CATH LAB PERSPECTIVES STEMI PCI

Charles Barth MD FACC

No conflicts to declare

STEMI

Time is Muscle

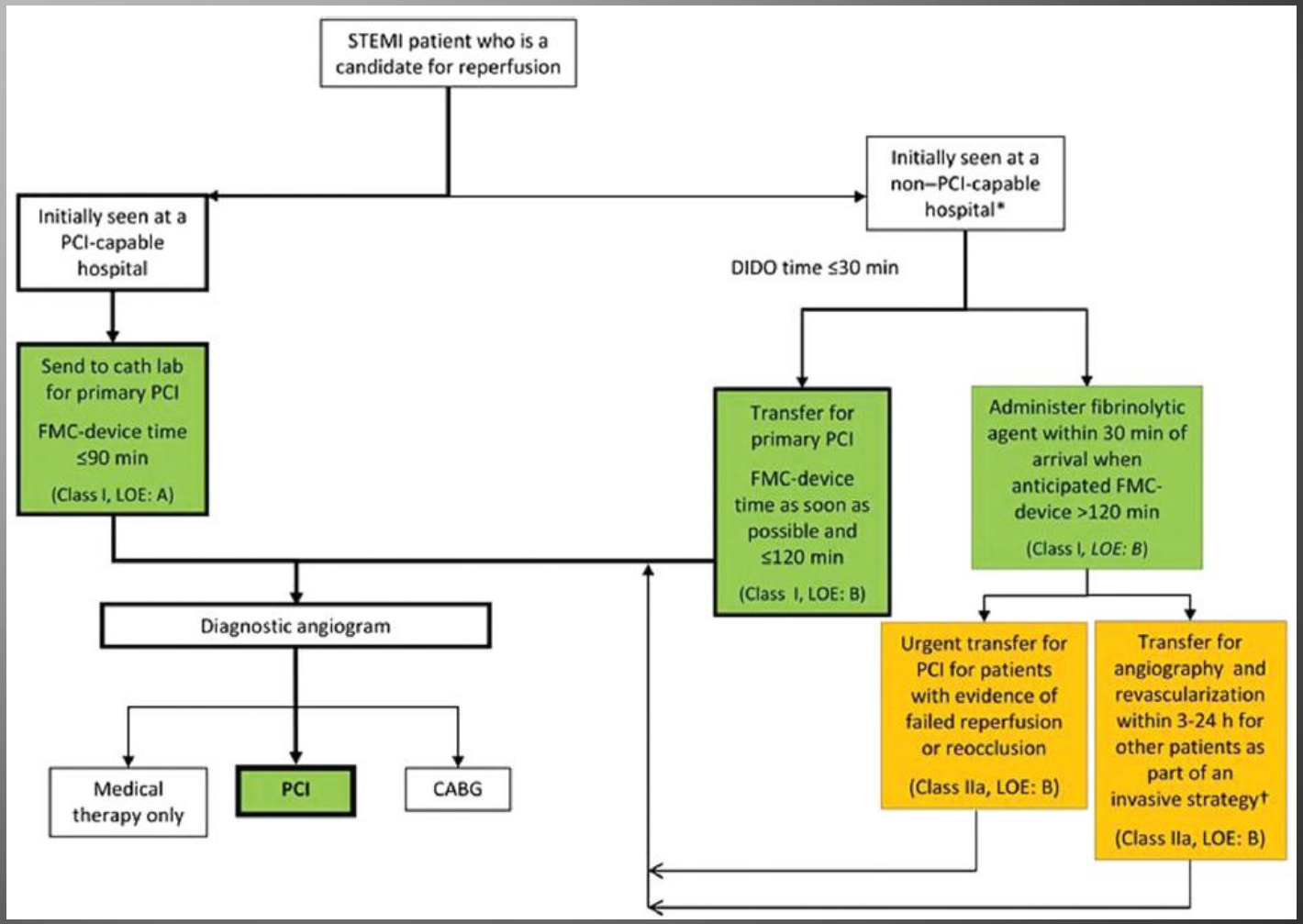
STEMI

Primary PCI is the preferred treatment modality for reperfusion for patients with STEMI…if timely access to a cardiac cath lab with PCI capability by an experienced operator is available

BRIEF HISTORY OF CARDIAC CATHETERIZATION

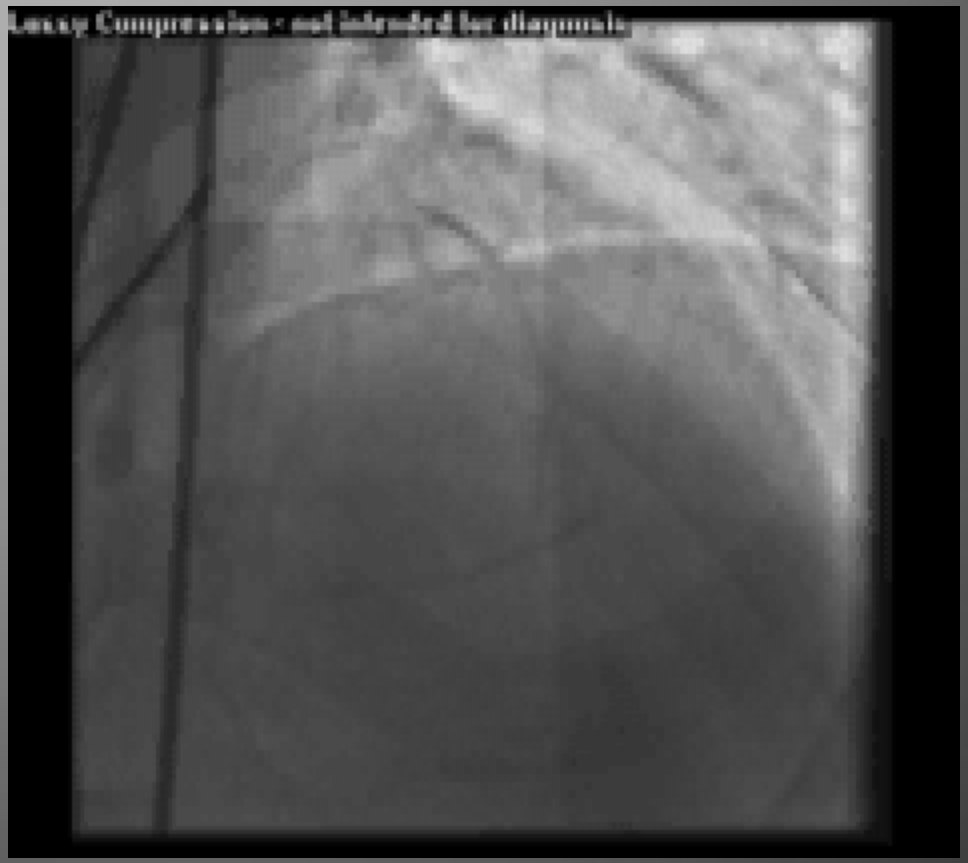
- 1950 CORONARY ANGIOGRAPHY
- 1960 CABG
- 1960-70s Proliferation of Cath & CABG
- 1970 Swan Ganz catheter introduced
- 1977 First Human PTCA by Andreas Gruentzig
- **1980 First STEMI PTCA Hartzler/Rutherford at MAHI**
- 1980s-90s Proliferation of PCI modalities
- Mid 1990s Bare Metal Stents
- 2003 Drug Eluting Stents

