

# TCTAP 2017

## Seoul

### Newer CABG Trials: INSIGHTS From ART and CORONARY

David P Taggart MD PhD FRCS  
Professor of Cardiovascular Surgery  
University of Oxford



**(i)Clinical:** Cardiac Surgeon

**(ii)Academic:** PI or Co-PI of Several CABG trials, ESC/EACTS Guideline Writer

**(iii)Commercial:** Advisor to VGS, Medistim, Medtronic, Somahlution, Cardioguard

50 YEARS AGO

# Saphenous Vein Autograft Replacement of Severe Segmental Coronary Artery Occlusion

ATS [Dec 11 1967]

Operative Technique

Rene G. Favaloro, M.D.

First report of **SYSTEMATIC** use of SV grafts for CABG

# 1986: SURVIVAL BENEFIT OF AN ITA GRAFT

## The New England Journal of Medicine

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Volume 314

JANUARY 2, 1986

Number 1

### INFLUENCE OF THE INTERNAL-MAMMARY-ARTERY GRAFT ON 10-YEAR SURVIVAL AND OTHER CARDIAC EVENTS

FLOYD D. LOOP, M.D., BRUCE W. LYTLE, M.D., DELOS M. COSGROVE, M.D., MARLENE GOORMASTIC, M.P.H., GEORGE W. WILLIAMS, PH.D., LEONARD S. COHEN, M.D., CARL G. GILL, M.D., PAUL C. TAYLOR, M.D., WILLIAM L. PROUDFIT, M.D., AND WILLIAM L. PROUDFIT, M.D.

- 10 years after CABG, an IMA to the LAD is associated with:
  - death (x1.6), MI (x1.4), and reoperation (x2)
  - Patency rate = 25% - 50%

### Internal Mammary Artery Grafts: 20-Year Clinical Follow-Up

... MD, FACC, GEORGE E. GREEN, MD, FACC,  
... MD, FACC, JOHN THORNTON, PhD

[JACC 1995; 25; 188-82]

>95% of all CABG patients get single ITA graft  
<10% of CABG in Europe and <5% in USA use BITA !!!  
> 60% in several Asian countries

If it was not for the ITA there would be no CABG today !!!

# 30 YEARS of CABG DEBATE



① Is there a benefit to more than a single ITA graft ?

② Is off-pump CABG (OPCABG) inferior/superior to on-pump CABG ?

ORIGINAL ARTICLE

# Randomized Trial of Bilateral versus Single Internal-Thoracic-Artery Grafts

David P. Taggart, M.D., Ph.D., Douglas G. Altman, D.Sc., Alastair M. Gray, Ph.D.,  
Belinda Lees, Ph.D., Stephen Gerry, M.Sc., Umberto Benedetto, M.D.,  
and Marcus Flather, M.B., B.S., for the ART Investigators\*





## Arterial Revascularization Trial (ART)

- 3102 patients randomized to Single or Bilateral ITA (plus supplemental vein grafts or RA) in 28 centres in 7 countries from June 2004-Dec 2007
- Primary Outcome: All-cause mortality at ten years (Dec 2017)
- Secondary Outcomes: Mortality, MI and stroke at ten years
- Interim Analyses at 1 (EHJ) and 5 years (NEJM)





European Heart Journal  
doi:10.1093/eurheartj/ehq318

EUROPEAN  
SOCIETY OF  
CARDIOLOGY®

**FASTTRACK**  
**ESC HOT LINE**

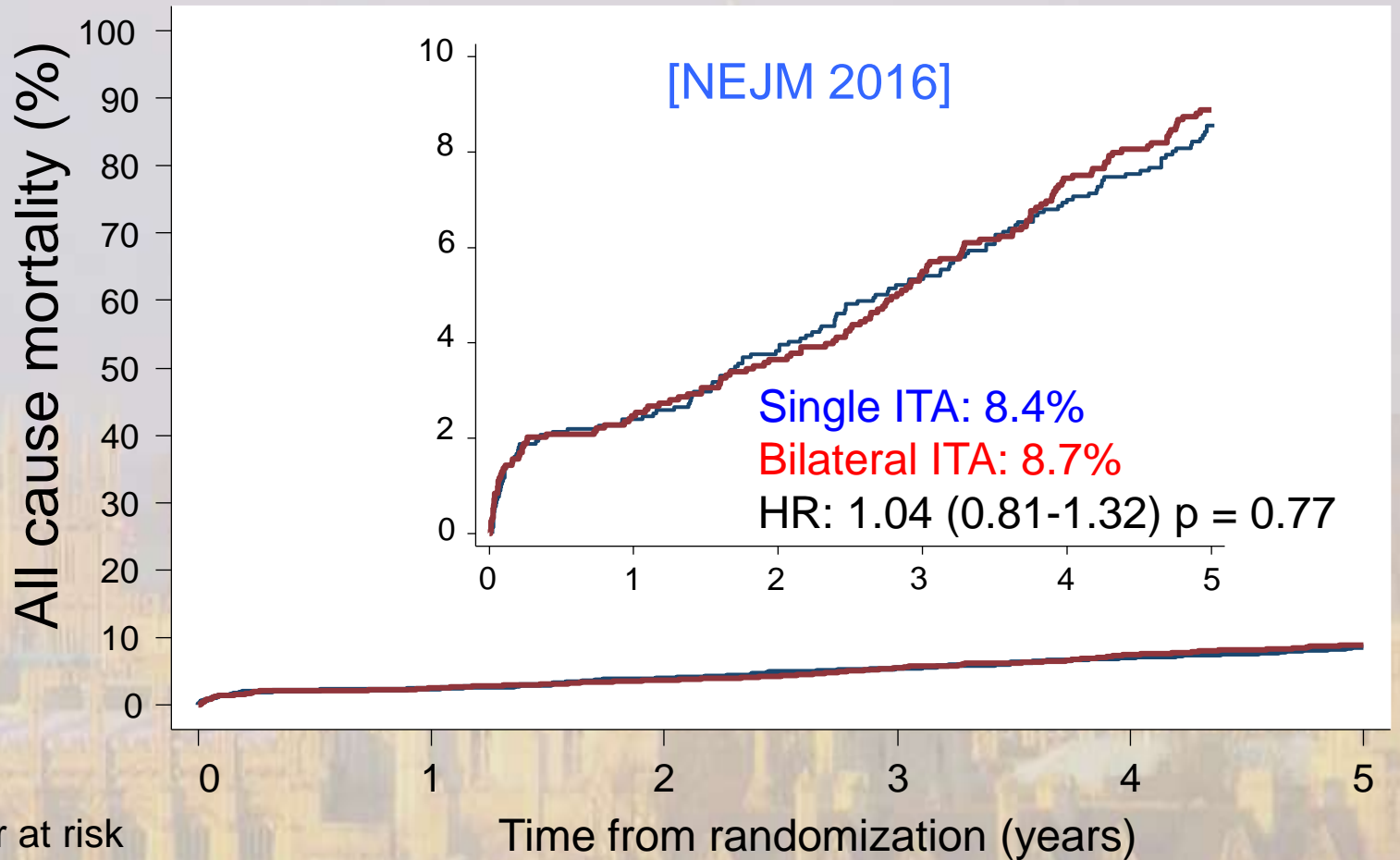
# Randomized trial to compare bilateral vs. single internal mammary coronary artery bypass grafting: 1-year results of the Arterial Revascularisation Trial (ART)

David P. Taggart<sup>1\*</sup>, Douglas G. Altman<sup>2</sup>, Alastair M. Gray<sup>3</sup>, Belinda Lees<sup>4,5</sup>, Fiona Nugara<sup>4</sup>, Ly-Mee Yu<sup>2</sup>, Helen Campbell<sup>3</sup> and Marcus Flather<sup>4,5</sup>, on behalf of the ART Investigators

- ✓ 30 day mortality 1.2%, 1 yr mortality 2.4%
- ✓ 1 year incidence of stroke, MI, repeat revasc all < 2%
- ✗ Sternal wound reconstruction: 0.6% SIMA vs 1.9% BIMA (NNH = 78)

# All Cause Mortality at 5 years (Interim Analyses)

CABG MORTALITY @ 5 YEARS: SYNTAX 9%; NOBLE 9%; BEST 12%; CORONARY 14%



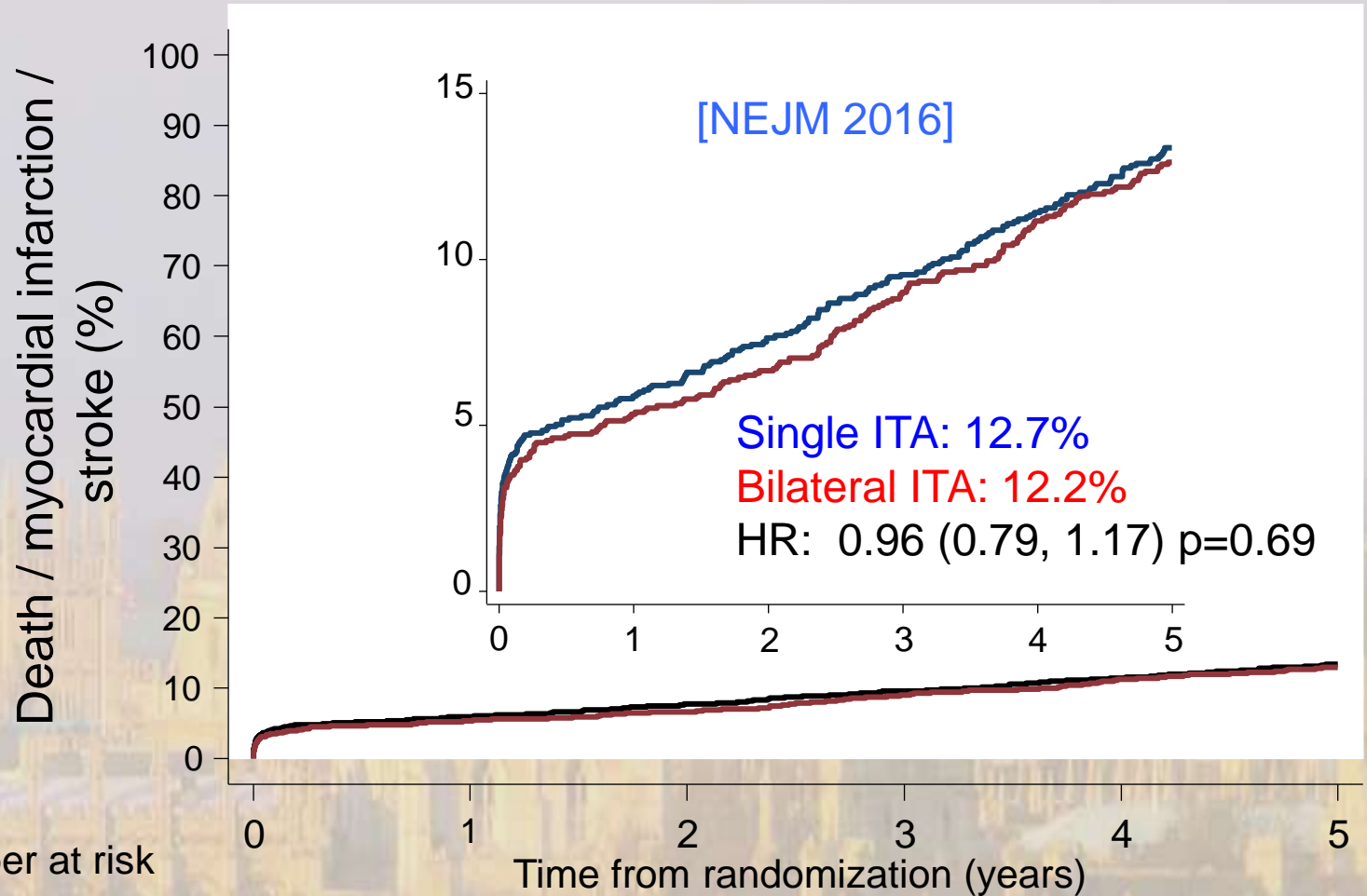
Number at risk

	0	1	2	3	4	5
Single ITA	1554	1502	1467	1435	1389	1332
Bilateral ITA	1548	1496	1468	1425	1370	1321

