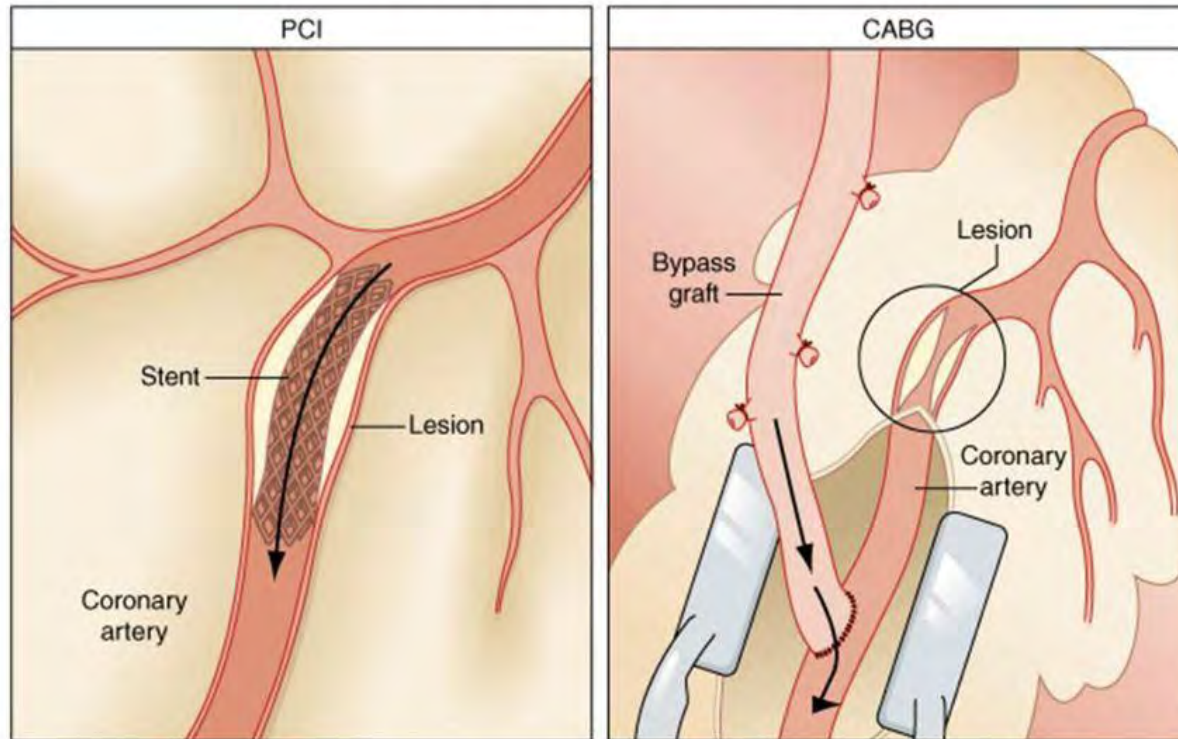
Historical Advantage of CABG over PCI



Coronary Revascularization Trends (United States)



PCI vs CABG



Stent addresses the existing lesion but not future lesions.

Bypass grafting addresses the existing lesion and also future culprit lesions.