Reperfusion Therapy for Patients with STEMI

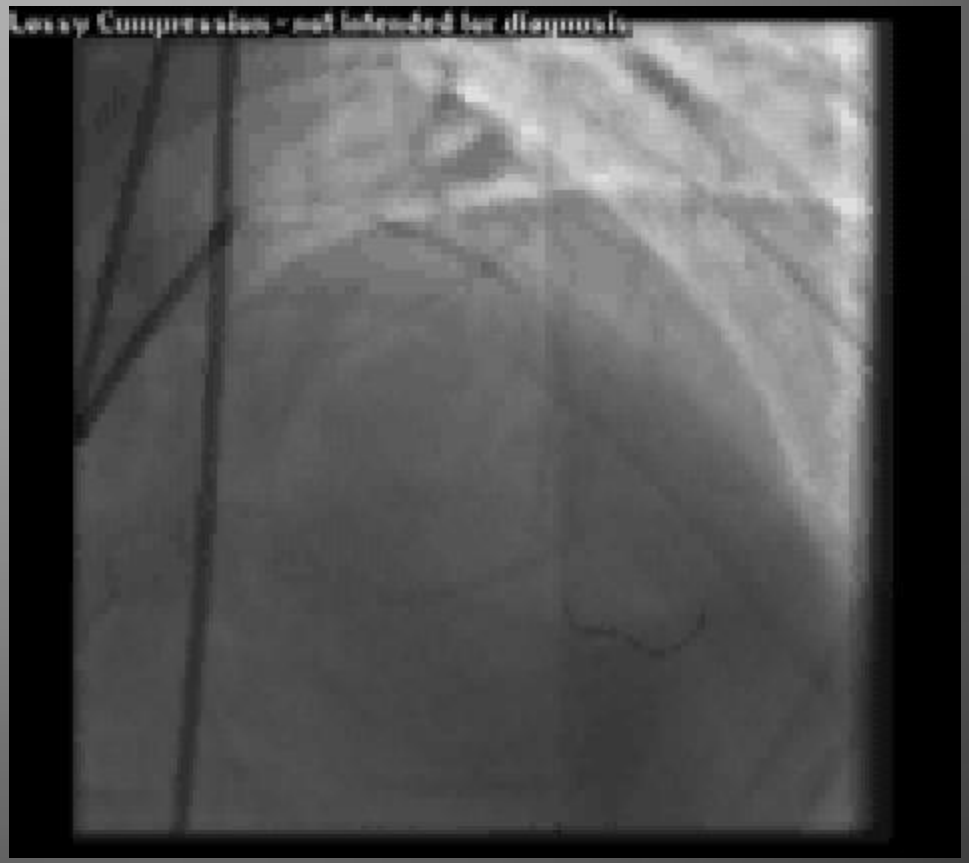


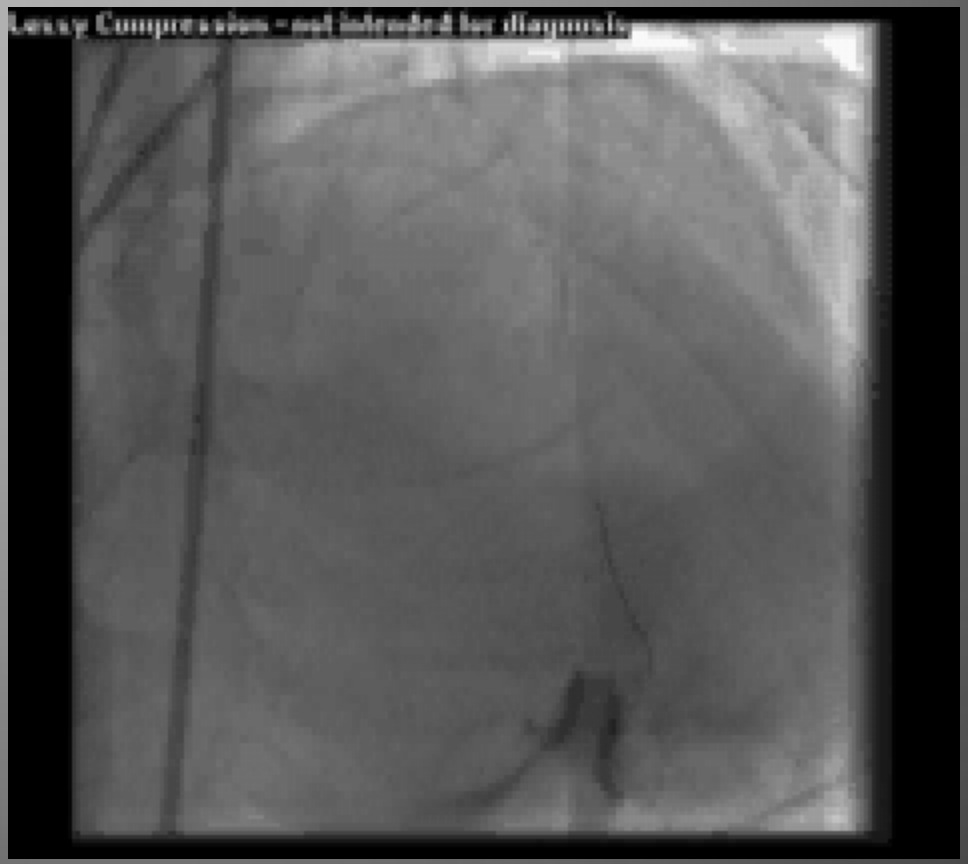
*Patients with cardiogenic shock or severe heart failure initially seen at a non–PCI-capable hospital should be transferred for cardiac catheterization and revascularization as soon as possible, irrespective of time delay from MI onset (*Class I, LOE: B*). †Angiography and revascularization should not be performed within the first 2 to 3 hours after administration of fibrinolytic therapy.