— Single Graft — Bilateral Graft



# Death, MI, Stroke at 5 years (Interim Analyses)



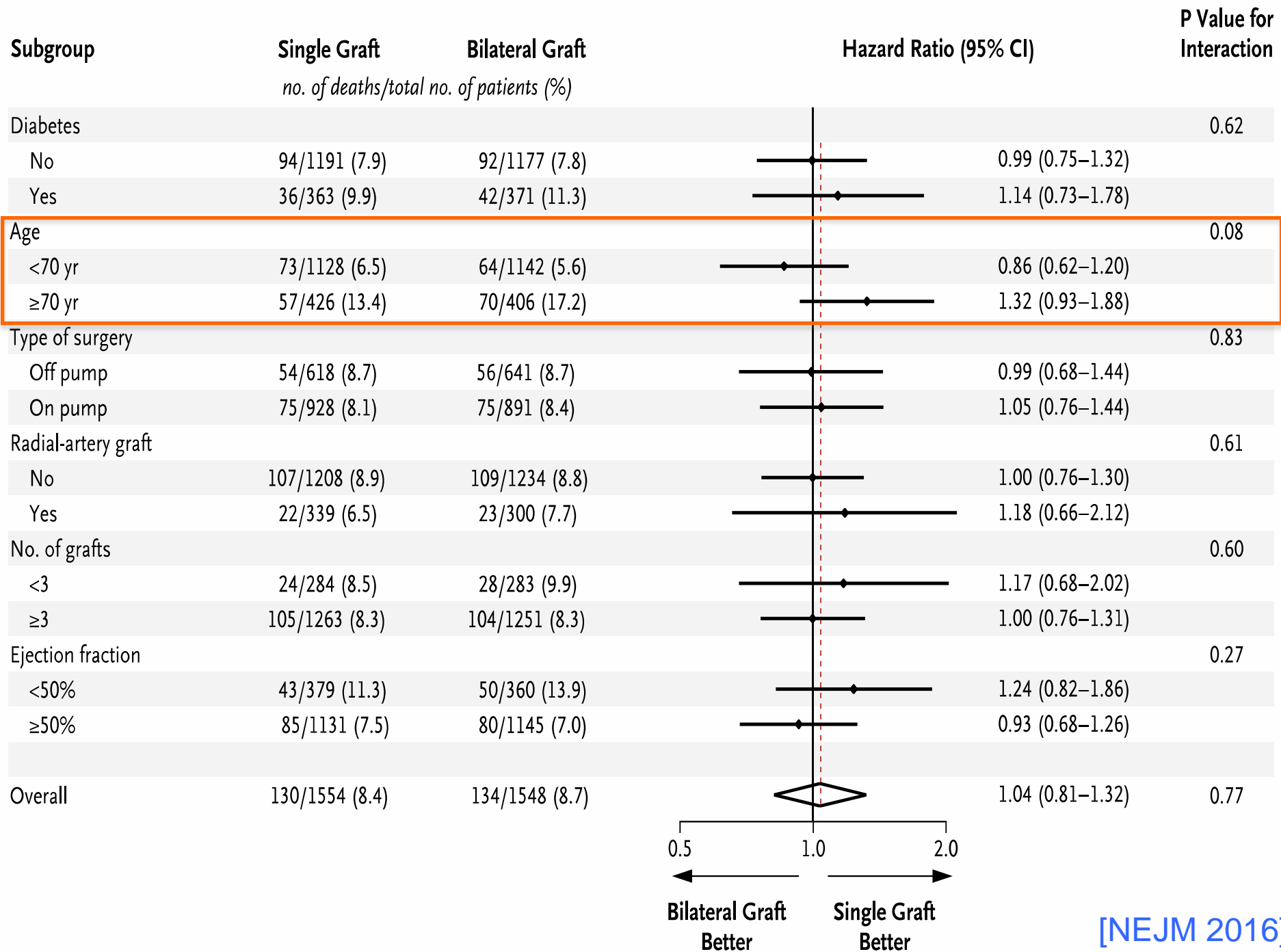
Number at risk

Single ITA

1554      1448      1410      1371      1322      1261

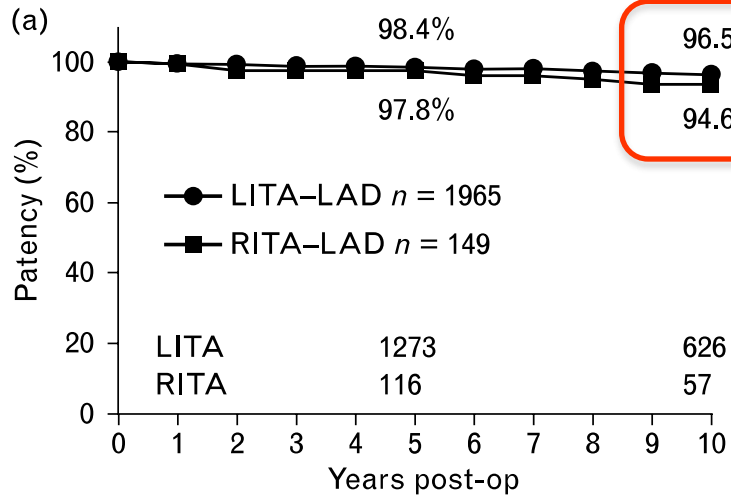
Bilateral ITA

1548      1452      1422      1373      1317      1266

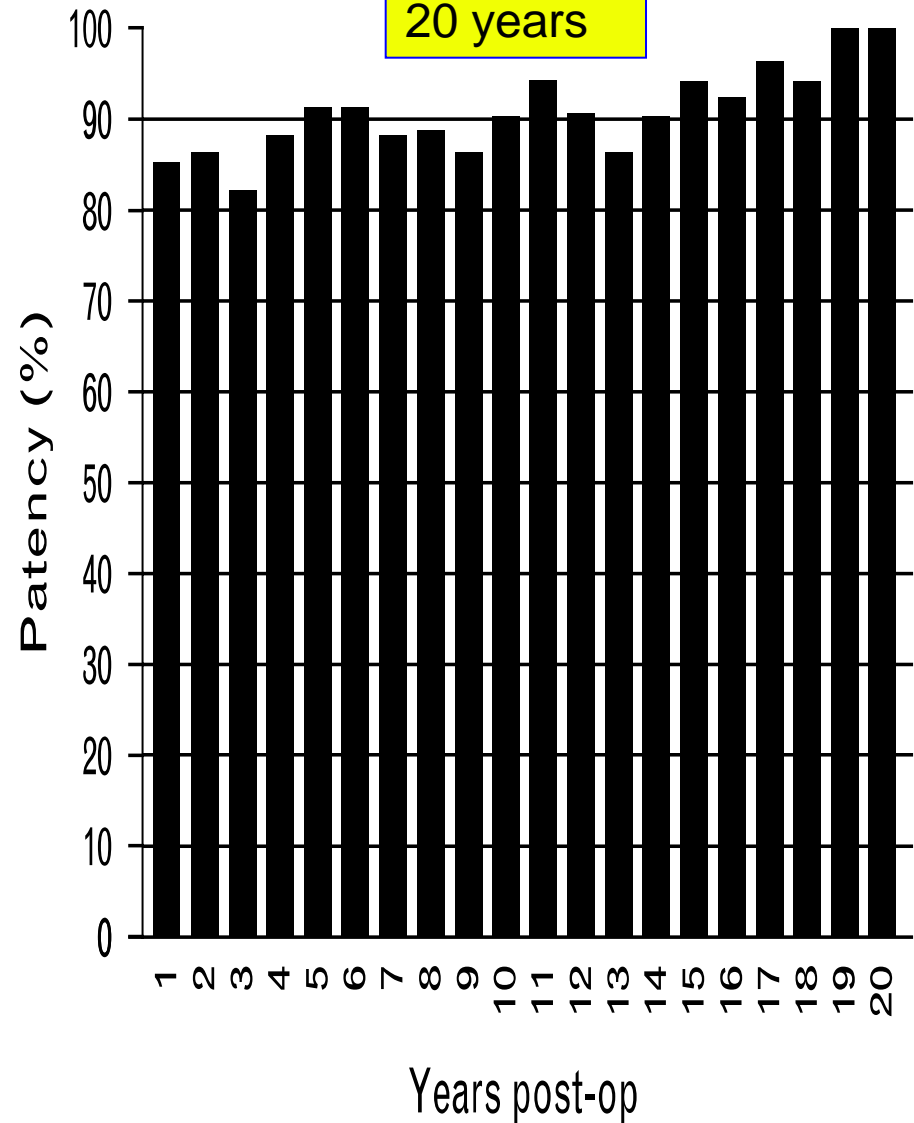
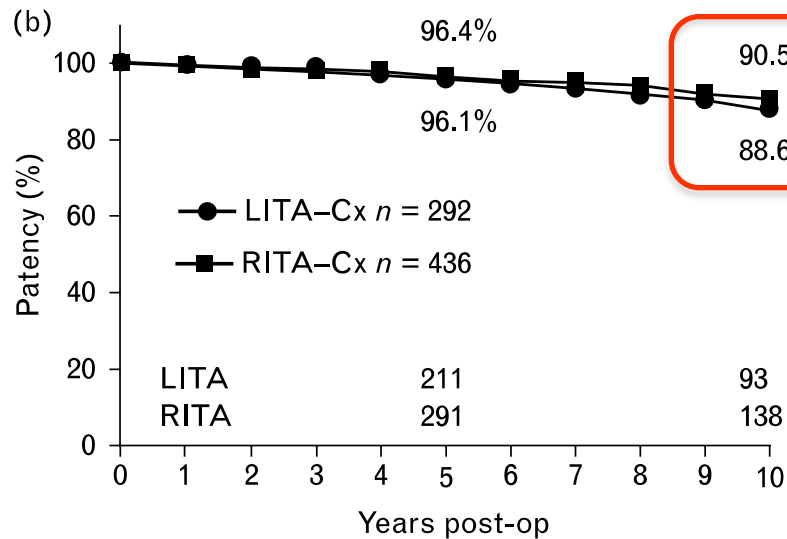