PCI overtakes CABG

Improved techniques
All-arterial graft
Off-pump

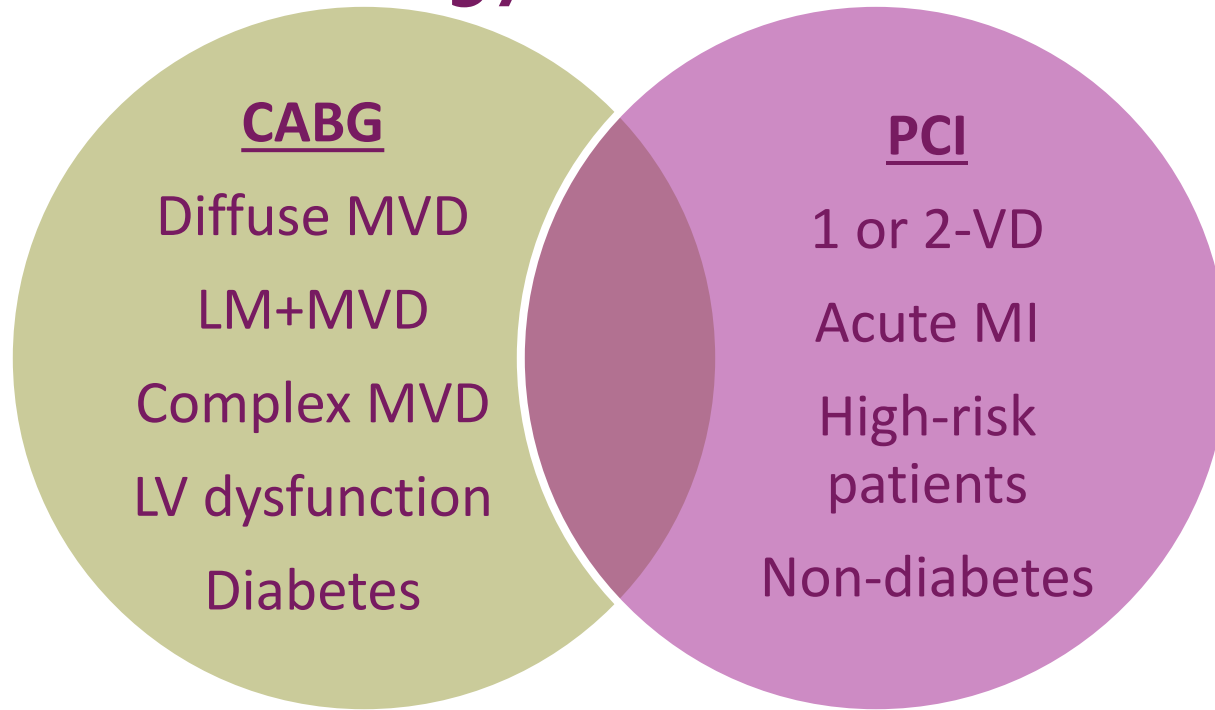
CABG

Drug-eluting stents
Improved techniques
Widely available
Lower risk

PCI

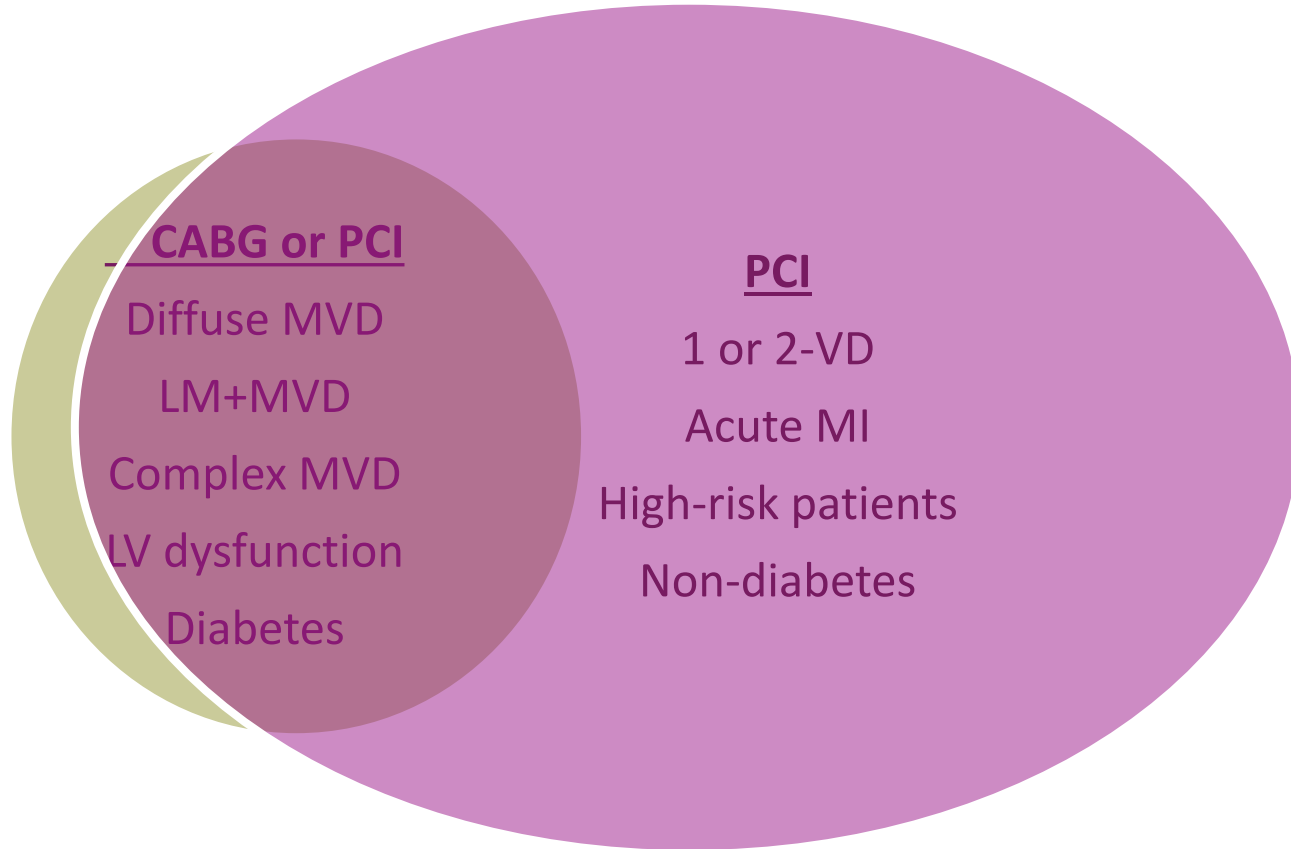
Distinct Indications for CABG and PCI

1970's-2000



A Blurring of the Indications Between CABG & PCI

2000's to Present



PCI vs. CABG in the Pre Drug-Eluting Stent Era

Superior treatment modality

CABG

PCI

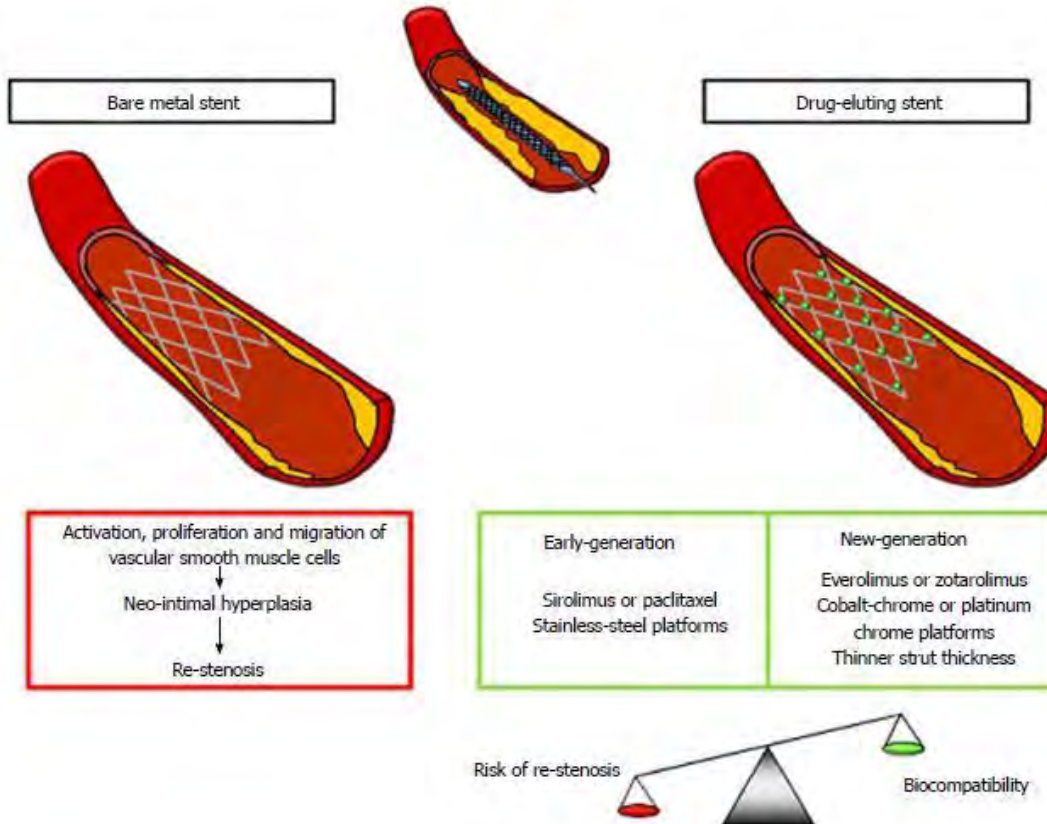
No difference

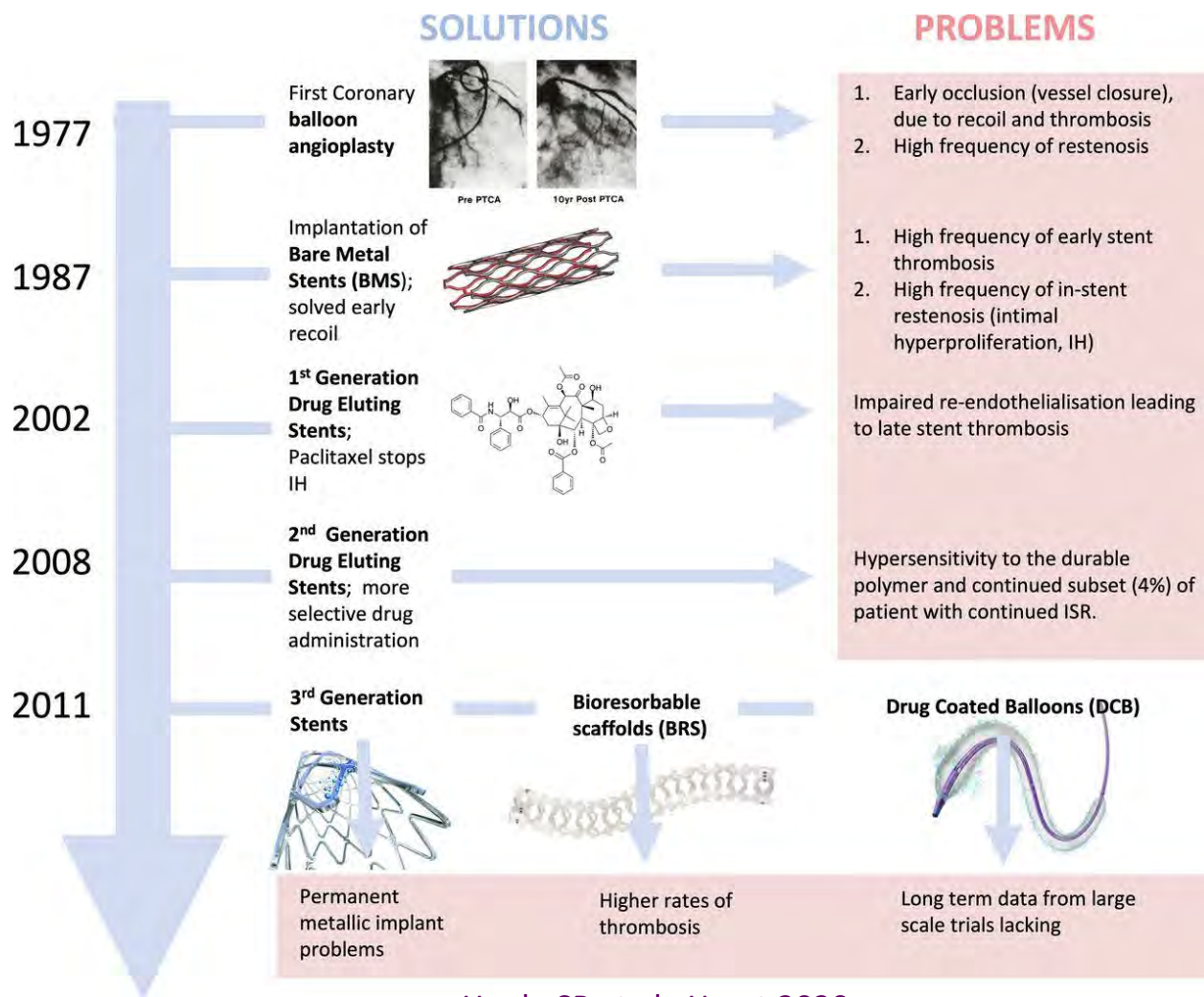
No stents used

BMS stents used

	Mortality & MI	Angina relief	Repeat revascularization	Stroke
GABI	No difference	No difference	CABG	n/a
EAST	No difference	CABG	CABG	No difference
RITA	No difference	CABG	CABG	n/a
ERACI	No difference	CABG	CABG	n/a
CABRI	No difference	CABG	CABG	n/a
BARI	No difference	No difference	CABG	n/a
MASS-II	CABG (MI)	No difference	CABG	No difference
AWESOME	No difference	No difference	CABG	No difference
ERACI-II	PCI	n/a	CABG	n/a
SoS	CABG (mortality)	CABG	CABG	n/a
ARTS-I	No difference	n/a	CABG	No difference