Anterior STEMI

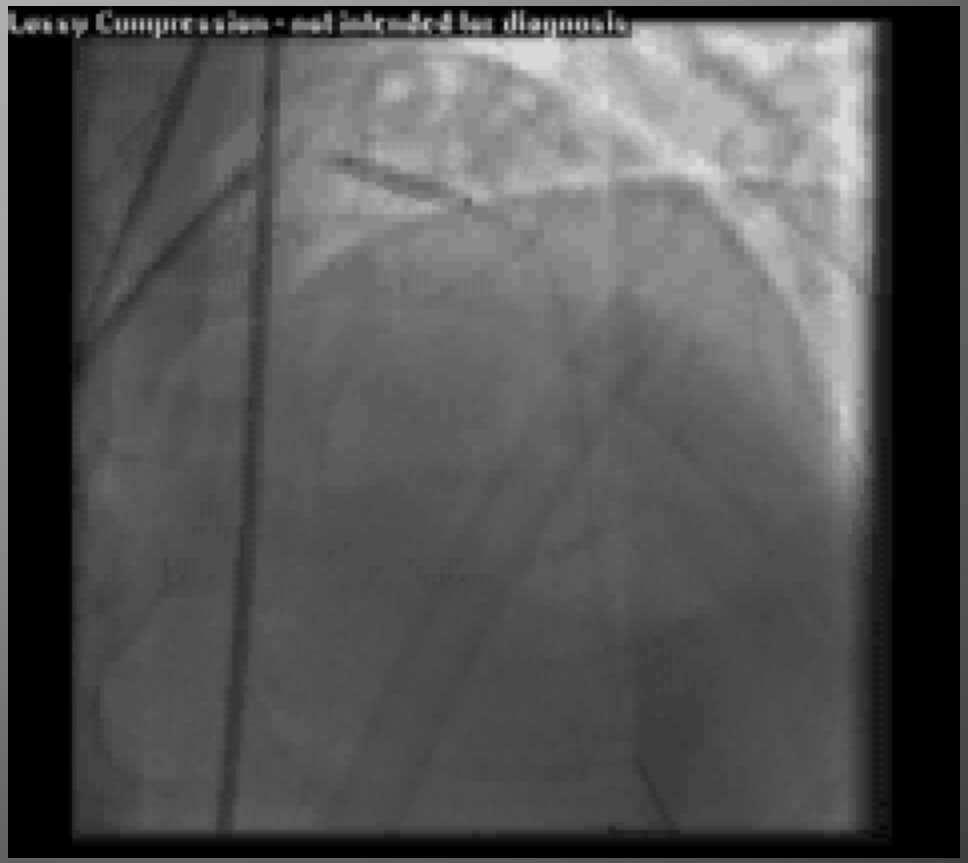


Proximal LAD PTCA

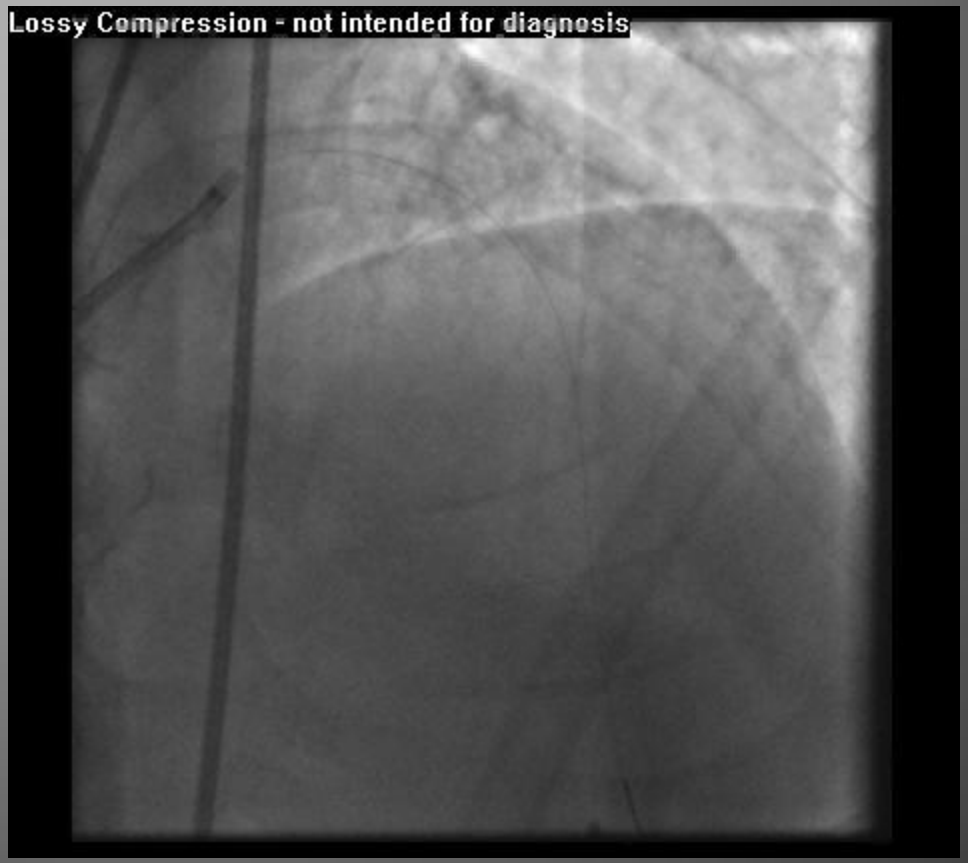



Lossy Compression - not intended for diagnosis

Stent placement



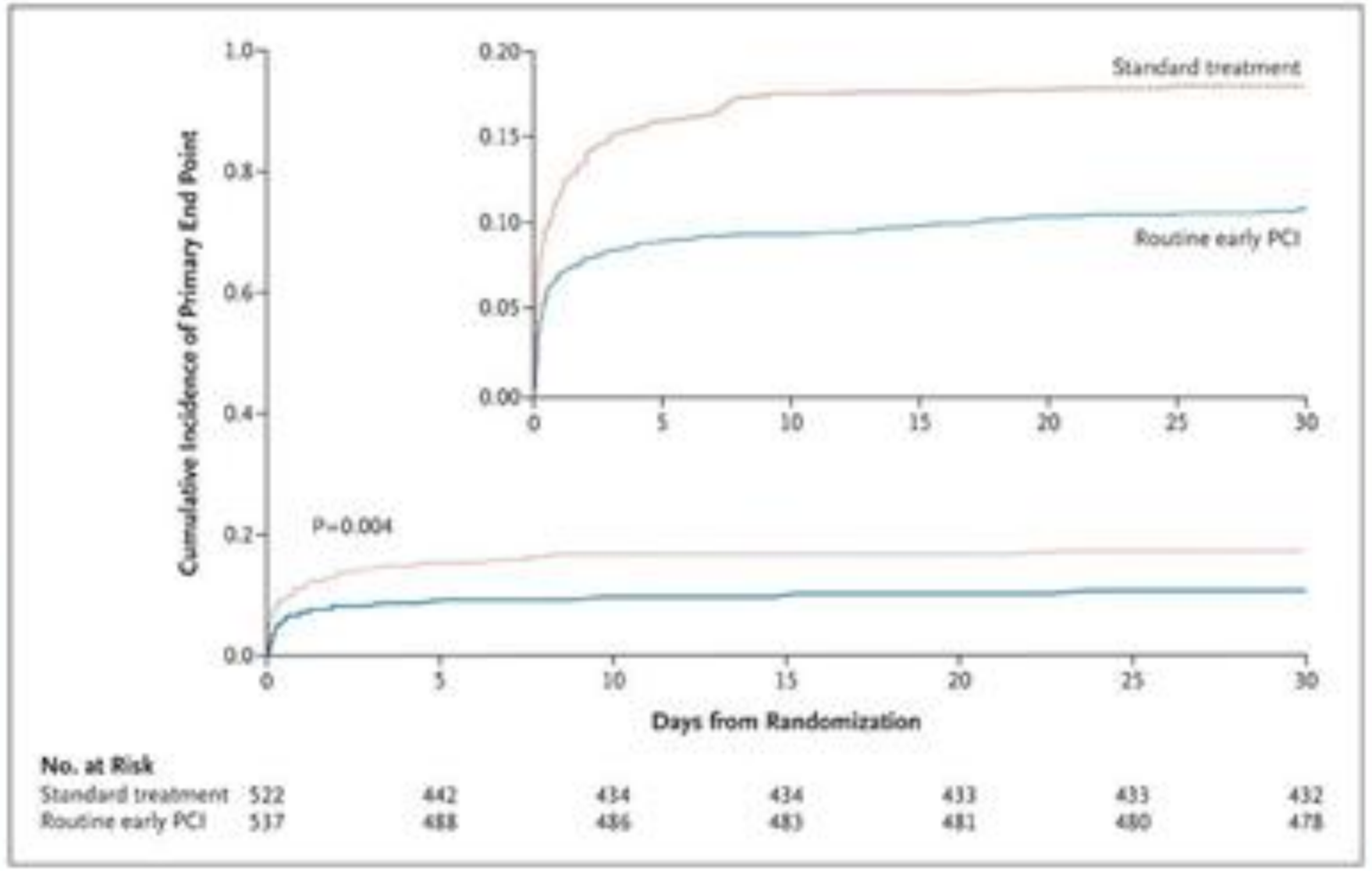
Post-Stent Result



Reperfusion at a PCI-Capable Hospital

Primary PCI in STEMI

Primary End Point* in TRANSFER-AMI



* Composite of death, reinfarction, worsening heart failure, or cardiogenic shock within 30 days

Cantor WJ. *NEJM* 2009;360:2705-2718

ACC/AHA CLASSIFICATION

Class I

Evidence/general agreement that procedure or treatment is useful and effective

Class II

Conflicting evidence/divergence of opinion about the usefulness of procedure or treatment

a. Weight of evidence/opinion in favor

b. Usefulness less well established

Class III

Procedure/Rx is not useful/effective and may be harmful

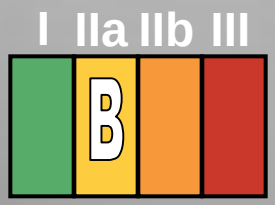
2013 Guidelines for Primary PCI in STEMI

Primary PCI should be performed in patients with STEMI and ischemic symptoms of less than 12 hours' duration.

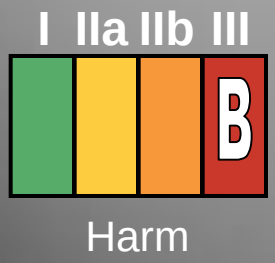
Primary PCI should be performed in patients with STEMI and ischemic symptoms of less than 12 hours' duration who have contraindications to fibrinolytic therapy, irrespective of the time delay from FMC.

Primary PCI should be performed in patients with STEMI and cardiogenic shock or acute severe HF, irrespective of time delay from MI onset.

2013 Guidelines for Primary PCI in STEMI



Primary PCI is reasonable in patients with STEMI if there is clinical and/or ECG evidence of ongoing ischemia between 12 and 24 hours after symptom onset.



Harm

PCI should not be performed in a noninfarct artery at the time of primary PCI in patients with STEMI who are hemodynamically stable

PCI of a Non-infarct Artery Before Hospital Discharge

PCI is indicated in a non-infarct artery at a time separate from primary PCI in patients who have spontaneous symptoms of myocardial ischemia.

PCI is reasonable in a non-infarct artery at a time separate from primary PCI in patients with intermediate- or high-risk findings on noninvasive testing.

Recent Changes in ACC/AHA Guidelines for Treatment of STEMI with Primary PCI

- Non-culprit artery PCI
- Aspiration thrombectomy

Reperfusion at a PCI-Capable Hospital

Adjunctive Antithrombotic Therapy for Primary PCI

Reperfusion at a PCI-Capable Hospital

Antiplatelet Therapy to Support Primary PCI for STEMI

Antiplatelet Therapy to Support Primary PCI for STEMI

Aspirin 162 to 325 mg should be given before primary PCI.

After PCI, aspirin should be continued indefinitely.

ASPIRIN

- Antiplatelet effect is mediated via the inhibition of enzyme cyclooxygenase that prevents synthesis of thromboxane A2 a potent stimulator of platelet aggregation
- The effect is irreversible for the life of the platelet

Antiplatelet Therapy to Support Primary PCI for STEMI

A loading dose of a $P2Y_{12}$ receptor inhibitor should be given as early as possible or at time of primary PCI to patients with STEMI. Options include:

- Clopidogrel 600 mg; or
- Prasugrel 60 mg; or
- Ticagrelor 180 mg

Clopidogrel (Plavix)

- a pro-drug that must be converted to active drug in liver and therefore has a longer onset of action
- Genetic polymorphism based poor metabolizers may have suboptimal response to clopidogrel and less effective platelet inhibition that could be associated with an increase risk of stent thrombosis

Prasugrel (Effient)

- pro-drug with rapid partial metabolism by intestinal and blood esterases and single step hepatic metabolism to active drug
- More rapid and reliable inhibition of platelet aggregation (50% at 1 hr up to max of 80% inhibition)
- TRITON-TIMI 38 Trial demonstrated a **19%** reduction in CV death, MI or CVA vs clopidogrel
- Avoid in pts over 75 or with prior TIA/CVA due to higher risk of intracranial hemorrhage

Ticagrelor (Brilinta)

- Does not require hepatic metabolism to active drug therefore has quicker onset of platelet inhibition
- Reversible P2Y12 inhibition with shorter half life that requires twice daily dosing
- Plato Trial …significant decrease in mortality in ACS pts treated with ticagrelor vs clopidogrel (**9.8% vs 11.7%**)
- 14% Incidence in peculiar dyspnea
- Use only with 81mg of ASA, not 325mg

Maintenance Antiplatelet Therapy to Support Primary PCI for STEMI

$P2Y_{12}$ inhibitor therapy should be given for 1 year to patients with STEMI who receive a stent (BMS or DES) during primary PCI using the following maintenance doses:

- Clopidogrel 75 mg daily; or
- Prasugrel 10 mg daily; or
- Ticagrelor 90 mg twice a day*

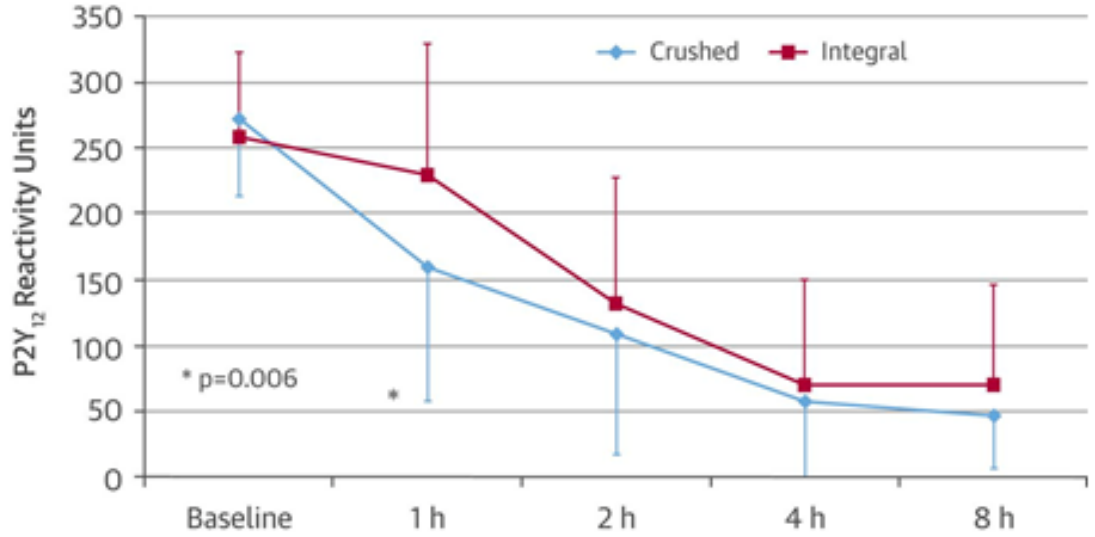
*The recommended maintenance dose of aspirin to be used with ticagrelor is 81 mg daily.