# The right internal thoracic artery: is it underutilized?

James Tatoulis<sup>a,c</sup>, Brian F. Buxton<sup>b,c</sup> and John A. Fuller<sup>b</sup> [2011]



10 years



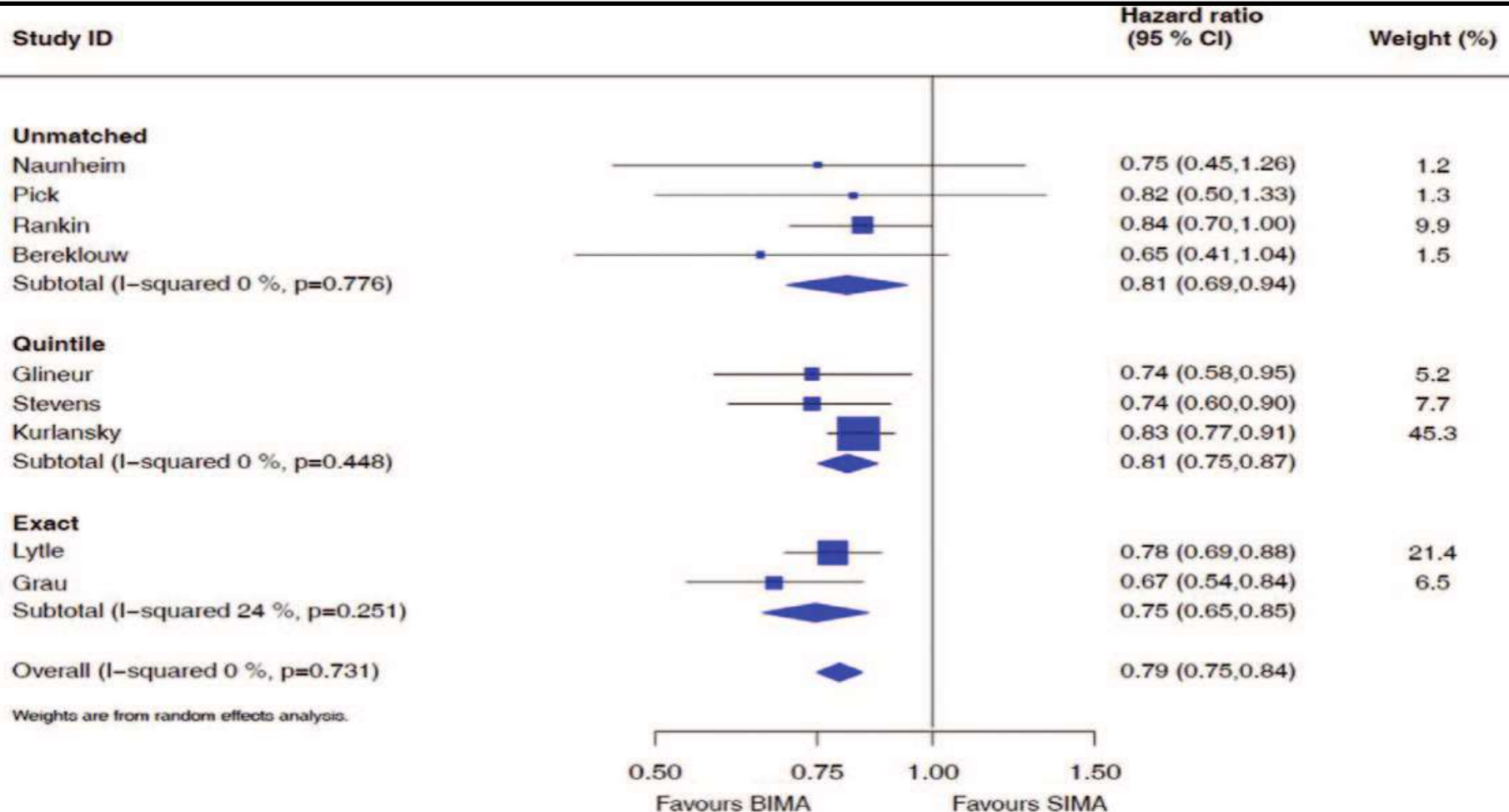
## Effect of Bilateral Internal Mammary Artery on Long-Term Survival

### A Meta-Analysis Approach

[CIRC 2014]

Gijong Yi, PhD; Brian Shine, MD; Syed M. Rehman, MD; Douglas G. Altman, DSc; David P. Taggart, PhD

15,583 patients followed for a mean of >9 years



## Why no difference in ART for BITA vs SITA @ 5 years ?

- ① Too early (interim analyses of 10 year outcome)
- ② Vein graft failure low until 5 years then accelerates
- ③ Very high use of GBMT (slows vein graft failure ?)
- ④ High X-over: 16% of BITA → SITA; 4% SITA → BITA
- ⑤ 20% of SITA and BITA also had Radial Artery
- ⑥ Trend towards better survival < 70 years (p=0.08)



**On PUMP (ONCABG) vs OFF PUMP (OPCABG)**



# On-Pump versus Off-Pump Coronary-Artery Bypass Surgery

[NEJM 2009]

A. Laurie Shroyer, Ph.D., Frederick L. Grover, M.D., Brack Hattler, M.D., Joseph F. Collins, Sc.D., Gerald O. McDonald, M.D., Elizabeth Kozora, Ph.D., John C. Lucke, M.D., Janet H. Baltz, R.N., and Dimitri Novitzky, M.D., Ph.D., for the Veterans Affairs Randomized On/Off Bypass (ROOBY) Study Group

		OFF (1104)	ON (1099)	Delta ON vs OFF	p
30 Day	Composite (Death, Major Complication)	7	5.6	-1.4	0.19
	Death	1.6	1.2	-0.4	0.47
1 Year	Composite	9.9	7.4	-2.5	0.04
	Death	4.1	2.9	-1.2	0.15
	Cardiac Death	2.7	1.3	-1.4	0.03
Graft Patency	Overall	82.6	87.8	5.2	<0.001
	SVG	76.6	83.8	7.2	<0.001
	LIMA	95.3	96.2	0.9	0.48

## Resulted in Numerous Articles by Senior Surgeons to Abandon OPCABG

### FIERCELY CRITICIZED by EXPERIENCED OPCABG SURGEONS:

- Surgeon experience entry level 20 OPCABG patients (median 50)
- 12% X-over from OFF to ON (STS database reported <4%)
- 60% of operations done by trainees (supervised)
- Average entry of 8 patients per year per surgeon

NO 5-YEAR OUTCOMES

# The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812

MARCH 28, 2013

VOL. 368 NO. 13

## Effects of Off-Pump and On-Pump Coronary-Artery Bypass Grafting at 1 Year

André Lamy, M.D., P.J. Devereaux, M.D., Ph.D., Dorairaj Prabhakaran, M.D., David P. Taggart, Ph.D.,

ORIGINAL ARTICLE

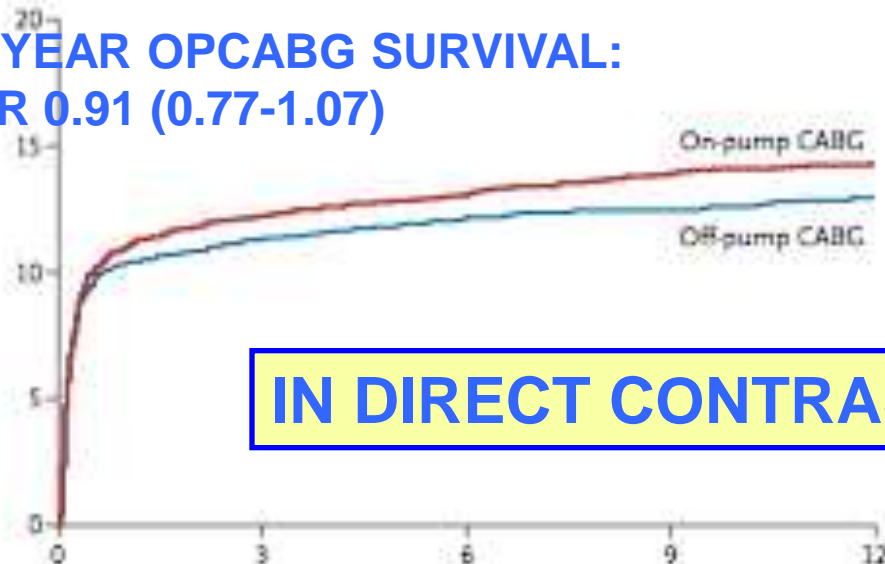
## Off-Pump versus On-Pump Coronary-Artery Bypass Grafting in Elderly Patients

Anno Diegeler, M.D., Ph.D., Jochen Börgermann, M.D., Ph.D.,

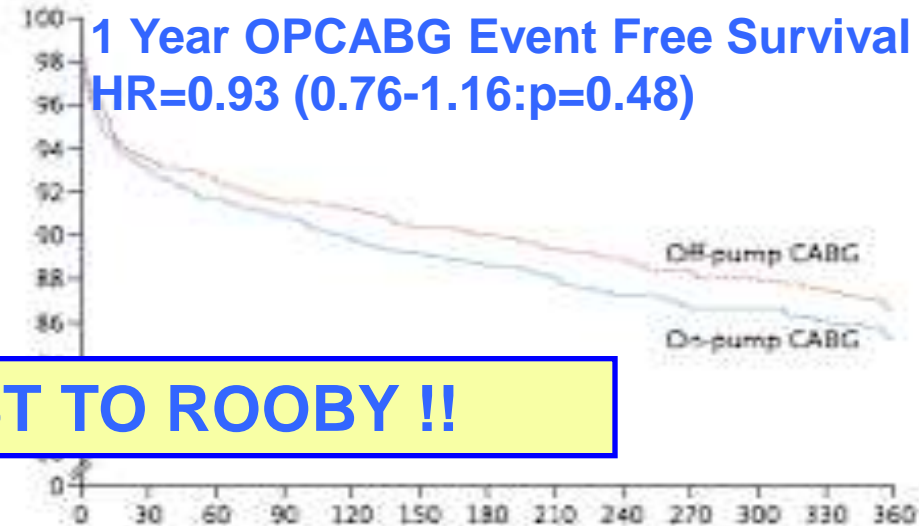
- 4752 patients
- **EXPERIENCE: Surgeon >100 OPCABG**
- (82% of patients Euroscore <5)
- Mean number of grafts 3.0 vs 3.2

- 2539 patients > 75 years
- **EXPERIENCE: 322 OPCAB vs 578 ON**
- Predicted mortality 3.8%
- Mean number of grafts 2.7 vs 2.8