Revolution of Drug-Eluting Stents



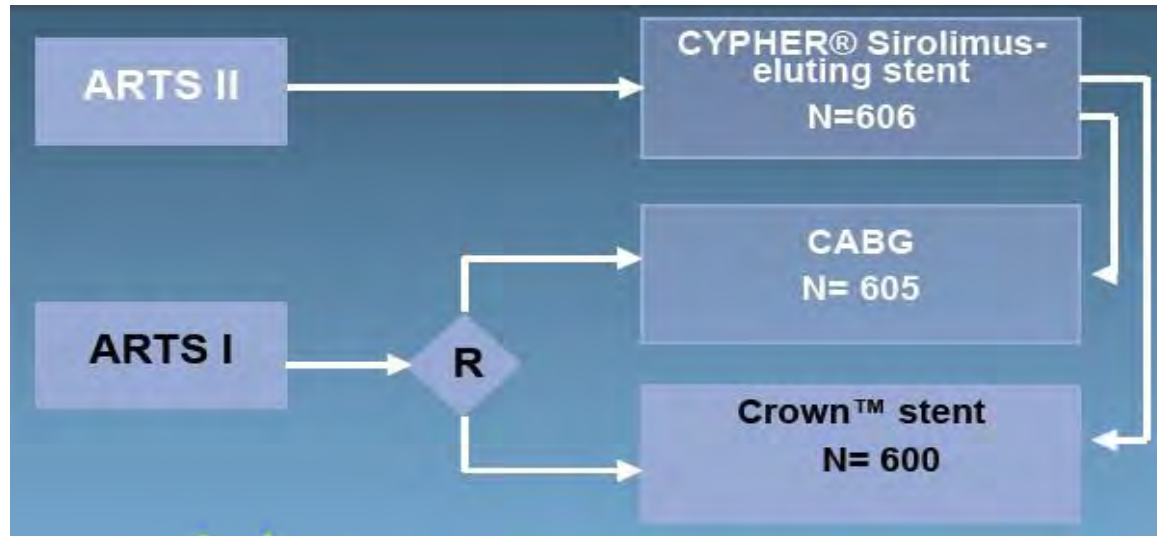


Major DES vs. CABG Trials

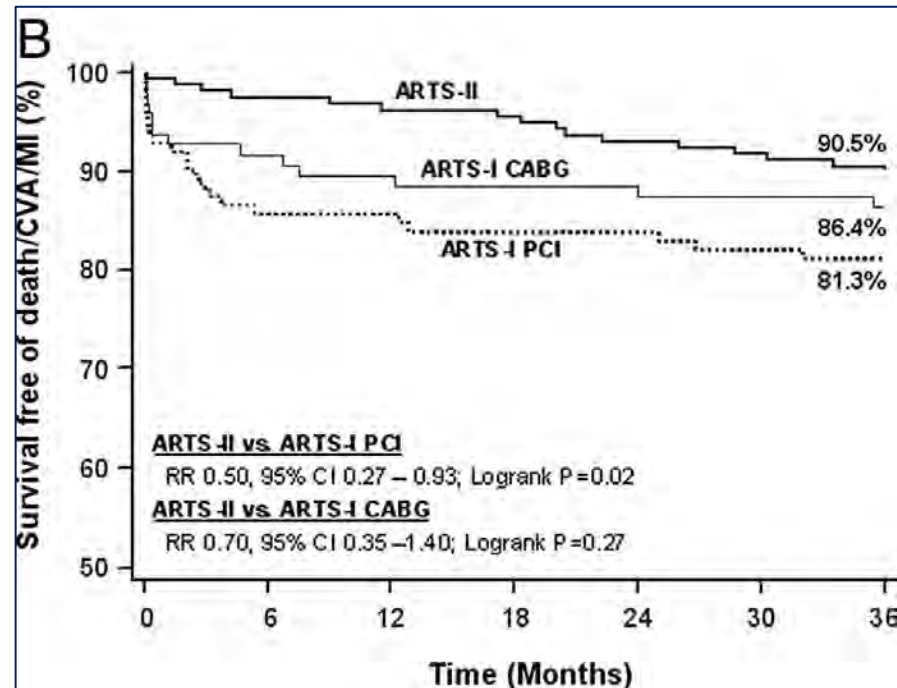
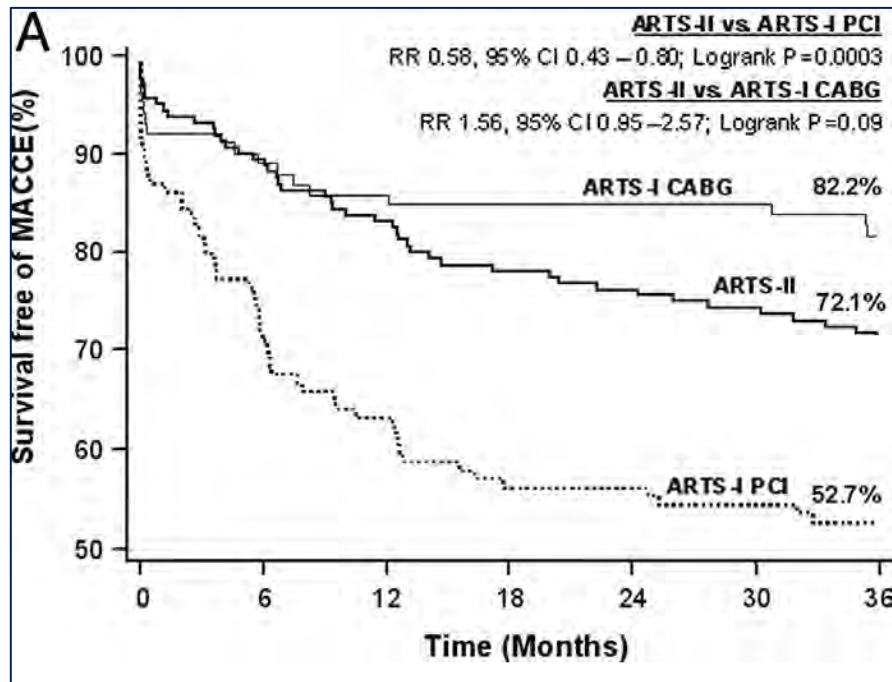
- ARTS II
- SYNTAX
- FREEDOM
- CARDia

ARTS-II Trial

- Arterial Revascularization Therapies Part II
 - Non-randomized comparison of contemporary PCI and CABG in patients with multivessel CAD



ARTS II: 3-Year Results



SYNTAX Trial

The NEW ENGLAND JOURNAL *of* MEDICINE

ESTABLISHED IN 1812

MARCH 5, 2009

VOL. 360 NO. 10

Percutaneous Coronary Intervention versus Coronary-Artery Bypass Grafting for Severe Coronary Artery Disease

Patrick W. Serruys, M.D., Ph.D., Marie-Claude Morice, M.D., A. Pieter Kappetein, M.D., Ph.D.,
Antonio Colombo, M.D., David R. Holmes, M.D., Michael J. Mack, M.D., Elisabeth Stähle, M.D.,
Ted E. Feldman, M.D., Marcel van den Brand, M.D., Eric J. Bass, B.A., Nic Van Dyck, R.N., Katrin Leadley, M.D.,
Keith D. Dawkins, M.D., and Friedrich W. Mohr, M.D., Ph.D., for the SYNTAX Investigators*

SYNTAX Trial Design

SYNTAX)

62 EU Sites + 23 US Sites

Heart Team (surgeon & interventional cardiologist)

Amenable for both
treatment options

Amenable for only one
treatment approach

Stratification:
LM and Diabetes

Randomized Arms
N=1800

Two Registry Arms
N=1275

CABG

n=897

vs

TAXUS*

n=903

CABG

n=1077

PCI

n=198

3VD

n=549
(66.3%)

LM

n=348
(33.7%)

3VD

n=546
(65.4%)

LM

n=357
(34.6%)

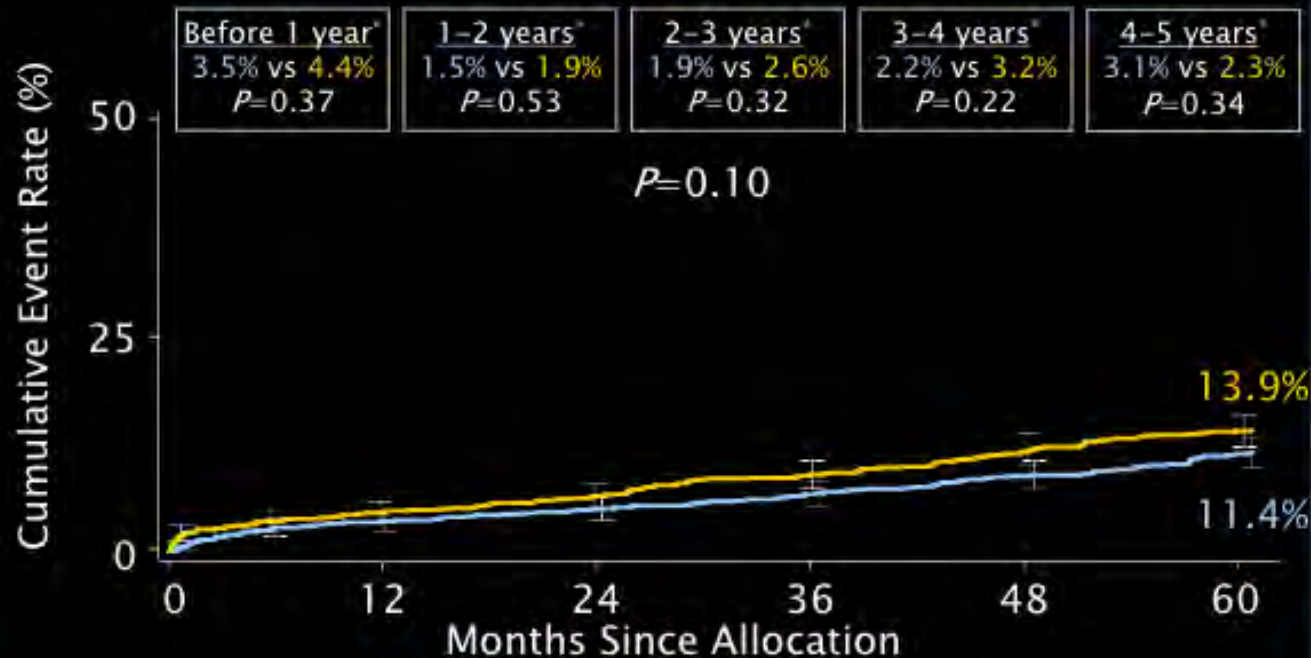
*TAXUS Express

All-Cause Death to 5 Years

SYNTAX)