Antiplatelet Therapy to Support Primary PCI for STEMI

It is reasonable to use 81 mg of aspirin per day in preference to higher maintenance doses after primary PCI.

Morphine use will slow the absorption and delay efficacy of oral antiplatelet agents

MOJITO STUDY
CRUSHED VS INTACT TICAGRELOR (STEMI)



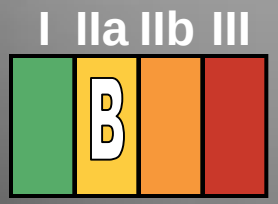
Guido Parodi et al. JACC 2015;65:511-512

JACC

Intravenous Antiplatelet Therapy to Support Primary PCI for STEMI

It is reasonable to start treatment with an intravenous GP IIb/IIIa receptor antagonist at the time of primary PCI (with or without stenting or clopidogrel pretreatment) in selected patients with STEMI who are receiving UFH.

- Abciximab: 0.25 mg/kg IV bolus, then 0.125 mcg/kg/min (maximum 10 mcg/min); or

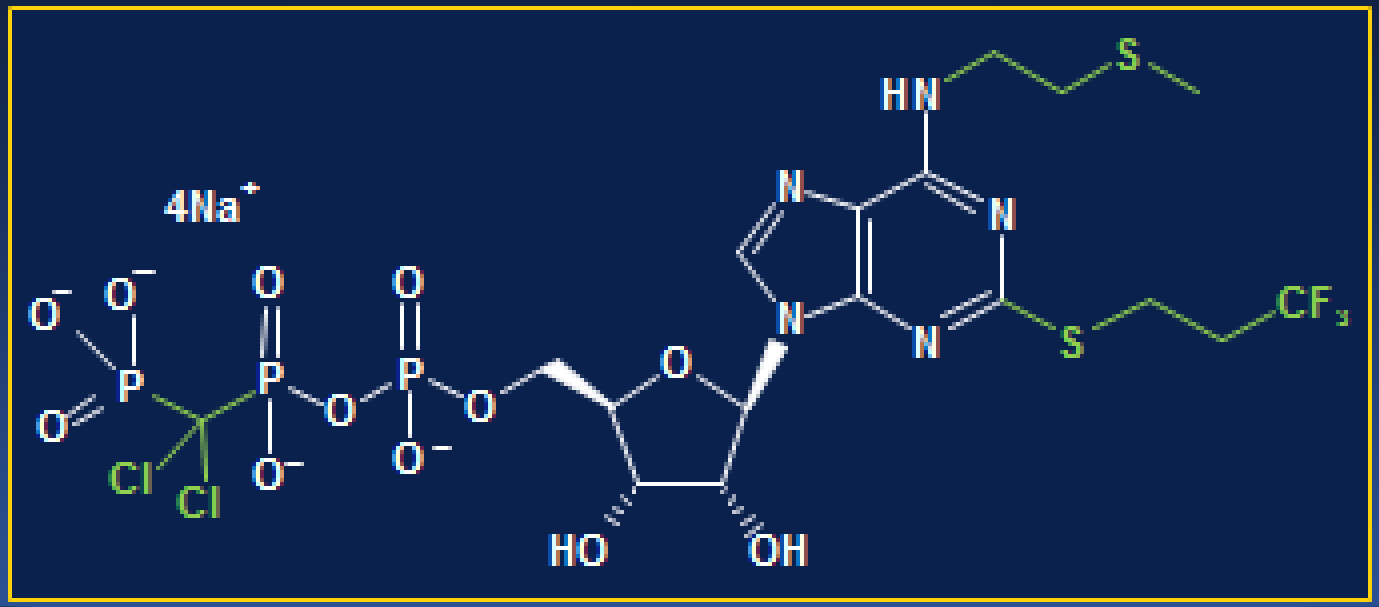


- High-bolus-dose tirofiban: 25 mcg/kg IV bolus, then 0.15 mcg/kg/min; or

- Double-bolus eptifibatide: 180 mcg/kg IV bolus, then 2 mcg/kg/min; a 2nd 180-mcg/kg bolus is administered 10 min after the 1st bolus.

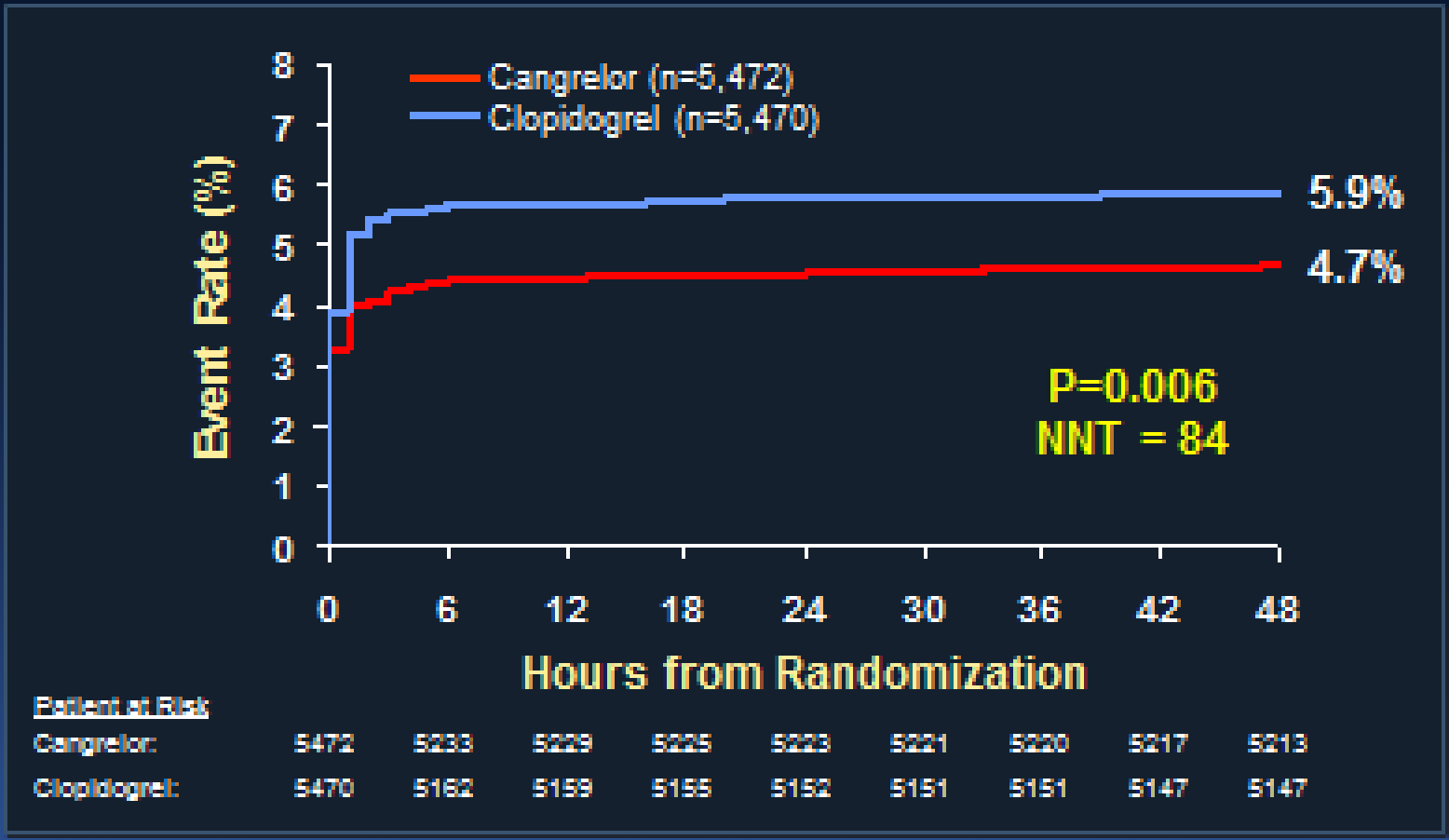
Cangrelor

- Direct $P2Y_{12}$ receptor antagonist (non thienopyridine)
  - ATP analogue; MW=800 Daltons
    - Parenteral administration
      - $T_{1/2}$ = 3 to 6 minutes
      - Offset = 60 minutes