**1 YEAR OPCABG SURVIVAL:  
HR 0.91 (0.77-1.07)**



**1 Year OPCABG Event Free Survival  
HR=0.93 (0.76-1.16:p=0.48)**

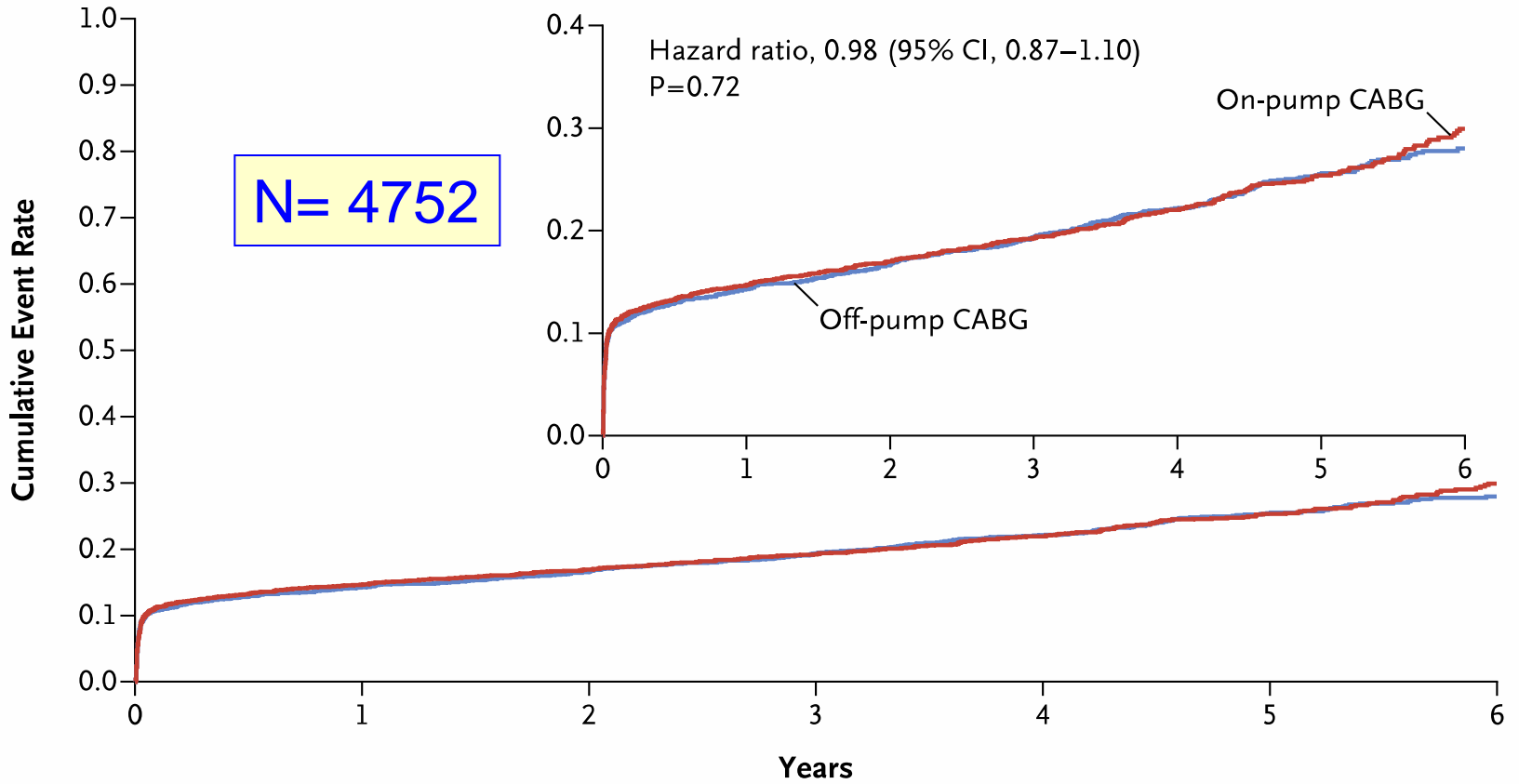


**IN DIRECT CONTRAST TO ROOBY !!**

# Five-Year Outcomes after Off-Pump or On-Pump Coronary-Artery Bypass Grafting

André Lamy, M.D., P.J. Devereaux, M.D., Ph.D., Dorairaj Prabhakaran, M.D.,  
David P. Taggart, Ph.D., Shengshou Hu, M.D., Zbynek Straka, M.D.,

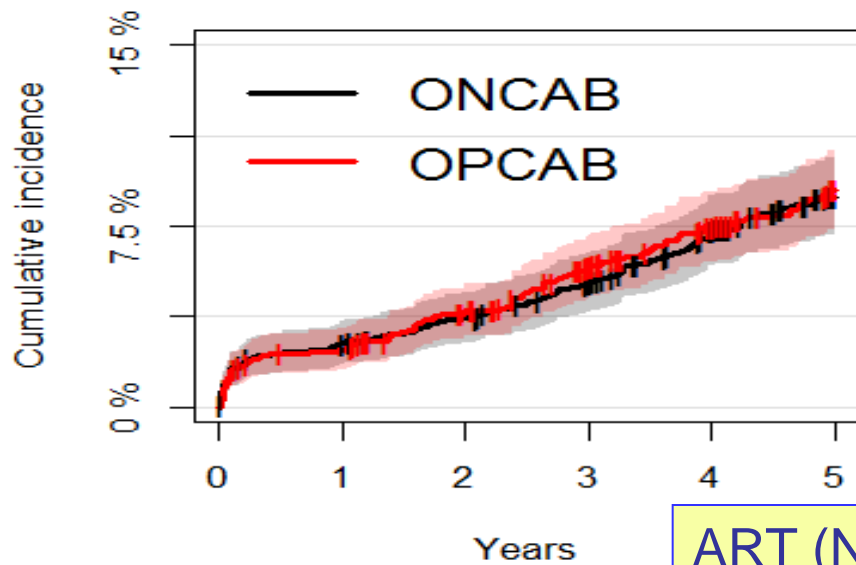
Surgeon Experience > 100 OPCAB



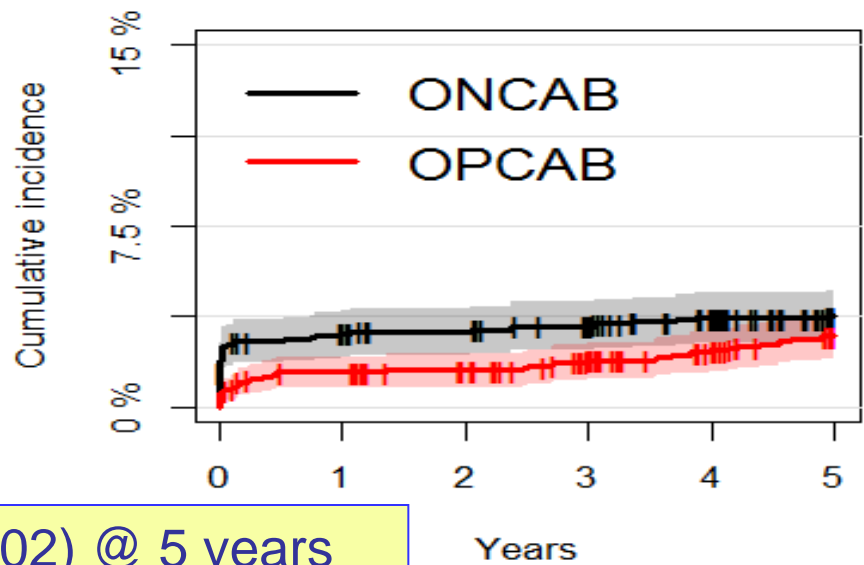
## No. at Risk

On-pump CABG	2377	2048	1989	1937	1746	973	433
Off-pump CABG	2375	2057	1996	1937	1744	969	440