■ CABG (N=897)

■ TAXUS (N=903)



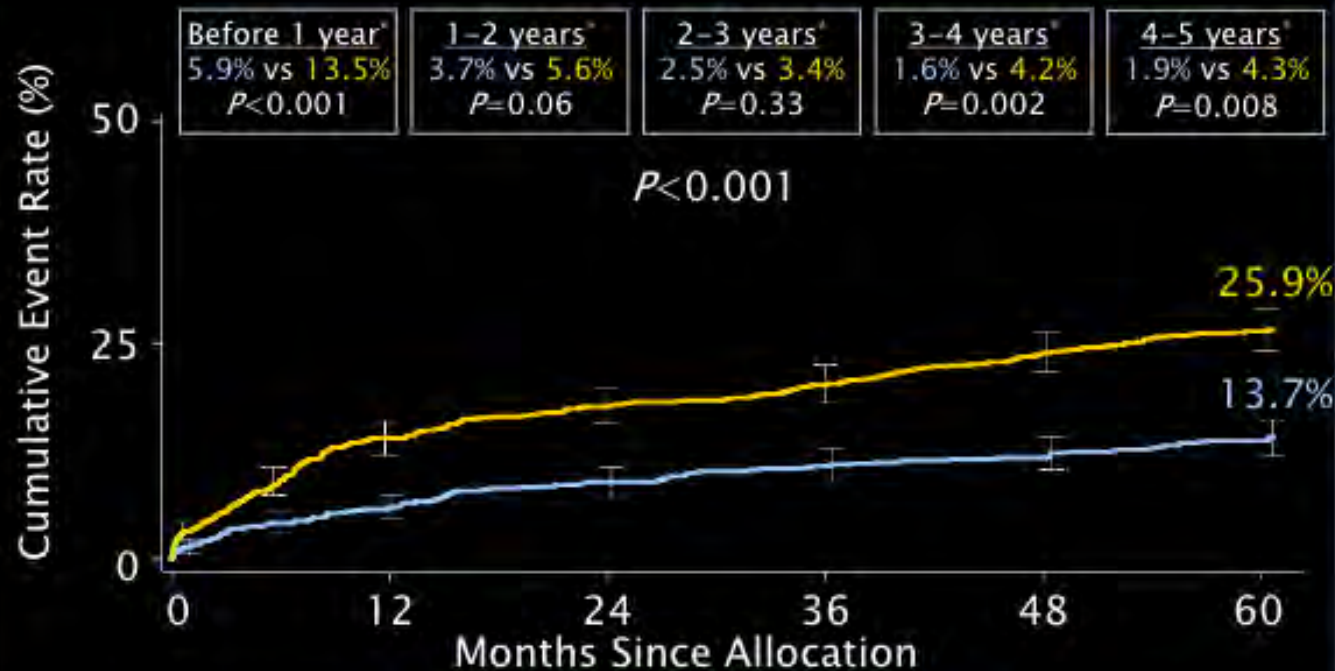
Cumulative KM Event Rate \pm 1.5 SE; log-rank P value; Binary rates

ITT population

Repeat Revascularization to 5 Years SYNTAX)

■ CABG (N=897)

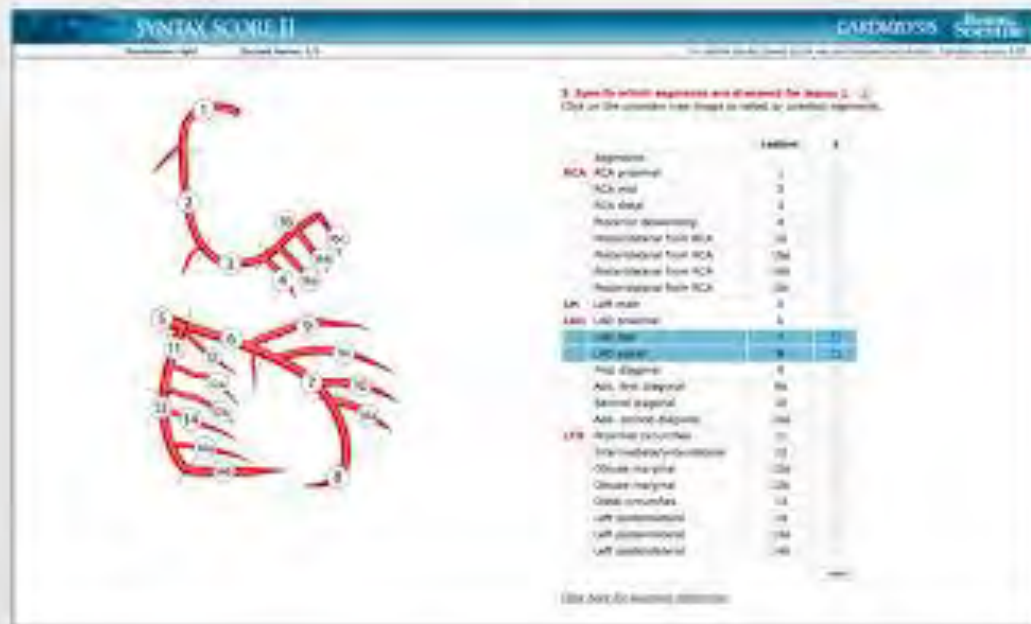
■ TAXUS (N=903)



Cumulative KM Event Rate \pm 1.5 SE; log-rank Pvalue; *Binary rates

ITT population

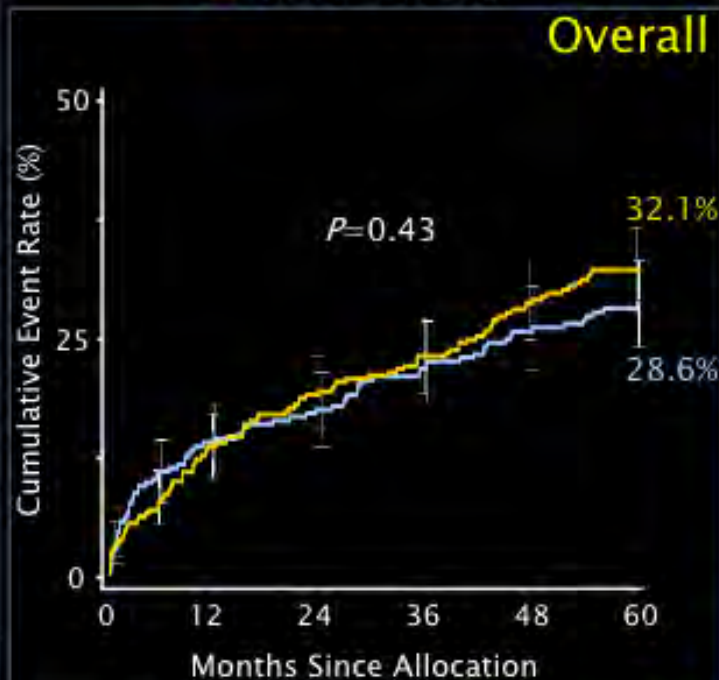
SYNTAX SCORE



MACCE to 5 Years by SYNTAX Score Tercile *Low Scores (0-22)*

SYNTAX)

■ CABG (N=275)
■ TAXUS (N=299)