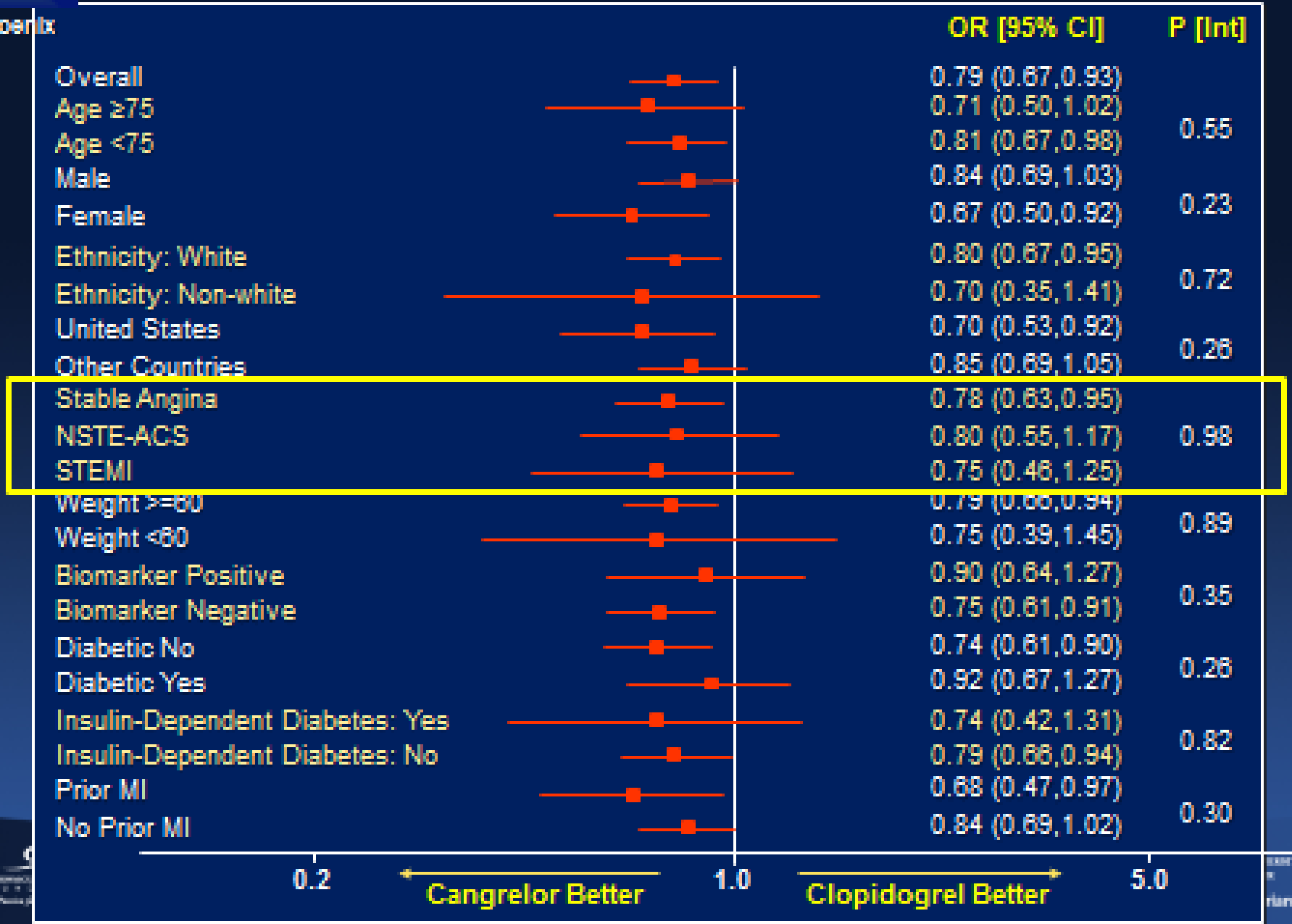
Phoenix

Phoenix: Death, MI, IDR, Stent Thrombosis within 48 Hrs (n=10,942)



Bhatt DL et al. NEJM 2013;368:1303-13

Death, MI, IDR, ST at 48 Hours



Uses for Cangrelor Across the Spectrum of CAD

Withhold oral agents, start cangrelor at time of PCI!

Scenario	Compared to no pre-loading with oral agents	Compared to pre-loading with oral agents
Stable CAD	- Decreases stent thrombosis (ST) and MI in all pts undergoing PCI	- Avoids unnecessary exposure in pts not requiring PCI (decrease bleeding)
NSTE-ACS		- Avoids unnecessary exposure in med Rx pts - Allows CABG to be performed early instead of 5-7 days
STEMI		- Decreases acute ST and MI in pts undergoing PCI (oral agents not active)
All patients	Decreases ST and MI in PCI pts unable to take oral meds (sedation, intubation, vomiting, shock, etc.)	

Cangrelor

- Has short half life and reversibly affects platelet aggregation therefore is administered as a bolus and infusion
- Is useful in patients who are vomiting or are intubated until oral agent can be reliably given
- Cangrelor infusion will block uptake of clopidogrel (Plavix) and prasugrel (Effient) by the platelet, but not ticagrelor (Brilinta).

Reperfusion at a PCI-Capable Hospital

Anticoagulant Therapy to Support Primary PCI

Anticoagulant Therapy to Support Primary PCI

For patients with STEMI undergoing primary PCI, the following supportive anticoagulant regimens are recommended:

- UFH, with additional boluses administered as needed to maintain therapeutic activated clotting time levels, taking into account whether a GP IIb/IIIa receptor antagonist has been administered; or

- Bivalirudin with or without prior treatment with UFH.

Anticoagulant Therapy to Support Primary PCI

In patients with STEMI undergoing PCI who are at high risk of bleeding, it is reasonable to use bivalirudin monotherapy in preference to the combination of UFH and a GP IIb/IIIa receptor antagonist.

Fondaparinux should not be used as the sole anticoagulant to support primary PCI because of the risk of catheter thrombosis.

Unfractionated heparin

- Indirect thrombin inhibitor that will not inactivate clot bound thrombin and has variable anticoagulation
- Assess level of anticoagulation with ACT
- Longer half life
- Small incidence of heparin induced thrombocytopenia
- Can activate platelets

Bivalirudin (Angiomax)

- Direct thrombin inhibitor that will inhibit clot bound thrombin
- More predictable anticoagulation
- Shorter half life
- Horizon AMI Trial…lower major bleeding risk and lower 1 year mortality vs UFH
- Higher acute stent thrombosis risk particularly in STEMI pts
- HEAT-PPCI Trail…in STEMI pts there was lower incidence of MACE with UFH (5.7% vs 8.7%) with similar major bleeds (3.1% vs 3.5%) c/t bivalirudin (same GP2b3a inh use in both groups)

Meta-analysis: Bivalirudin vs. Heparin in STEMI

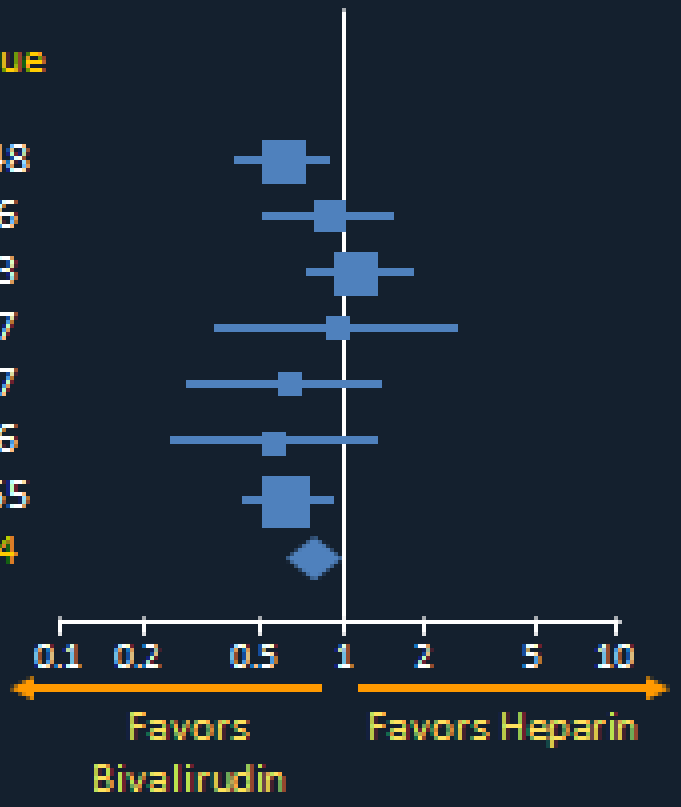
6 trials, 14,095 patients

30-Day All-Cause Mortality

Study name	Risk Ratio	Lower Limit	Upper Limit	P value
HORIZONS-AMI	0.661	0.439	0.997	0.048
EUROMAX	0.958	0.569	1.542	0.86
HEAT-PPCI	1.182	0.779	1.793	0.43
BRAVE-4	1.022	0.363	2.875	0.97
BRIGHT (heparin alone)	0.678	0.292	1.574	0.37
BRIGHT (heparin + GPI)	0.617	0.269	1.416	0.26
MATRIX-STEMI	0.684	0.464	1.008	0.055
Total	0.815	0.670	0.992	0.04

Statistics for Each Study

Risk ratio and 95% CI



18%⇓, P=0.04

Heterogeneity: (Q statistic=6.0, df=6; P=0.41, I^2=1.4)

iASSESS

Shah R et al. *Am Heart J* 2016;171:14-24

Cardiovascular Research Foundation

Reperfusion at a PCI-Capable Hospital

Use of Stents in Primary PCI

Use of Stents in Patients With STEMI

Placement of a stent (BMS or DES) is useful in primary PCI for patients with STEMI.