### Mortality

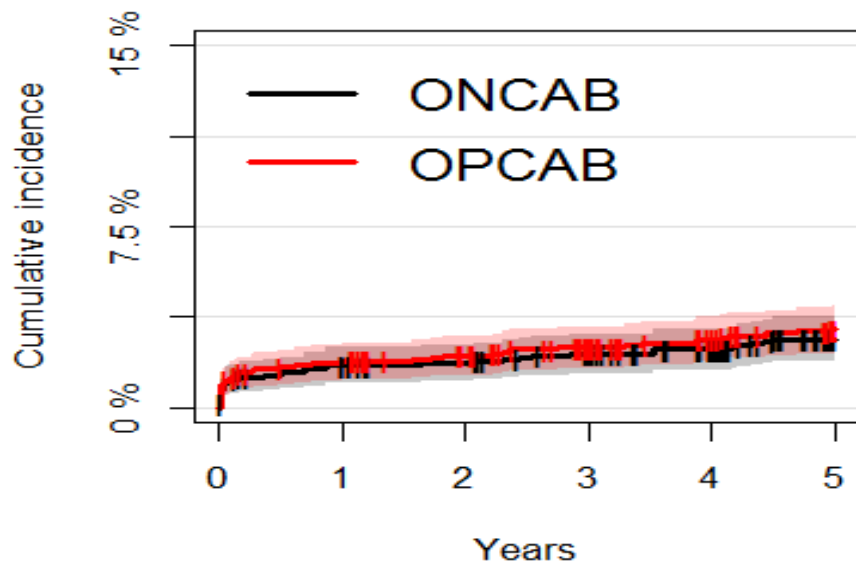


### MI

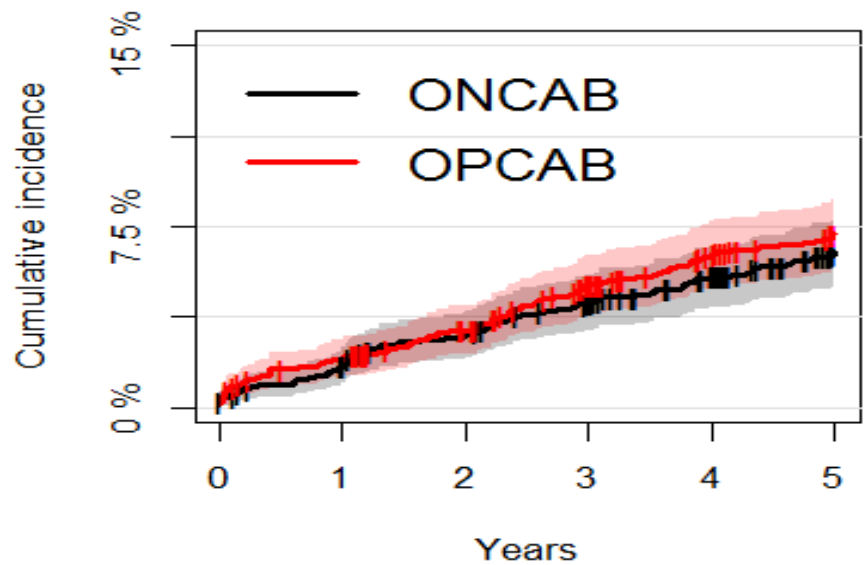


ART (N=3102) @ 5 years  
40% OPCABG

### CVA



### Revascularization





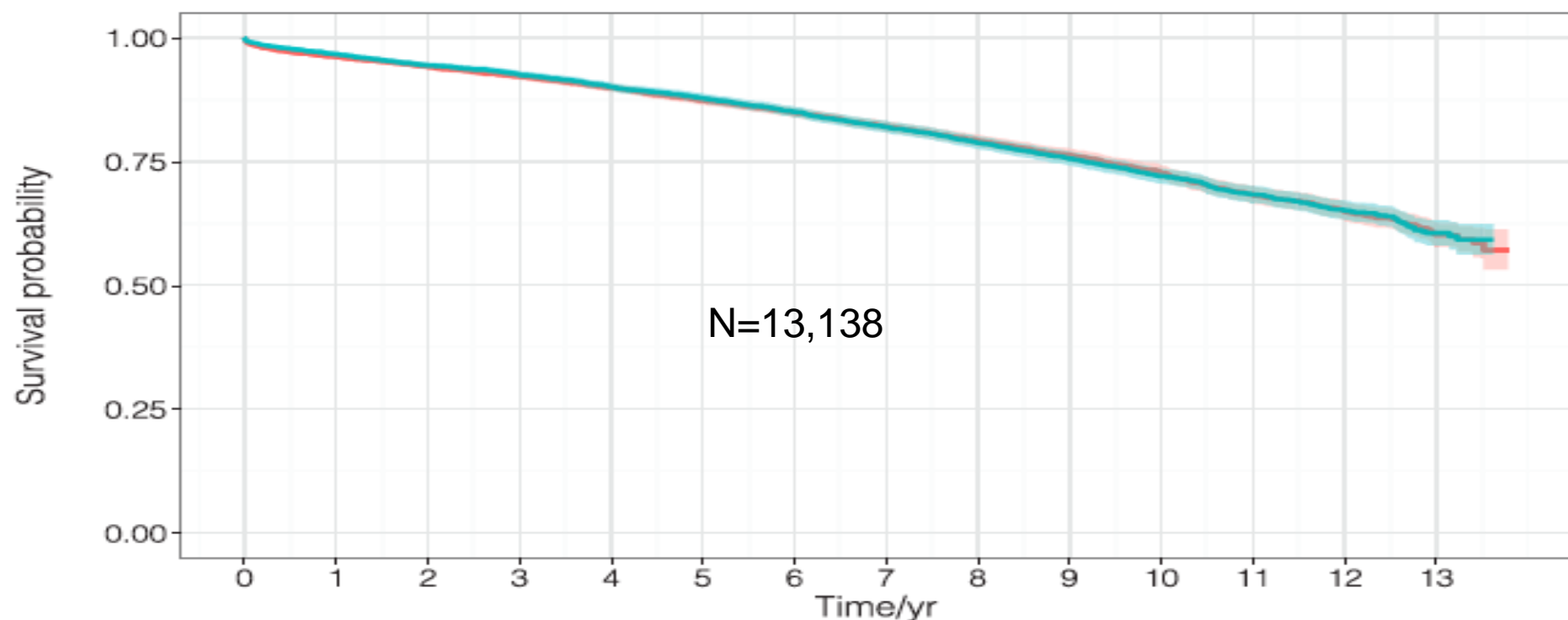
# Long-Term Survival and Freedom From Reintervention After Off-Pump Coronary Artery Bypass Grafting

A Propensity-Matched Study

[CIRC 2016]

Editorial, see p 1221

Bilal H. Kirmani, BSc,



Number at risk

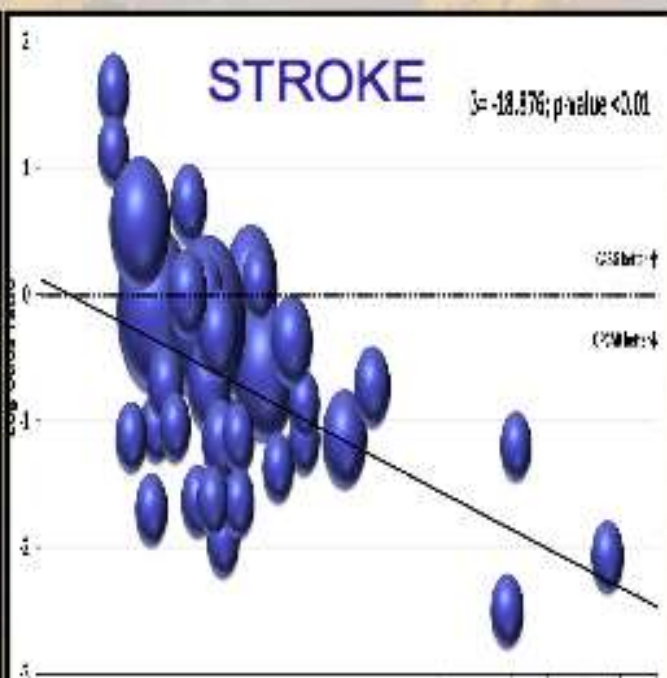
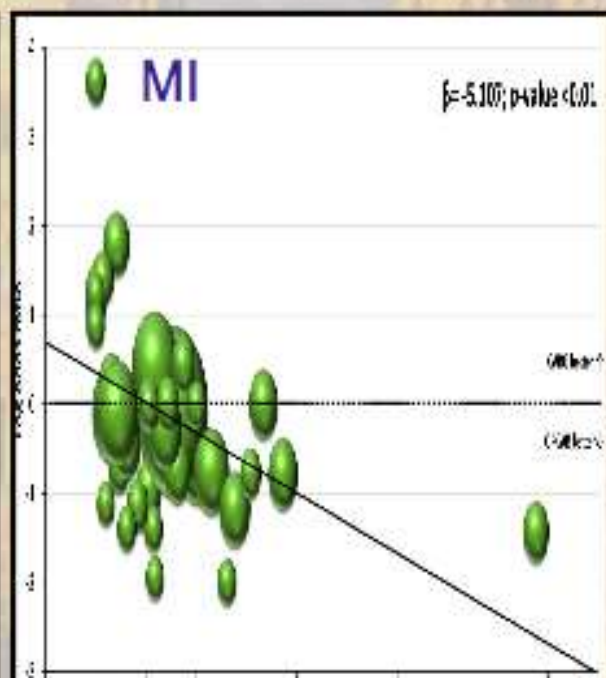
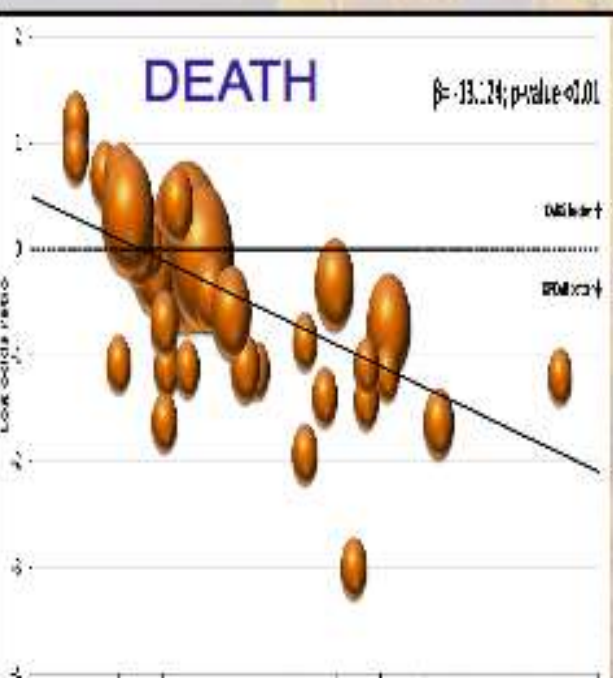
CPB-	7297	6575	5949	5303	4767	4191	3597	2987	2363	1871	1443	1034	695	264
OPCAB-	5841	5285	4827	4417	3949	3587	3173	2806	2390	1975	1506	1086	583	141

# Off-pump coronary artery bypass grafting improves short-term outcomes in high-risk patients compared with on-pump coronary artery bypass grafting: Meta-analysis

[JTCVS 2016]

Mariusz Kowalewski, MD,<sup>a,b,c</sup> Wojciech Pawliszak, MD,<sup>a</sup> Pietro Giorgio Malvindi, MD,<sup>d</sup> Marek Pawel Boksanski, MD,<sup>a</sup> Damian Perlinski, MD,<sup>a</sup> Giuseppe Maria Raffa, MD,<sup>e</sup> Magdalena Ewa Kowalkowska, MD,<sup>c,f</sup> Katarzyna Zaborowska, RN,<sup>a</sup> Eliano Pio Navarese, MD, PhD,<sup>c,g</sup> Michalina Kolodziejczak, MD,<sup>c,h</sup> Janusz Kowalewski, MD, PhD,<sup>i</sup> Giuseppe Tarelli, MD,<sup>j</sup> David Paul Taggart, MD, PhD,<sup>k</sup> and Lech Anisimowicz, MD, PhD<sup>a</sup>

- 100 studies: 19,192 patients
- no difference in all-cause mortality [OR =0.88] and MI [OR =0.90].
- OPCAB: 28% reduction in HR cerebral stroke [OR, 0.72; .p=009).
- **Significant relationship between patient risk and benefits of OPCAB in mortality (p<.01), MI (p<.01), and cerebral stroke (p<.01).**
- Mean grafts 2.9 OPCABG vs 3.1 ONCABG (p=0.01)



# Coronary Artery Bypass Grafting With and Without Manipulation of the Ascending Aorta

[JACC 2017]



## A Network Meta-Analysis

Dong Fang Zhao, BA,<sup>a,b</sup> J. James Edelman, PhD,<sup>a,b,c</sup> Michael Seco, MBBS,<sup>a,b,c</sup> Paul G. Bannon, PhD,<sup>a,b,c,d,e</sup>  
Michael K. Wilson, MBBS,<sup>b,c,e</sup> Michael J. Byrom, PhD,<sup>a,b,c,d,e</sup> Vinod Thourani, MD,<sup>f</sup> Andre Lamy, MD, MHSC,<sup>g</sup>  
David P. Taggart, PhD,<sup>h</sup> John D. Puskas, MD,<sup>i</sup> Michael P. Vallely, PhD<sup>a,b,c,d,e</sup>

○ 13 studies with 37,720 patients

(i) ONCABG

(ii) OPCABG + Partial Clamp (PC) to attach SVG to aorta

(iii) OPCABG + Heart String (HS) device to attach SVG to aorta

(iv) ANOPCABG (OPCABG + Anaortic /No Touch Aortic Technique)