Cumulative KM Event Rate \pm 1.5 SE; log-rank P value

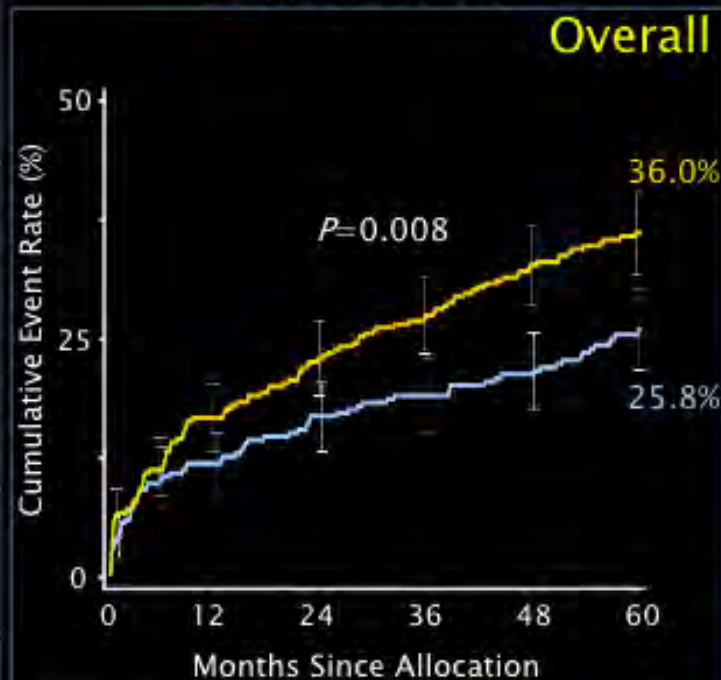
	CABG	PCI	P value
Death	10.1%	8.9%	0.64
CVA	4.0%	1.8%	0.11
MI	4.2%	7.8%	0.11
Death, CVA or MI	14.9%	16.1%	0.81
Revasc.	16.9%	23.0%	0.06

Core lab-reported Data; ITT population

MACCE to 5 Years by SYNTAX Score Tercile *Intermediate Scores (23-32)*

SYNTAX)

■ CABG (N=300)
■ TAXUS (N=310)



Cumulative KM Event Rate \pm 1.5 SE; log-rank P value

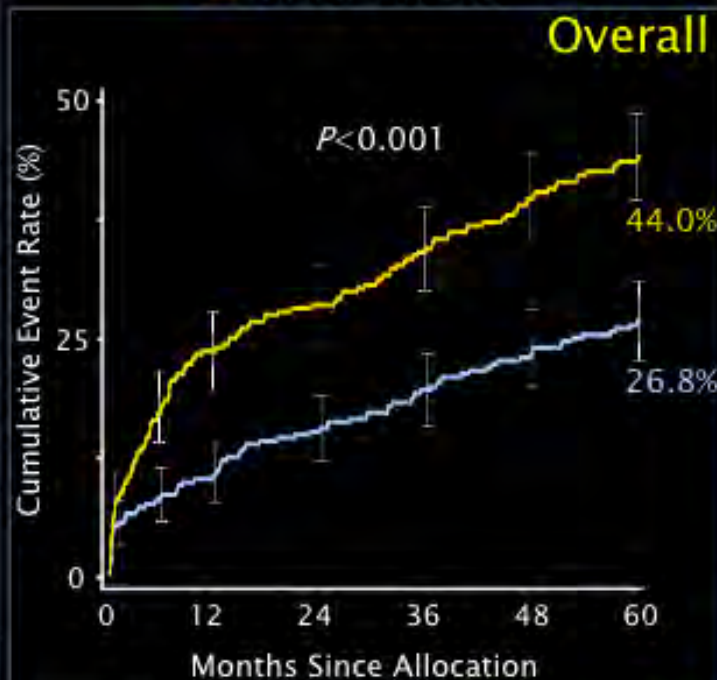
	CABG	PCI	P value
Death	12.7%	13.8%	0.68
CVA	3.6%	2.0%	0.25
MI	3.6%	11.2%	<0.001
Death, CVA or MI	18.0%	20.7%	0.42
Revasc.	12.7%	24.1%	<0.001

Core lab-reported Data; ITT population

MACCE to 5 Years by SYNTAX Score Tercile *High Scores (≥ 33)*

SYNTAX)

■ CABG (N=315)
■ TAXUS (N=290)



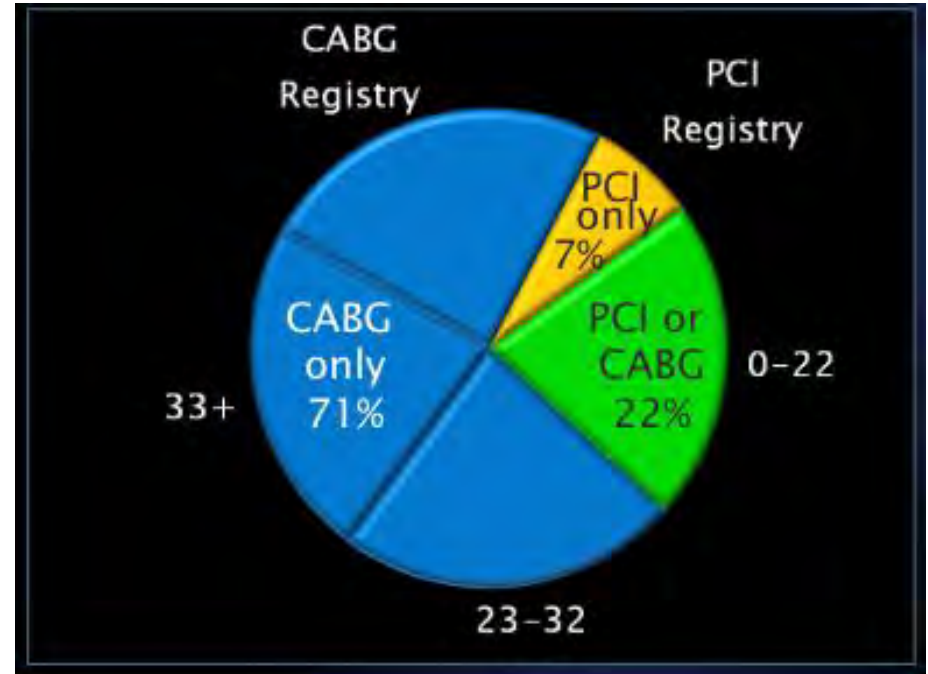
Cumulative KM Event Rate \pm 1.5 SE; log-rank P value

	CABG	PCI	P value
Death	11.4%	19.2%	0.005
CVA	3.7%	3.5%	0.80
MI	3.9%	10.1%	0.004
Death, CVA or MI	17.1%	26.1%	0.007
Revasc.	12.1%	30.9%	<0.001

Core lab-reported Data; ITT population

SYNTAX Trial – 5-Year Summary

- 71% of all patients with MVD are still best treated with CABG



Freedom Trial

The image shows the front cover of The New England Journal of Medicine. The title is in a large, red, serif font. Below the title, the journal's history, date, and volume information are printed in a smaller, black, sans-serif font.

The NEW ENGLAND
JOURNAL *of* MEDICINE

ESTABLISHED IN 1812

DECEMBER 20, 2012

VOL. 367 NO. 25

Strategies for Multivessel Revascularization in Patients
with Diabetes

Freedom Trial Design

Patients with DM and multivesel CAD eligible for PCI or CABG

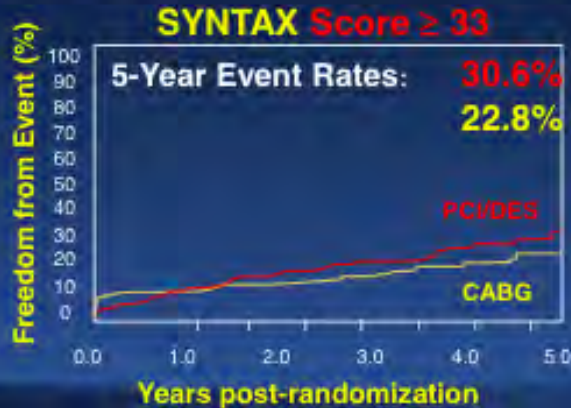
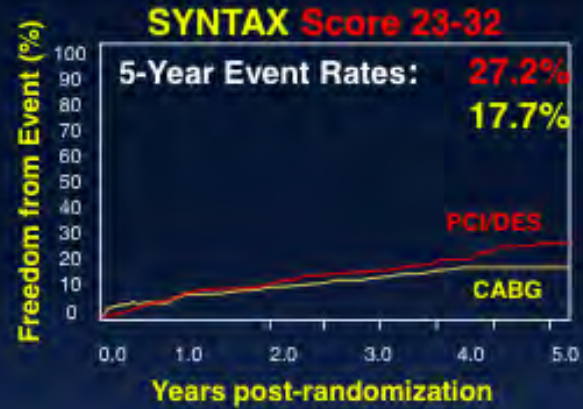
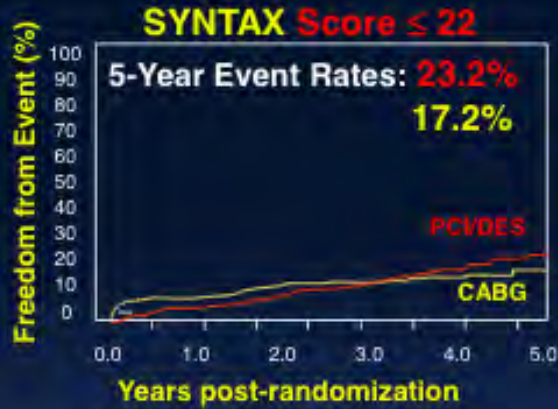
Randomized 1:1