BMS* should be used in patients with high bleeding risk, inability to comply with 1 year of DAPT, or anticipated invasive or surgical procedures in the next year.

Harm

DES should not be used in primary PCI for patients with STEMI who are unable to tolerate or comply with a prolonged course of DAPT because of the increased risk of stent thrombosis with premature discontinuation of one or both agents.

*Balloon angioplasty without stent placement may be used in selected patients.

Use of Drug-Eluting Stents in Acute Myocardial Infarction

A Systematic Review and Meta-Analysis

Somjot S. Brar, MD, Martin B. Leon, MD, Gregg W. Stone, MD, Roxana Mehran, MD, Jeffrey W. Moses, MD, Simerjeet K. Brar, BS, George Dangas, MD, PhD

New York, New York

Objectives The primary aim of the analysis was to compare outcomes by stent type for death, myocardial infarction (MI), target vessel revascularization (TVR), and stent thrombosis in randomized trials of ST-segment elevation myocardial infarction (STEMI). A secondary analysis was performed among registry studies.

Background It is not known whether there are differences in outcomes between drug-eluting stents (DES) and bare-metal stents (BMS) for STEMI.

Methods We searched MEDLINE, EMBASE, the Cochrane Library, and Internet sources for articles comparing outcomes between DES and BMS among patients with STEMI between January 2000 and October 2008. Randomized controlled trials and registries including patients 18 years of age and older receiving a DES or BMS were included. We extracted variables related to the study design, setting, participants, and clinical end points.

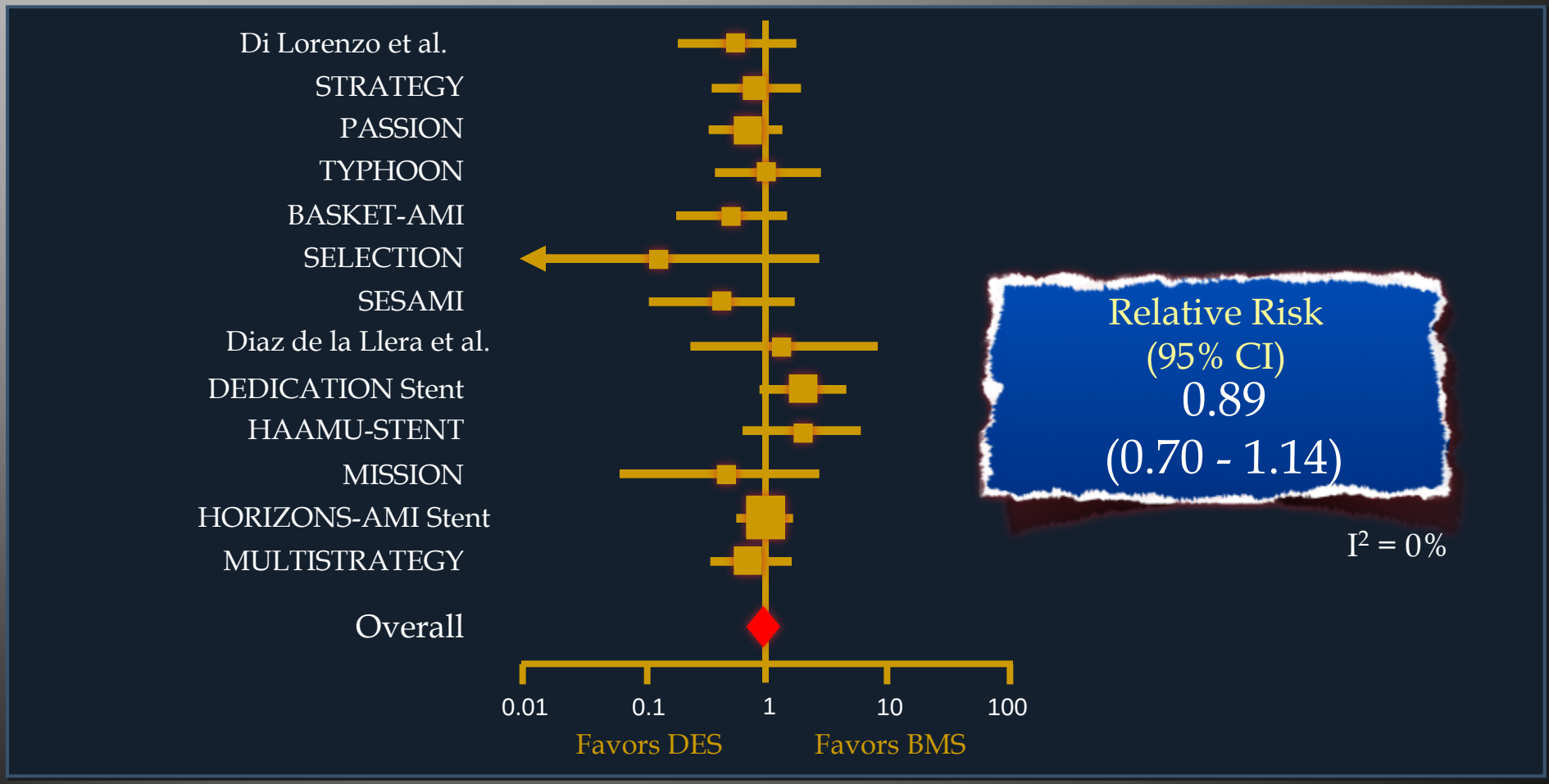
Results Thirteen randomized trials were identified (N = 7,352). Compared with BMS, DES significantly reduced TVR (relative risk [RR]: 0.44; 95% confidence interval [CI]: 0.35 to 0.55), without increasing death (RR: 0.89; 95% CI: 0.70 to 1.14), MI (RR: 0.82; 95% CI: 0.64 to 1.05), or stent thrombosis (RR: 0.97; 95% CI: 0.73 to 1.28). These observations were durable over 2 years. Among 18 registries (N = 26,521), DES significantly reduced TVR (RR: 0.54; 95% CI: 0.40 to 0.74) without an increase in MI (RR: 0.87, 95% CI: 0.62 to 1.23). Death was significantly lower in the DES group within 1 year of the index percutaneous coronary intervention, but there were no differences within 2 years (p = 0.45).

Conclusions The use of DES appears safe and efficacious in randomized trials and registries of patients with STEMI. The DES significantly reduce TVR compared with BMS, without an increase in death, MI, or stent thrombosis within 2 years of the index procedure. (J Am Coll Cardiol 2009;53:1677–89)

Brar et al. JACC 2009; 53(18)

DES in AMI Meta-Analysis

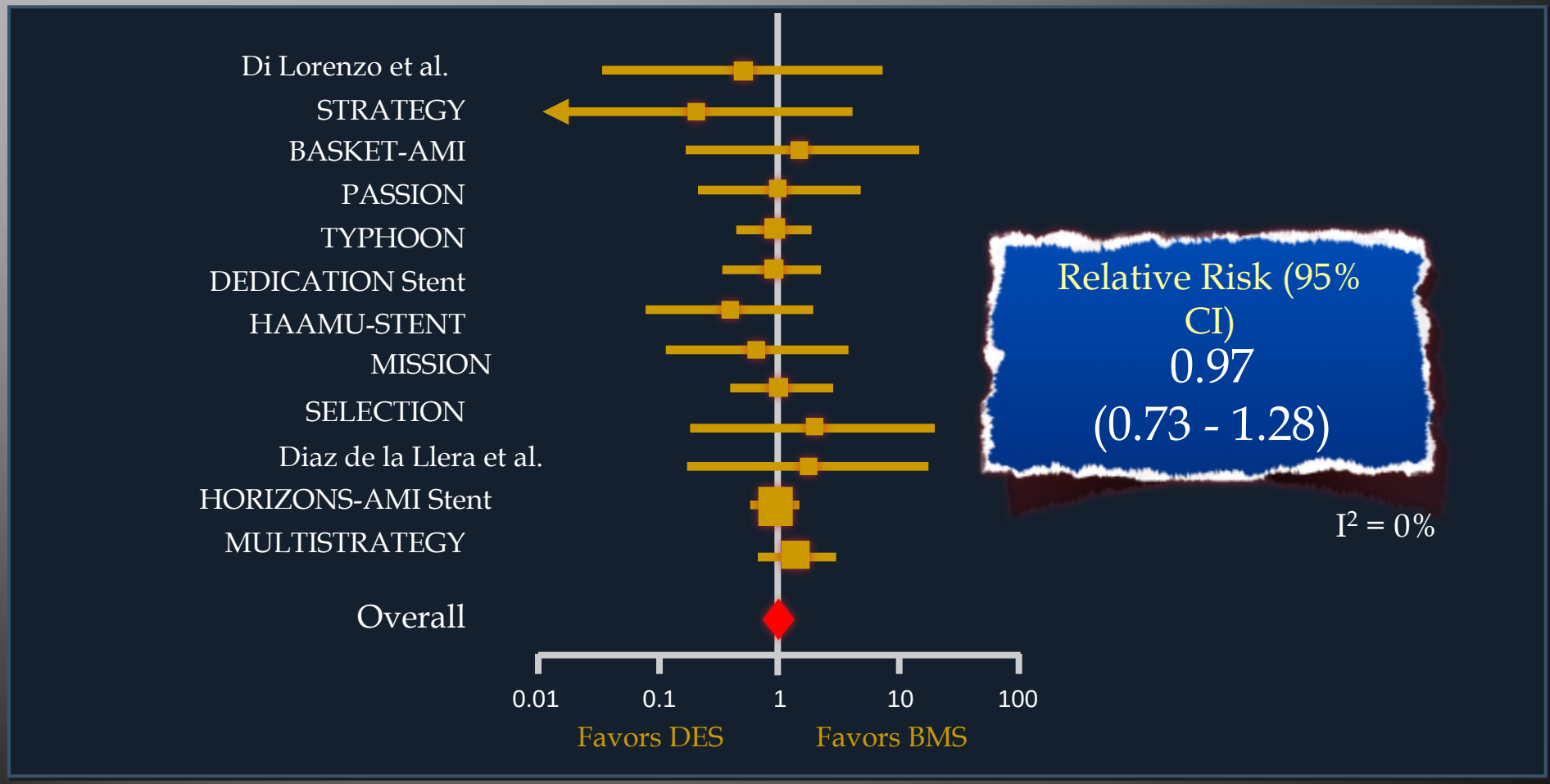
Mortality (RCTs)