○ **Effects on Death, Stroke, MI, Renal Failure, AF, Bleeding**

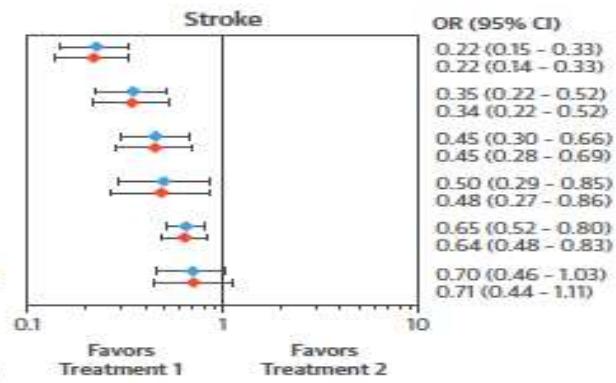


**FIGURE 3 Forest Plots for CABG With and Without Manipulation of the Aorta**

**A**

anOPCABG vs CABG

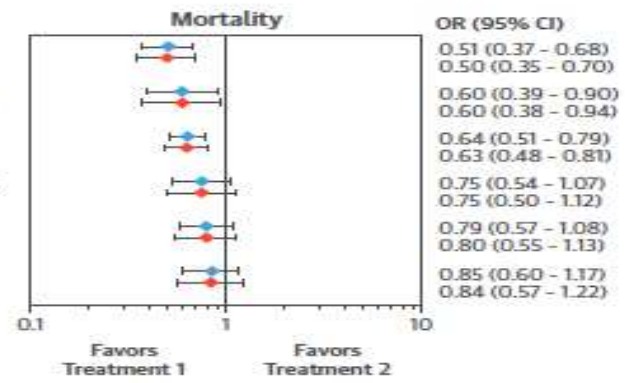
anOPCABG vs OPCABG-PC  
 OPCABG-HS vs CABG  
 anOPCABG vs OPCABG-HS  
 OPCABG-PC vs CABG  
 OPCABG-HS vs OPCABG-PC



**B**

anOPCABG vs CABG

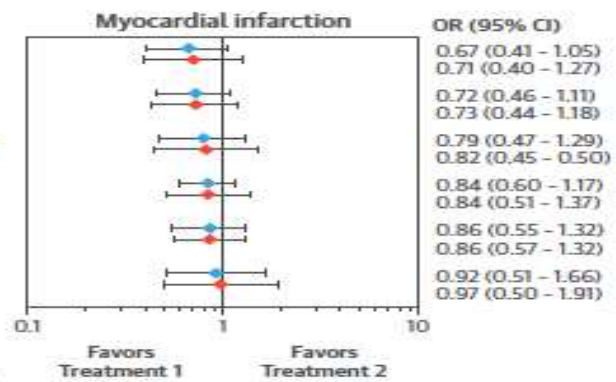
anOPCABG vs OPCABG-HS  
 OPCABG-PC vs CABG  
 OPCABG-PC vs OPCABG-HS  
 anOPCABG vs OPCABG-PC  
 OPCABG-HS vs CABG



**C**

OPCABG-HS vs CABG

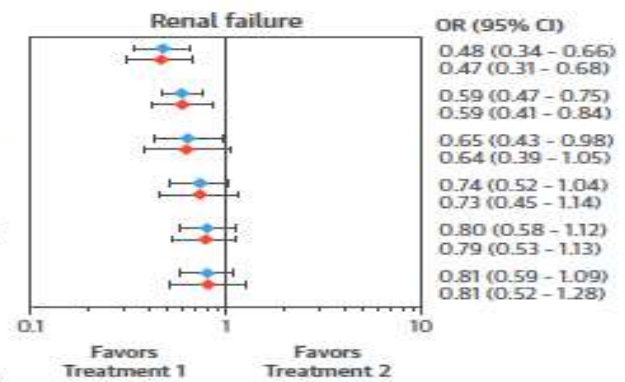
anOPCABG vs CABG  
 OPCABG-HS vs OPCABG-PC  
 OPCABG-PC vs CABG  
 anOPCABG vs OPCABG-PC  
 OPCABG-HS vs anOPCABG



**D**

anOPCABG vs CABG

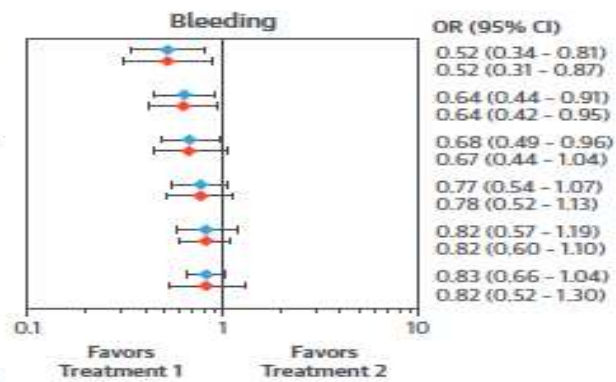
OPCABG-PC vs CABG  
 anOPCABG vs OPCABG-HS  
 OPCABG-HS vs CABG  
 OPCABG-PC vs OPCABG-HS  
 anOPCABG vs OPCABG-PC



**E**

anOPCABG vs OPCABG-HS

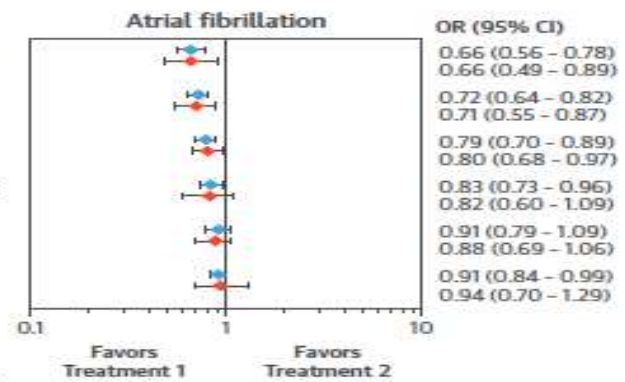
anOPCABG vs CABG  
 OPCABG-PC vs OPCABG-HS  
 anOPCABG vs OPCABG-PC  
 CABG vs OPCABG-HS  
 OPCABG-PC vs CABG



**F**

anOPCABG vs OPCABG-HS

anOPCABG vs CABG  
 anOPCABG vs OPCABG-PC  
 OPCABG-PC vs OPCABG-HS  
 CABG vs OPCABG-HS  
 OPCABG-PC vs CABG



—●— Fixed Effects      —●— Random Effects (Informative Prior)

# Comparison of **Graft Patency** Between Off-Pump and On-Pump Coronary Artery Bypass Grafting: An Updated Meta-Analysis

ATS 2014

Busheng Zhang, PhD,\* Jingxin Zhou, PhD,\* Haiqing Li, PhD, Zixiong Liu, PhD, Anqing Chen, MD, and Qiang Zhao, MD

12 RCT: 8031 grafts, up to 1yr angio

GRAFT FAILURE	OFF	ON	Off $\Delta$	HR	p
OVERALL	15%	11%	-4%	1.35	0.000
VEIN	23%	16%	-7%	1.41	0.000
LIMA	5.7%	5.0%	-0.7%	1.15	0.41
RA	12%	7.3%	-4.7%	1.37	0.30

OPCABG  $\uparrow$  graft failure, especially SVG  $\gt$  RA: early DAPT



# PIVOTAL CABG TRIALS: Summary and Conclusions

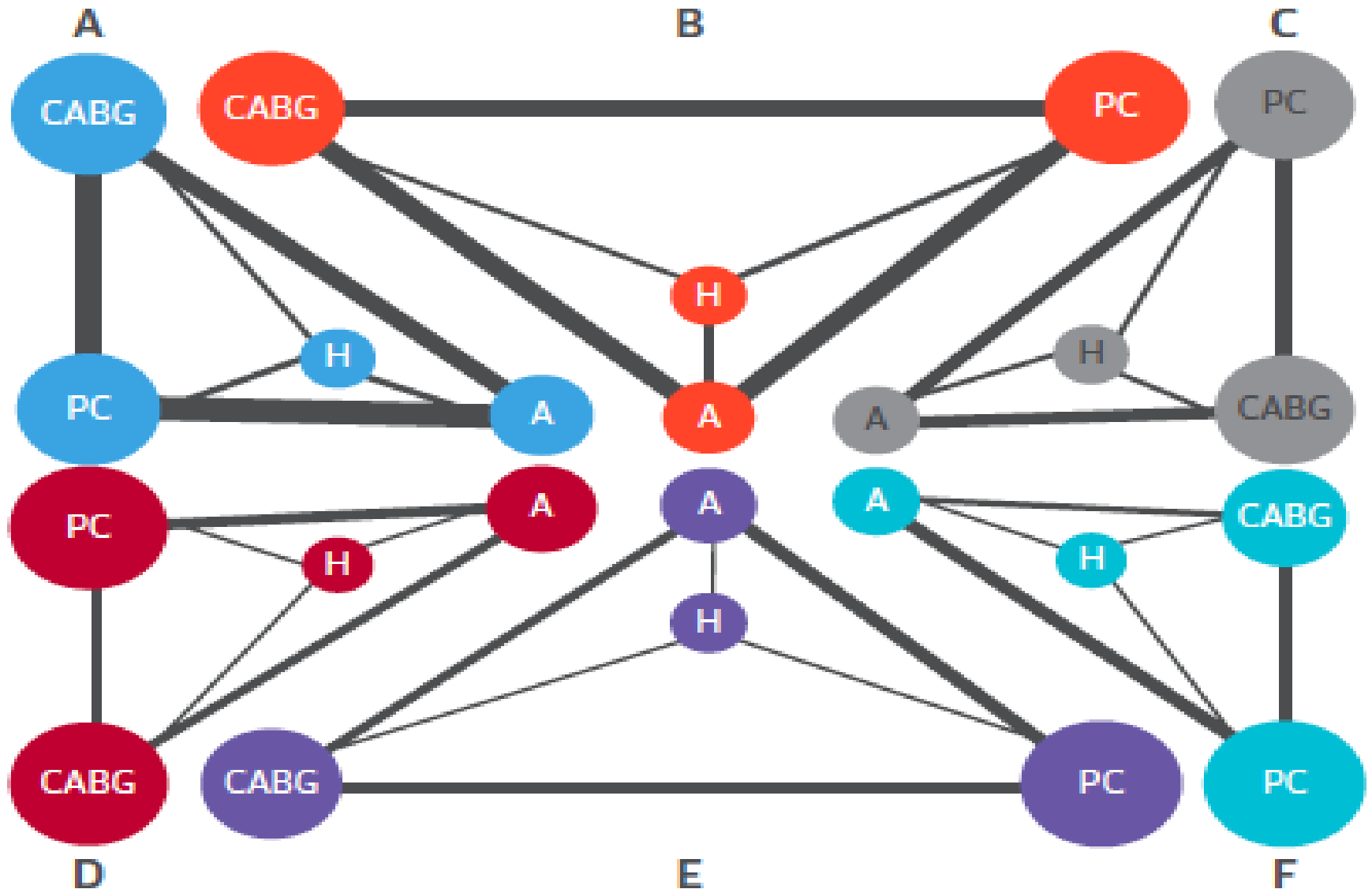
## 1. Arterial Revascularization Trial (ART): 3102 BITA vs SITA patients