**Contemporary PCI
with DES
N=1200**

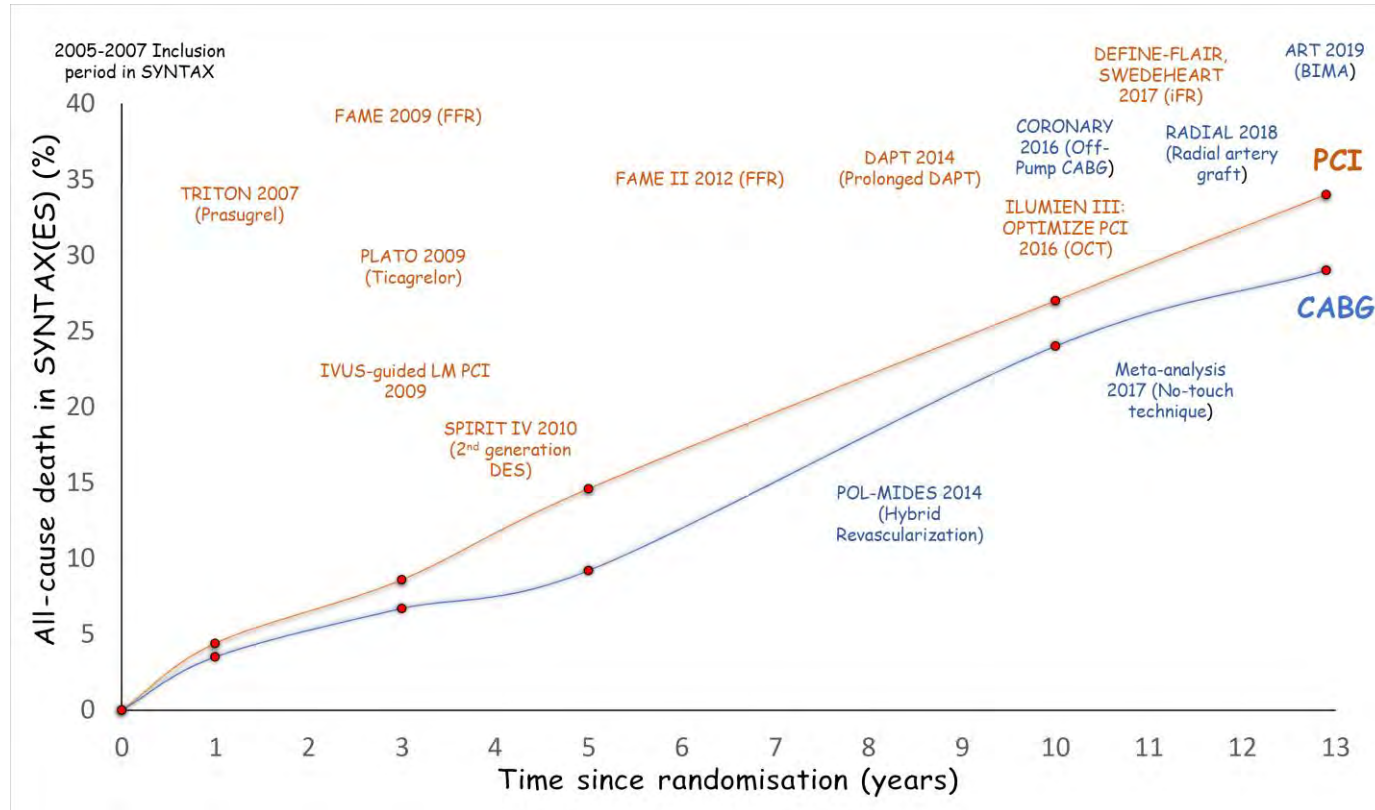
**Contemporary CABG
with or without CPB
N=1200**

*Contemporary background therapy
for CAD and diabetes*

PRIMARY ENDPOINT – DEATH / STROKE / MI
TREATMENT / SYNTAX INTERACTION - $p=0.58$



10-Years After SYNTAX



Beware the Influence of Social Media



PCI vs. CABG in MVD: UPMC Population

Coronary Bypass Versus Percutaneous Revascularization in Multivessel Coronary Artery Disease

Suresh R. Mulukutla, MD, Thomas Gleason, MD, Michael Sharbaugh, MPH, Ibrahim Sultan, MD, Oscar C. Marroquin, MD, Floyd Thoma, BS, Conrad Smith, MD, Catalin Toma, MD, Joon S. Lee, MD, and Arman Kilic, MD

Heart and Vascular Institute, University of Pittsburgh Medical Center, Pittsburgh, Pennsylvania

Background. This study focused on contemporary outcomes after coronary artery bypass graft (CABG) surgery versus percutaneous coronary intervention (PCI) in patients with multivessel coronary artery disease (MVCAD).

Methods. This was a propensity-matched retrospective, observational analysis. Patients with MVCAD who underwent CABG or PCI between 2010 and 2018 and for whom data were available through the National Cardiovascular Data Registry or The Society of Thoracic Surgeons Adult Cardiac Surgery Database were included. The primary outcome was overall survival. Secondary outcomes included freedom from inpatient readmission and freedom from repeat revascularization.

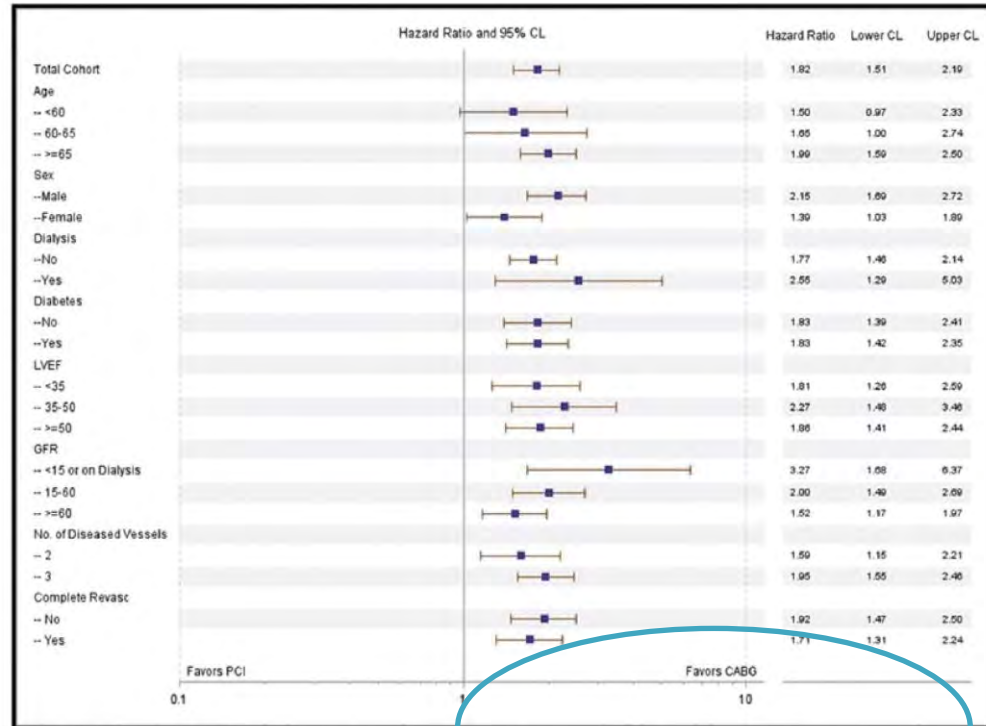
Results. Of the initial 6,163 patients with MVCAD, the propensity-matched cohort included 844 in each group. The estimated 1-year mortality was 11.5% and 7.2% ($p < 0.001$) in the PCI and CABG groups, respectively, with an overall hazard ratio for mortality of PCI versus CABG of 1.64 (95% confidence interval [CI], 1.29 to 2.10;

$p < 0.001$). The overall hazard ratio for readmission for PCI versus CABG was 1.42 (95% CI, 1.23 to 1.64; $p < 0.001$). The overall hazard ratio for repeat revascularization for PCI versus CABG was 4.06 (95% CI, 2.39 to 6.91; $p < 0.001$). Overall major adverse cardiovascular events and individual outcomes of mortality, readmission, and repeat revascularization all favored CABG across virtually all major clinical subgroups.

Conclusions. This contemporary propensity-matched analysis of patients undergoing coronary revascularization for MVCAD demonstrates a significant mortality benefit with CABG over PCI, and this benefit is consistent across virtually all major patient subgroups. Future studies are needed reflecting routine practice to assess how best to approach shared decision making and informed consent when it comes to revascularization decisions in any patient with MVCAD.