Brar et al. JACC 2009; 53(18)

DES in AMI Meta-Analysis

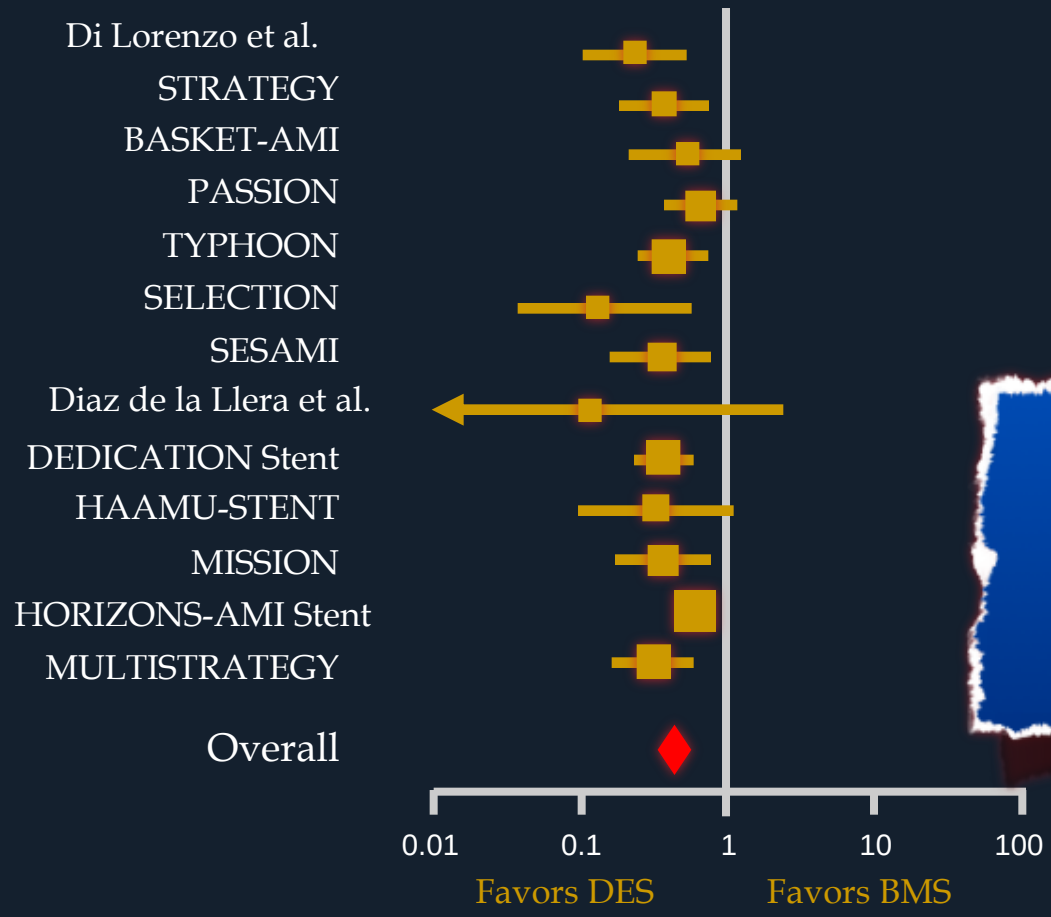
Stent Thrombosis (RCTs)



Brar et al. JACC 2009; 53(18)

DES in AMI Meta-Analysis

Target Vessel Revascularization (RCTs)



REDUCTION

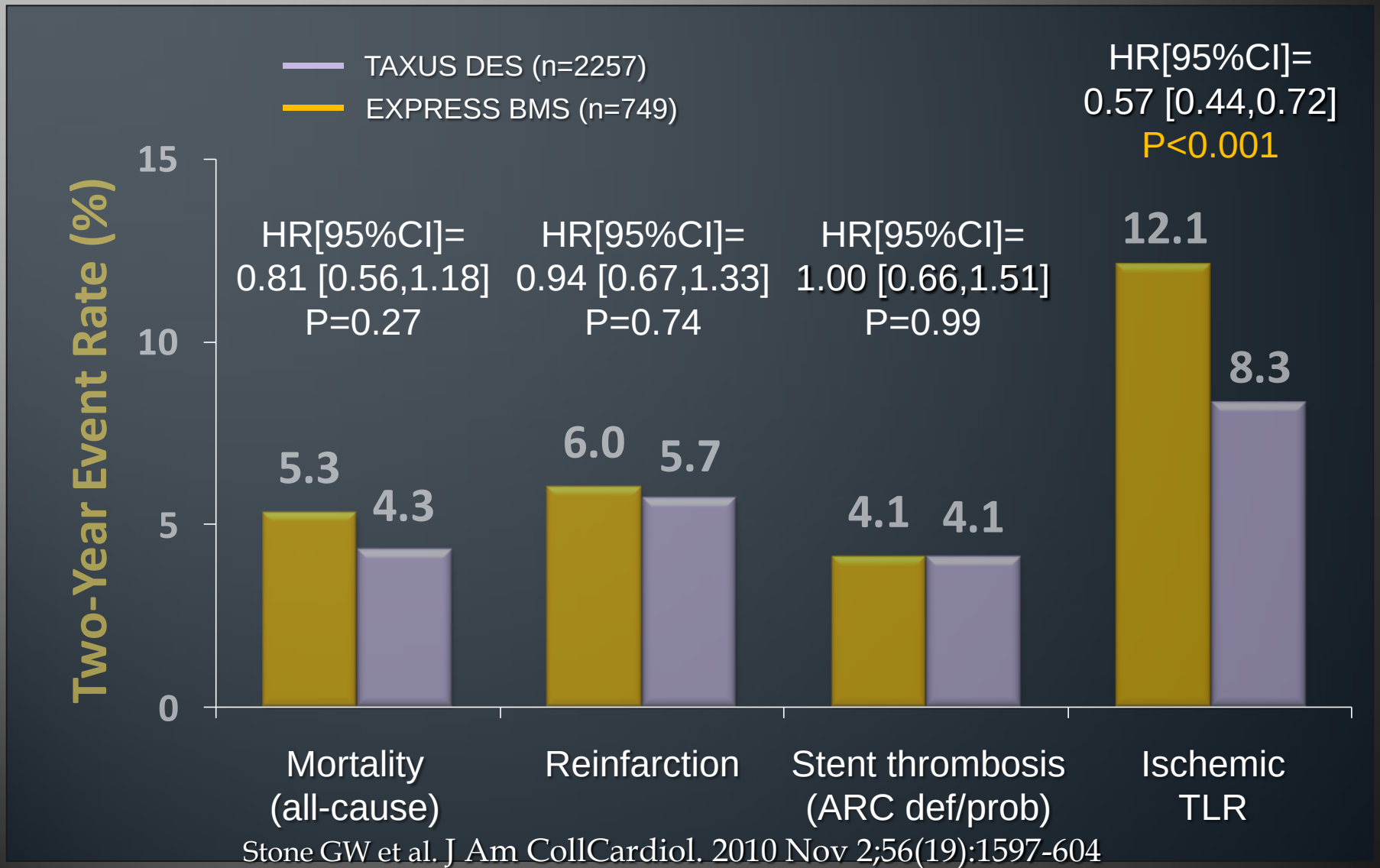
56%

Relative Risk (95% CI)
0.44
(0.35 - 0.55)
$p < 0.001$

$I^2 = 26\%$

Brar et al. JACC 2009; 53(18)

HORIZONS-AMI: Two Year Endpoints



Stone GW et al. J Am CollCardiol. 2010 Nov 2;56(19):1597-604

*Kaplan-Meier estimates

CULPRIT ARTERY ONLY VS MULTIVESSEL PCI

50% of STEMI pts have multivessel CAD

STEMI PCI OPTIONS

1. Culprit artery PCI only with PCI of non-culprit vessels for spontaneous ischemia or intermediate/high risk non-invasive testing