- @ 5 years use of BITA vs SITA did not improve survival/MI/stroke
- 1.3% (NNH 78 patients) increase in sternal wound complications (DM,BMI)
- @ 10 years ? (results available Dec 2017)
- @ 15 years (funding application under review)

## 2. CORONARY Trial: 4752 ONCABG vs OPCABG

- @ 5 years identical results
- Strong evidence that OPCABG with NTAT reduces death, stroke, renal failure, bleeding and AF
- Use DAPT for SVG

**FIGURE 2** Network Diagram for CABG With and Without Manipulation of the Aorta



A: Anaortic  
H: Heartstring  
PC: Partial Clamp

- Stroke
- Mortality
- Myocardial infarction
- Renal failure
- Bleeding
- Atrial fibrillation

# Off-pump versus on-pump coronary artery bypass grafting for ischaemic heart disease

[Cochrane Database 2012]

Christian H Møller<sup>1</sup>, Luit Penninga<sup>2</sup>, Jørn Wetterslev<sup>3</sup>, Daniel A Steinbrüchel<sup>1</sup>, Christian Glud<sup>4</sup>

- 298 electronic pages !!!!
- 86 trials (n=10,716) including ROOBY (but not CORONARY or GOPCABGE)
- OPCABG mortality 3.7% vs 3.1% ONCABG [RR 1.24 (95% CI p=0.04)]
- OPCABG fewer distal anastomoses (-0.28; -0.4 to -0.16)
- No significant difference in MI, stroke, renal insufficiency, re-intervention
- OPCABG reduced AF

‘Our systematic review showed no significant benefit of off-pump vs. on-pump CABG regarding mortality, stroke, or myocardial infarction. In contrast, we observed better long-term survival in on-pump CABG with CPB and cardioplegic arrest. Based on the current evidence, on-pump CABG should continue to be the standard surgical treatment. However, off-pump CABG may be acceptable when there are contraindications for cannulation of the aorta and CPB.’

‘Patients in the randomised trials may not be typical of all patients undergoing CABG. Mainly patients with low risk of post-operative complications have been enrolled and patients with three vessel coronary disease and impaired left ventricular function are under-represented.’

- ① Trials of mainly low risk patients
- ② Surgical expertise unknown (conversions 0%-27%)
- ③ Long-term survival (follow up >30 days)

**BUT !!**

### A Stroke

<b>anOPCABG</b>			
0.48 (0.27 – 0.86)	<b>OPCABG-HS</b>		
0.34 (0.22 – 0.52)	0.71 (0.44 – 1.11)	<b>OPCABG-PC</b>	
0.22 (0.14 – 0.33)	0.45 (0.28 – 0.69)	0.64 (0.48 – 0.83)	<b>CABG</b>

### B Mortality

<b>anOPCABG</b>			
0.80 (0.55 – 1.13)	<b>OPCABG-PC</b>		
0.60 (0.38 – 0.94)	0.75 (0.50 – 1.12)	<b>OPCABG-HS</b>	
0.50 (0.35 – 0.70)	0.63 (0.48 – 0.81)	0.84 (0.57 – 1.22)	<b>CABG</b>

### C Myocardial infarction

<b>OPCABG-HS</b>			
0.97 (0.50 – 1.91)	<b>anOPCABG</b>		
0.82 (0.45 – 1.50)	0.84 (0.51 – 1.37)	<b>OPCABG-PC</b>	
0.71 (0.40 – 1.27)	0.73 (0.44 – 1.18)	0.86 (0.57 – 1.32)	<b>CABG</b>

### D Renal failure

<b>anOPCABG</b>			
0.79 (0.53 – 1.13)	<b>OPCABG-PC</b>		
0.64 (0.39 – 1.05)	0.81 (0.52 – 1.28)	<b>OPCABG-HS</b>	
0.47 (0.31 – 0.68)	0.59 (0.41 – 0.84)	0.73 (0.45 – 1.14)	<b>CABG</b>

### E Bleeding

<b>anOPCABG</b>			
0.78 (0.52 – 1.13)	<b>OPCABG-PC</b>		
0.64 (0.42 – 0.95)	0.82 (0.60 – 1.10)	<b>CABG</b>	
0.52 (0.31 – 0.87)	0.67 (0.44 – 1.04)	0.82 (0.52 – 1.30)	<b>OPCABG-HS</b>

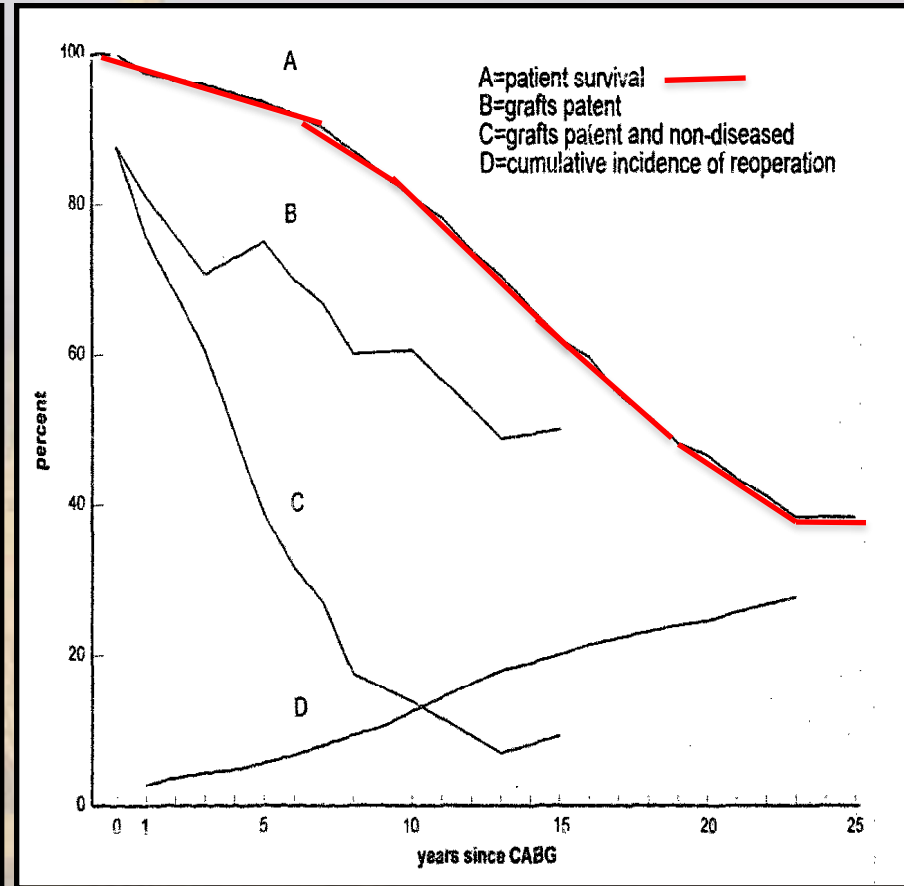
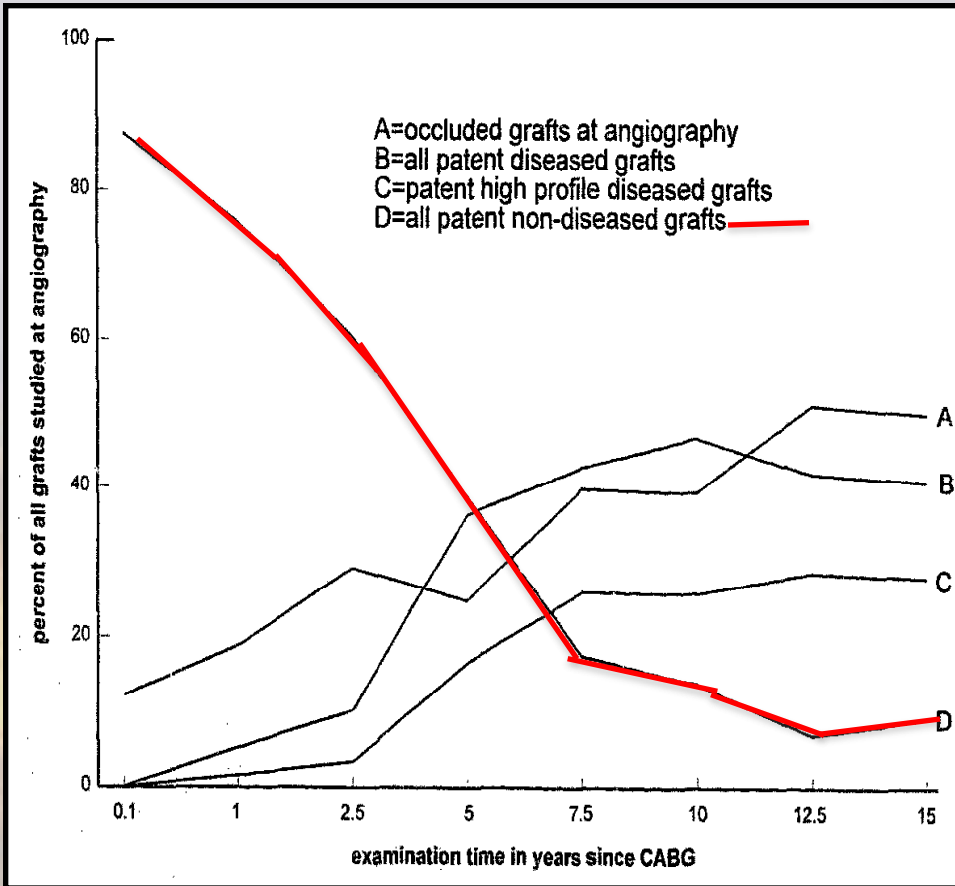
### F Atrial fibrillation

<b>anOPCABG</b>			
0.80 (0.68 – 0.97)	<b>OPCABG-PC</b>		
0.71 (0.55 – 0.87)	0.88 (0.69 – 1.06)	<b>CABG</b>	
0.66 (0.49 – 0.89)	0.82 (0.60 – 1.09)	0.94 (0.70 – 1.29)	<b>OPCABG-HS</b>

# Coronary Bypass Graft Fate and Patient Outcome: Angiographic Follow-Up of 5,065 Grafts Related to Survival and Reoperation in 1,388 Patients During 25 Years [JACC 1996]

GERALD M. FITZGIBBON, LRCP&S(IRELAND), FACC, HENRYK P. KAFKA, MD, FACC, ALAN J. LEACH, MD, FRCPC, WILBERT J. KEON, MD, FACC, G. DAVID HOOPER, MD, FACC,† JEFFREY R. BURTON, MD, FACC

In current practice of > 1 million CABG per year > 80% of all grafts are SVG



While some contemporary studies show superior vein graft patency the largest current angiographic study (PREVENT IV) show similar patency rates