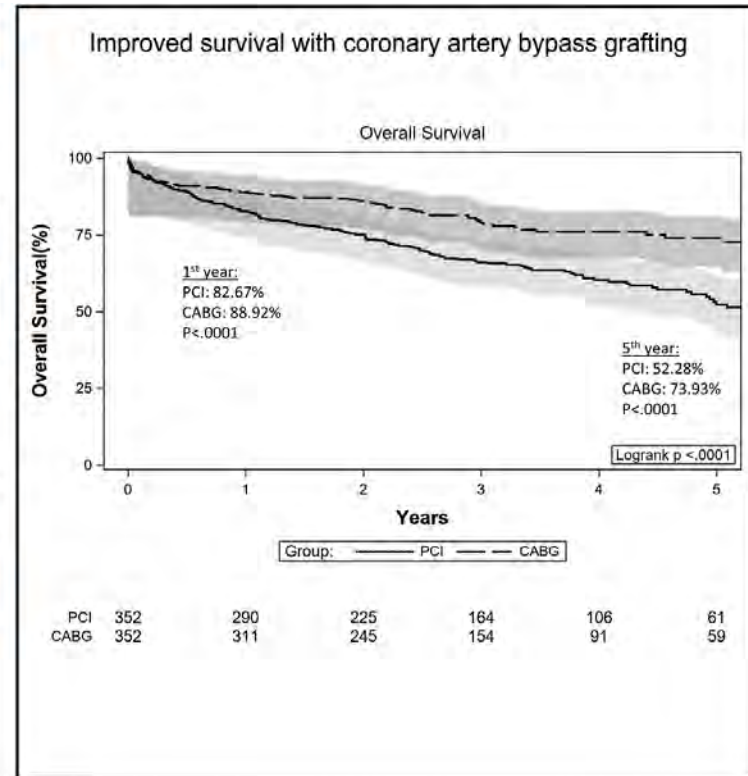
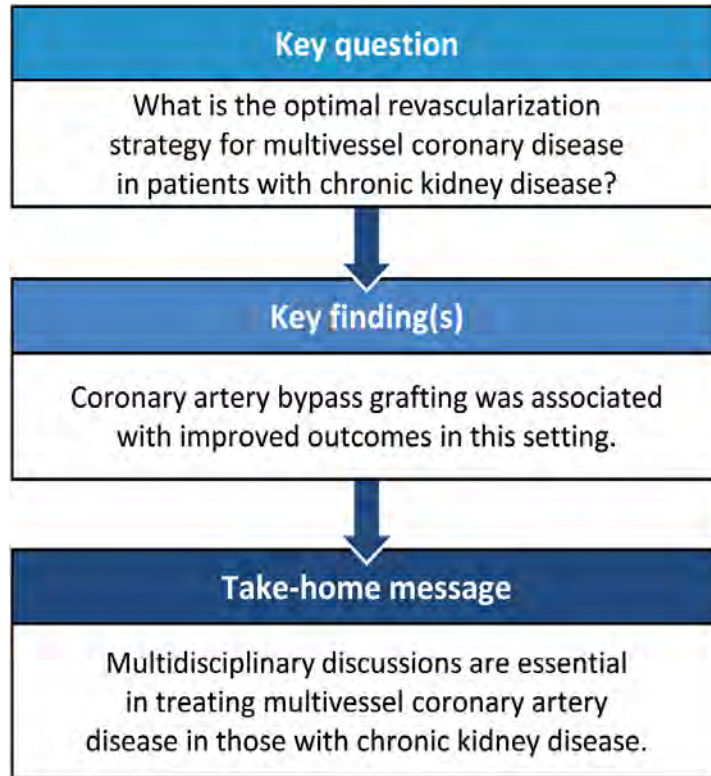
(Ann Thorac Surg 2019; ■■■■)

© 2019 by The Society of Thoracic Surgeons

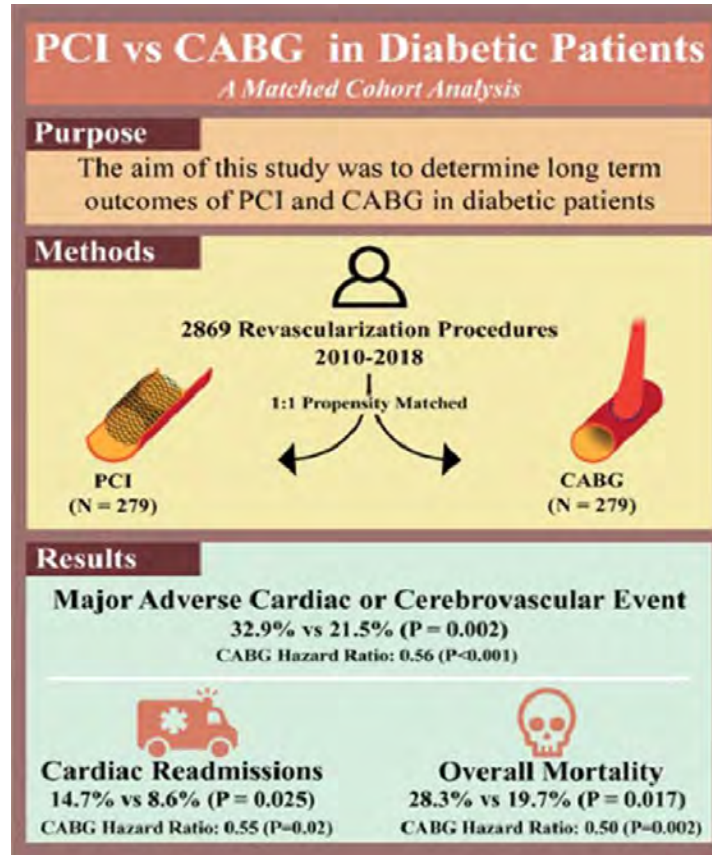


CABG FAVORED

PCI vs. CABG in MVD with CKD: UPMC Population



PCI vs. CABG in MVD with DM: UPMC Population



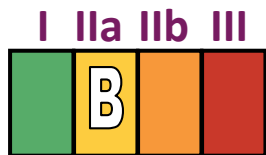
AUC in Multivessel CAD

	CABG	PCI
Two-vessel CAD with proximal LAD stenosis	A	A
Three-vessel CAD with low CAD burden (i.e., three focal stenosis, low SYNTAX score)	A	A
Three-vessel CAD with intermediate to high CAD burden (i.e., multiple diffuse lesions, presence of CTO, or high SYNTAX score)	A	U
Isolated left main stenosis	A	U
Left main stenosis and additional CAD with low CAD burden (i.e., one to two vessel additional involvement, low SYNTAX score)	A	U
Left main stenosis and additional CAD with intermediate to high CAD burden (i.e., three vessel involvement, presence of CTO, or high SYNTAX score)	A	I

Heart Team Approach to Revascularization Decisions



A Heart Team approach to revascularization is recommended in patients with unprotected left main or complex CAD.



Calculation of the STS and SYNTAX scores is reasonable in patients with unprotected left main and complex CAD.

Levine GN et al. J Am Coll Cardiol 2011.

Real World Decision Making Regarding Revascularization Strategies

Table 1. ACC/AHA Indications vs Catheterization Laboratory Recommendations, New York, January 1, 2005–December 31, 2007: Indications for ACC/AHA Class I and Class IIa Regarded as Equal

ACC/AHA Indication/Cath Lab Recommendation	CABG, n (%)	PCI, n (%)	Medical Treatment, n (%)	None, n (%)	Total, n (%)
CABG	712 (53)	455 (34)	156 (12)	14 (1)	1337 (100)
PCI	124 (2)	5660 (94)	255 (4)	12 (<1)	6051 (100)
CABG and PCI	84 (5)	1608 (93)	26 (2)	4 (<1)	1722 (100)
Neither CABG or PCI	70 (6)	261 (21)	873 (71)	19 (2)	1223 (100)
Total	990 (10)	7984 (77)	1310 (13)	49 (<1)	10 333 (100)

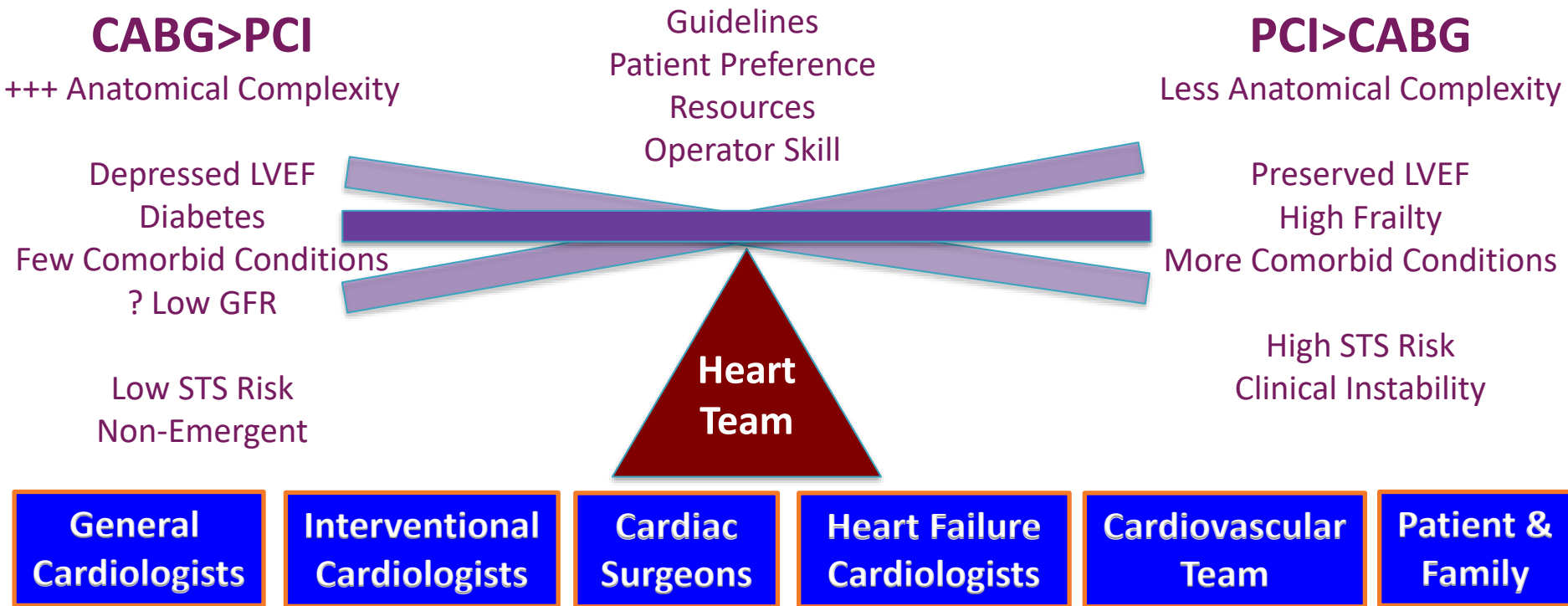
Cath Lab indicates catheterization laboratory.

Hannan et al. Circulation. 2010.

Revascularization Risk Scores

- SYNTAX score
- Clinical SYNTAX score
- Functional SYNTAX score
- EuroSCORE I
- EuroSCORE II
- ACEF
- Mayo clinic risk score
- Global risk
- STS
- New Risk Classification Score (NERS)

Complex Interactions Involved in Decision-Making



Adapted from
Serruys PW, Farooq V. JACC 2017.

Innovations in Care

Practical Implementation of the Coronary Revascularization Heart Team

Carlos E. Sanchez, MD; Vinay Badhwar, MD; Anthony Dota, MD; John Schindler, MD;
Danny Chu, MD; Anson J. Conrad Smith, MD; Joon S. Lee, MD; Sameer Khandhar, MD;
Catalin Toma, MD; Oscar C. Marroquin, MD; Mark Schmidhofer, MD; Jay Bhama, MD;
Lawrence Wei, MD; Sun Scolieri, MD; Stephen Esper, MD; Ashley Lee, MD;
Suresh R. Mulukutla, MD

It's Not Just About Revascularization Strategy

Hemodynamic
Support

Complete
Revascularization?

Concomitant
Valvular Dz?

Staged PCI

Viability or
Other Imaging?

Patient Goals &
Palliative Care

AUC and the (Future) of Reimbursement

Appropriate Use Criteria Update

Assessing the appropriate use of PCI in your practice.

BY STEVEN P. MARSO, MD

Percutaneous coronary intervention (PCI) is a mature medical procedure with established safety, efficacy, and procedural techniques. Moreover, there is a large body of evidence to support its use and nonuse. As such, public reporting, quality assessment, and appropriateness measurements are now commonplace for interventional cardiology practices. National efforts are underway to expand these quality assessment programs to include PCI-specific performance measures. There is no doubt that these national initiatives are here to stay. Quality assessment champions and early physician adopters will not only propel our specialty forward, but will also gain a competitive advantage over time. Medical practices and physicians that align themselves with the mission of their health system and these national priorities will be the health care leaders of the future. Although there are a number of terrific quality improvement initiatives to focus on in the coming year, perhaps there is none better than to codify your individual and institutional appropriate use criteria (AUC) for PCI.

Appropriate utilization of PCI is deservedly a national health care policy priority for the United States. PCI is a high-impact clinical procedure; it relieves angina, is life saving, and reduces reinfarction in patients with acute coronary syndromes (ACS). PCI is the most commonly performed coronary revascularization procedure in the United States (approximately 600,000 each year) at a per-procedural cost of approximately \$12,000 per patient. It also accounts for a substantial portion of Medicare payments to hospitals; the only other medical procedure that accounts for greater reimbursement would be total hip and knee replacements.

Physician variability is commonplace and associated with increased cost. Variability has been documented in a number of diverse medical situations, including antibiotic use, diagnostic testing, adherence to guidelines-based

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recommendations, and coronary revascularization. Many investigators have also documented substantial variability in the performance of PCI in the United States. PCI rates range from five to 42 procedures per 1,000 Medicare beneficiaries.¹ It is often argued that this variability far exceeds that which would be expected to be associated with patient preferences, regional differences in clinical comorbidities, and the clinical setting. Rather, this magnitude of variability is thought to be more likely related to physician preference and habits. Moreover, the high use of PCI is not easily associated with improved outcomes or quality.

The coronary revascularization AUC² have broad implications for both health care providers and our patients. These AUC will be used as the basis for indications, referral patterns, treatment options, physician education, shared decision making, and reimbursement for years to come. Although the AUC are not publicly reported, there will likely continue to be an increased push for transparency within institutions regarding the appropriate utilization of these procedures.

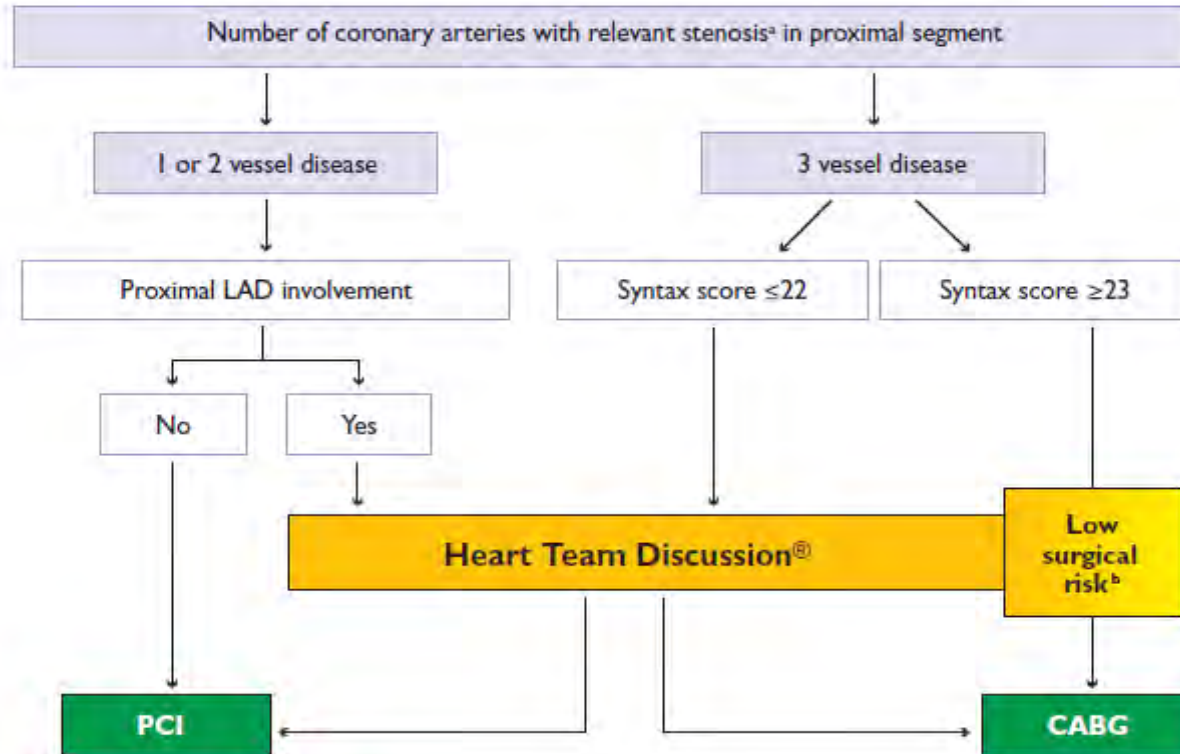
INCORPORATING AUC INTO CLINICAL PRACTICE

With a concerted effort in understanding the AUC, planning, and leveraging existing toolkits, incorporating AUC into your clinical practice need not be time consuming or cost prohibitive. Keep it simple!

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Marso SP. Cardiac Interv Today 2014.

A General Approach to Objective Decision Making



CABG vs. PCI vs. Medical Rx

Some Debates Never Seem to End...



Thank you for your attention!