# Arterial Revascularization Trial (ART)

Randomized comparison of single versus bilateral internal mammary artery grafting in 3102 patients: Effects on major cardiovascular outcomes after five years of follow up

AHA 2016

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the Arterial Revascularization Trial (ART) (no conflicts declared)



# Background: What We Already Know

- ① Coronary artery bypass grafting (CABG) is highly effective for the symptomatic and/or prognostic management of multi-vessel and left main coronary artery disease  
(SYNTAX, CORONARY, PRECOMBAT, BEST, EXCEL, NOBLE: 2013-2016)
- ② Over 1 million CABG performed worldwide each year; standard operation is CABG x 3 (using 1 internal mammary artery (IMA) and 2 vein grafts)
- ③ Strong **angiographic** evidence of increasing failure of vein grafts with time (due to progressive atherosclerosis) that accelerates after 5 years
- ④ Strong **angiographic** evidence that internal mammary (thoracic) arteries (IMA) have excellent long term patency rates (> 90% at 20 years)
- ⑤ Left IMA (LIMA) is established as the standard of care for grafting the left anterior descending (LAD) coronary artery during CABG
- ⑥ Numerous observational studies have estimated a 20% reduction in mortality with bilateral versus single IMA grafts over the long-term
- ⑦ Low use of bilateral IMA (<10% in Europe, <5% in USA) due to 3 concerns
  - (i) increased technical complexity,
  - (ii) potentially increased mortality and morbidity ?
  - (iii) lack of evidence from RCTs

# Sample Size



- **Estimate:** that at 10 years, bilateral IMA grafting will result in an absolute 5% reduction in mortality (i.e. from 25% to 20%) compared with single IMA grafting
- **Confirm:** with 90% power at the 5% significance level requires 2928 patients
- **Aim:** to enrol >3000 patients (1500 in each arm) over a 2- to 3-year recruitment period

# Eligibility



## INCLUSION:

- ✓ Patients with multi-vessel coronary artery disease scheduled for CABG on symptomatic and/or prognostic grounds
- Urgent cases for acute coronary syndrome (not evolving MI)
- CABG could be performed “on-pump or off-pump”

## EXCLUSION:

- Patients with evolving myocardial infarction
- Patients requiring single graft
- ✗ Patients requiring concomitant valve surgery
- Patients requiring redo CABG

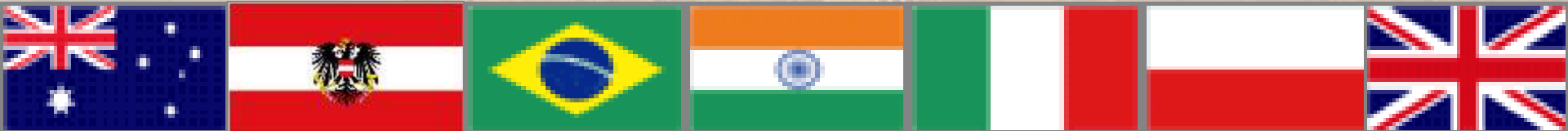


# Results

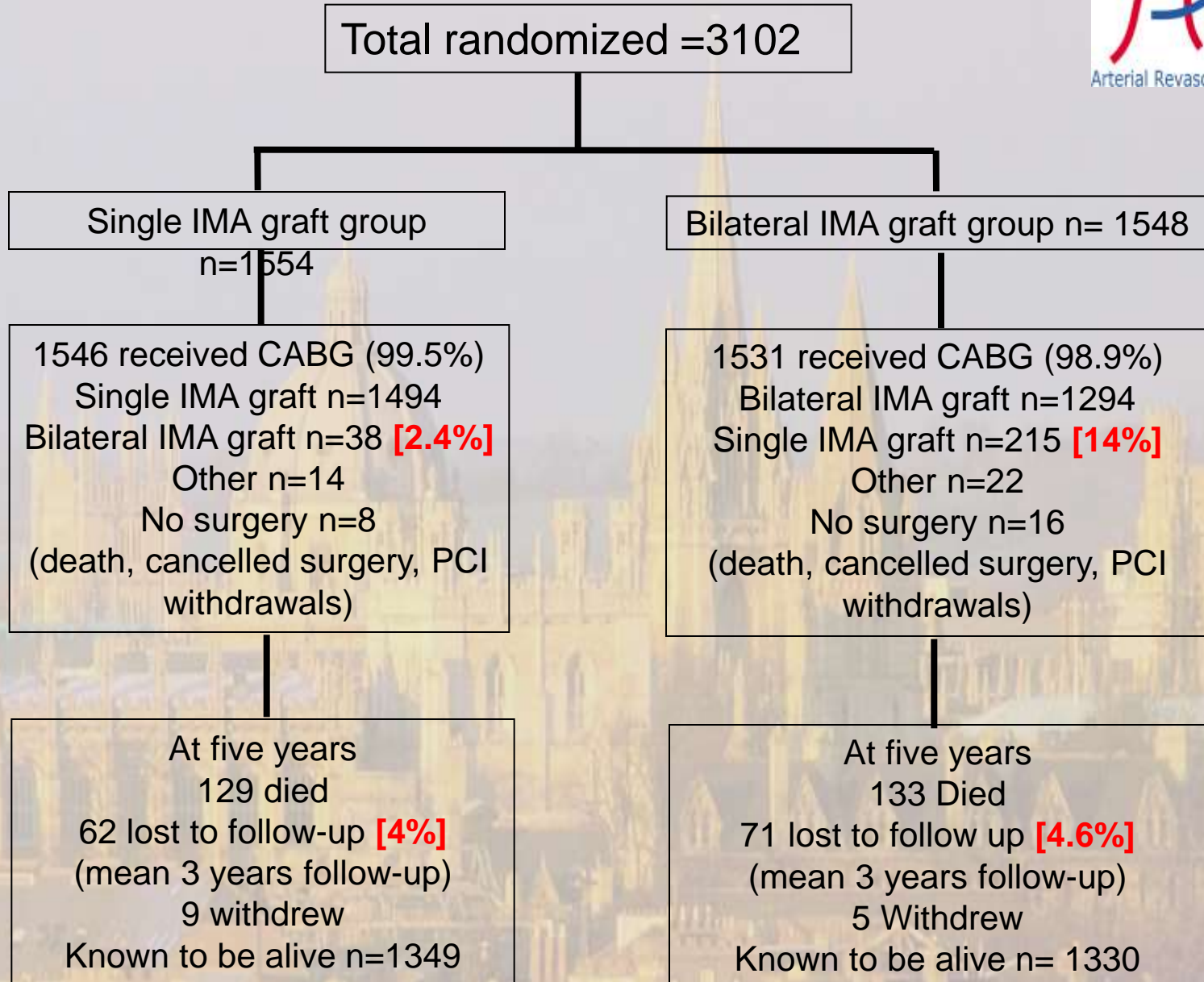


- Enrolment from June 2004 to December 2007
- 28 cardiac surgery centres
- 7 countries (UK, Poland, Australia, Brazil, India, Italy, Austria)
- 3102 patients in total
- 1554 patients randomized to single and 1548 to bilateral IMA
- At 5 years high use of guideline based medical therapy: aspirin (89%), statins (89%), ACE-inhibitor or Angiotensin receptor blockers (73%), beta blockers (75%)

(Much higher than other contemporary PCI vs CABG trials)



# Patient flow





**Baseline Characteristics  
Well Matched**Single graft  
(n=1554)Bilateral graft  
(n=1548)

Male	86%	85%
Age mean (SD) years	64 (9)	64 (9)
Current smoker	14 %	15 %
Systolic BP mean (SD) [mmHg]	132 (19)	132 (18)
Body Mass index mean (SD)	28 (4)	28 (4)
Caucasian	92 %	92 %
South Asian	5 %	5 %
Insulin dependent diabetes	5 %	6 %
Non insulin dependent diabetes	18 %	18 %
Hypertension	78 %	77 %
Hyperlipidemia	93 %	94 %
Peripheral arterial disease	8 %	7 %
Prior stroke	3 %	3 %
Prior myocardial infarction	44 %	40 %
Prior PCI	16 %	16 %
NYHA class 1 and 2	79%	78%
CCS class 1-3	84%	84%

# Surgical Details, Post-operative Care and Length of Stay

Procedures	Single graft	Bilateral graft
Details of operation	(n=1546)	(n=1531)
On pump	60 %	58 %
Off pump	40 %	42 %
Conversion to bypass	2 %	2 %
CABG duration minutes mean (SD)	199 (58)	222 (61)
Number of grafts		
2	18 %	18 %
3	49 %	50 %
4+	33 %	31 %
Cell saver	32 %	31 %
Aprotinin during surgery	24 %	24 %
Blood transfusion	12 %	12 %
Return to operating theatre	4 %	4 %
Intra-aortic balloon pump use	4 %	4 %
Renal support therapy	4 %	6 %
Hospital stay Mean days (SD)	8 (8)	8 (7)

# Clinical Outcomes and Adverse Events

Clinical Outcomes	Single graft (n=1554)	Bilateral graft (n=1548)	Hazard Ratio (95% CI)	P value
<b>PRIMARY: MORTALITY</b>	130 (8.4%)	134 (8.7%)	1.04 (0.81, 1.32)	0.77
<b>Composite – Death, myocardial infarction, stroke</b>	198 (12.7%)	189 (12.2%)	0.96 (0.79, 1.17)	0.69
<b>Myocardial infarction</b>	54 (3.5%)	52 (3.4%)	0.97 (0.66, 1.41)	0.86
<b>Stroke</b>	49 (3.2%)	38 (2.5%)	0.78 (0.51, 1.19)	0.24
<b>ADVERSE EVENTS</b>				
<b>Major Bleed</b>	41 (2.6%)	48 (3.1%)	1.18 (0.78, 1.77)	0.44
<b>Repeat Revascularisation</b>	103 (6.6%)	101 (6.5%)	0.98 (0.76, 1.28)	0.91
<b>Sternal wound complication</b>	29 (1.9%)	54 (3.5%)	1.87 (1.20, 2.92)	0.005
<b>Sternal wound reconstruction</b>	10 (0.6%)	29 (1.9%)	2.91 (1.42, 5.95)	0.002

# Summary: Five Year Analysis of the ART

- Excellent 5 year outcomes for CABG in both groups
- Confirmation of safety of bilateral IMA grafts over medium term
- No significant differences in all cause mortality or composite of mortality, myocardial infarction or stroke
- No significant differences in major bleeds, need for repeat revascularization, angina status and quality-of-life measures (angina and QoL data not shown)
- Early excess of sternal wound reconstruction with bilateral IMA (1.9% vs 0.6%) mainly in Diabetes Mellitus with high BMI
- Differential non-adherence to randomization (4% SIMA to BIMA vs 14% BIMA to SIMA): ? Surgeon experience with BIMA
- Primary outcome is 10 year survival (available in 2018)
- Acknowledgements