2. Multi-vessel PCI at time of primary PCI of culprit vessel

3. Culprit artery only primary PCI, followed by staged PCI of non-culprit lesions.

Non-culprit artery PCI in STEMI

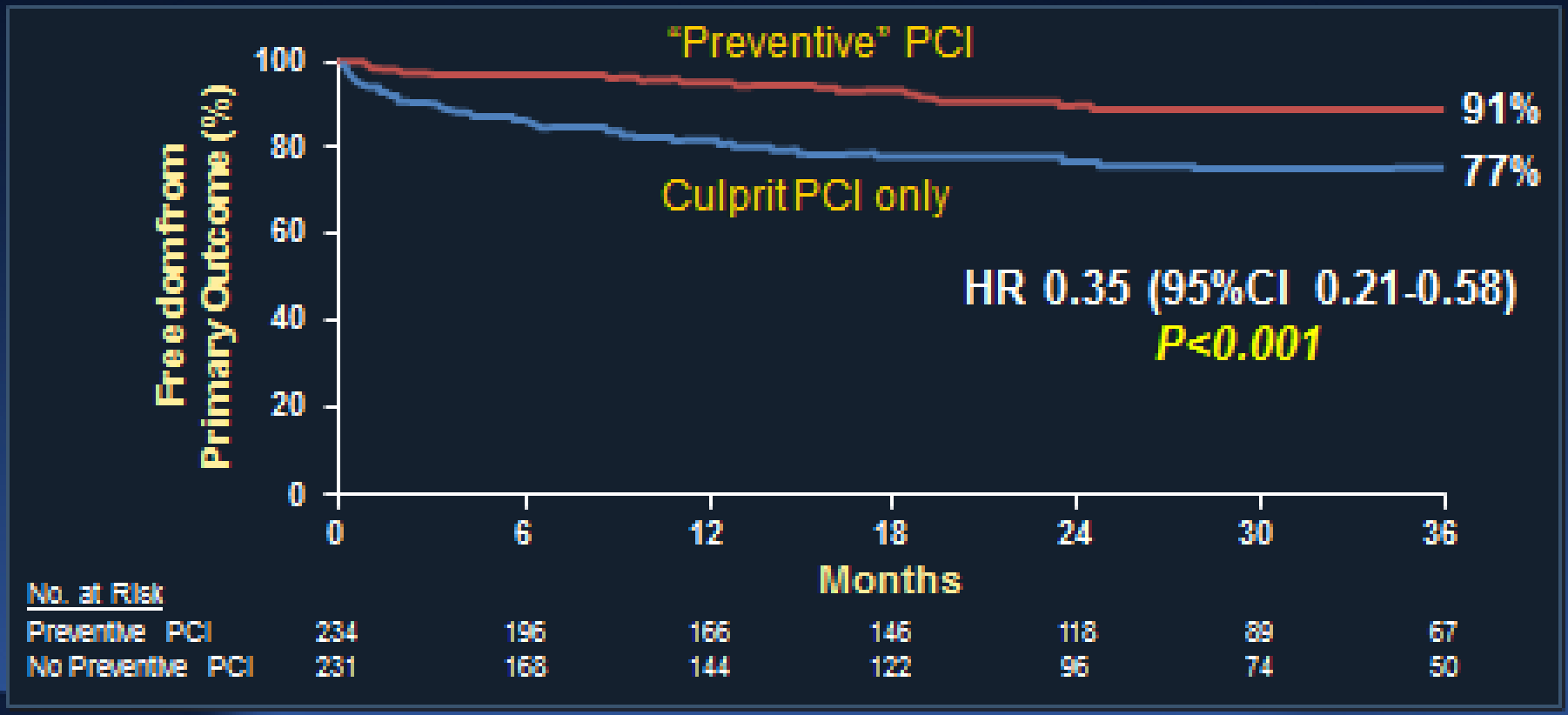
4 RCTs suggest strategy of of MV PCI at time of primary PCI or as planned staged procedure may be beneficial and safe in selected STEMI patients:

1. PRAMI Trial
2. CvLPRIT Trial
3. DANAMI 3 PRIMULTI Trial
4. PRAGUE 13 Trial

PRAMI: "Preventive" PCI of Non-culprit Lesions after Culprit Lesion Primary PCI in STEMI

465 non-shock pts at 5 UK sites with MVD; after successful primary PCI randomized to NCL PCI of non-LM DS 50-99% stenoses vs. conservative care immediately
600 pts planned; DSMB stopped trial early after 465 pts enrolled (2008-2013)

Primary endpoint: Cardiac death, MI or refractory angina



iASSESS

Wald DS. *NEJM* 2013; 19;369:1115-23

Cardiovascular Research Foundation

PRAMI: "Preventive" PCI of Non-culprit Lesions after Culprit Lesion Primary PCI in STEMI

465 non-shock pts at 5 UK sites with MVD; after successful primary PCI randomized to NCL PCI of non-LM DS 50-99% stenoses vs. conservative care immediately

600 pts planned; DSMB stopped trial early after 465 pts enrolled (2008-2013)

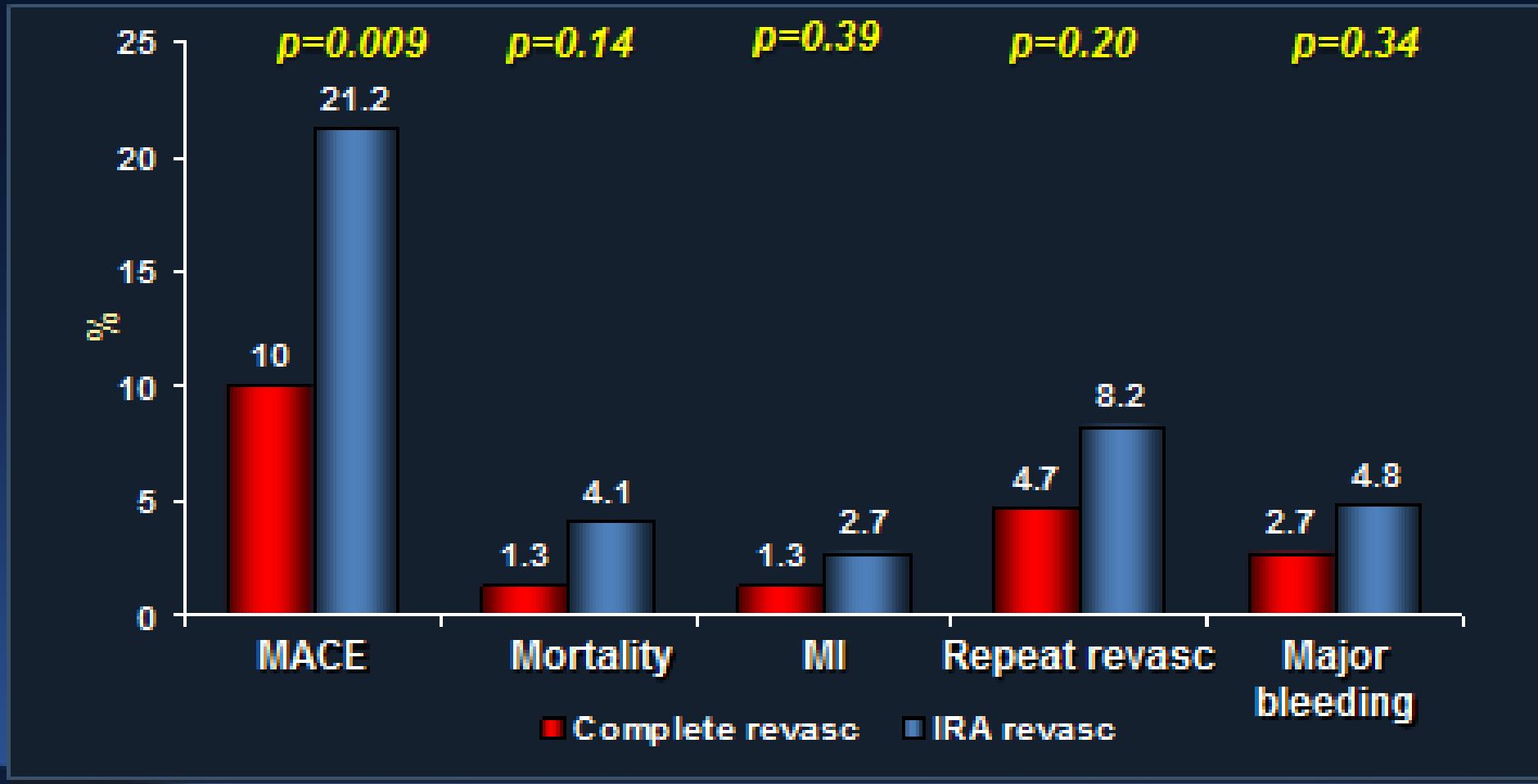
Median FU 2.3 Years

	Complete revasc (N=234)	Culprit PCI only (N=231)	HR (95%CI)	*P* value
Pre-specified outcomes				
Cardiac death, MI, or refractory angina	21	53	0.35 (0.21-0.58)	<0.001
Cardiac death or MI	11	27	0.36 (0.18-0.73)	0.004
Cardiac death	4	10	0.34 (0.11-1.08)	0.07
Nonfatal MI	7	20	0.32 (0.13-0.75)	0.009
Refractory angina w/o CD or MI	12	30	0.35 (0.18-0.69)	0.002
Secondary outcomes				
Noncardiac death	8	6	1.10 (0.38-3.18)	0.86
Repeat revascularization	16	46	0.30 (0.17-0.56)	<0.001

Wald DS. *NEJM* 2013; 19;369:1115-23

CvLPRIT Trial: 12 Month Results (n = 296)

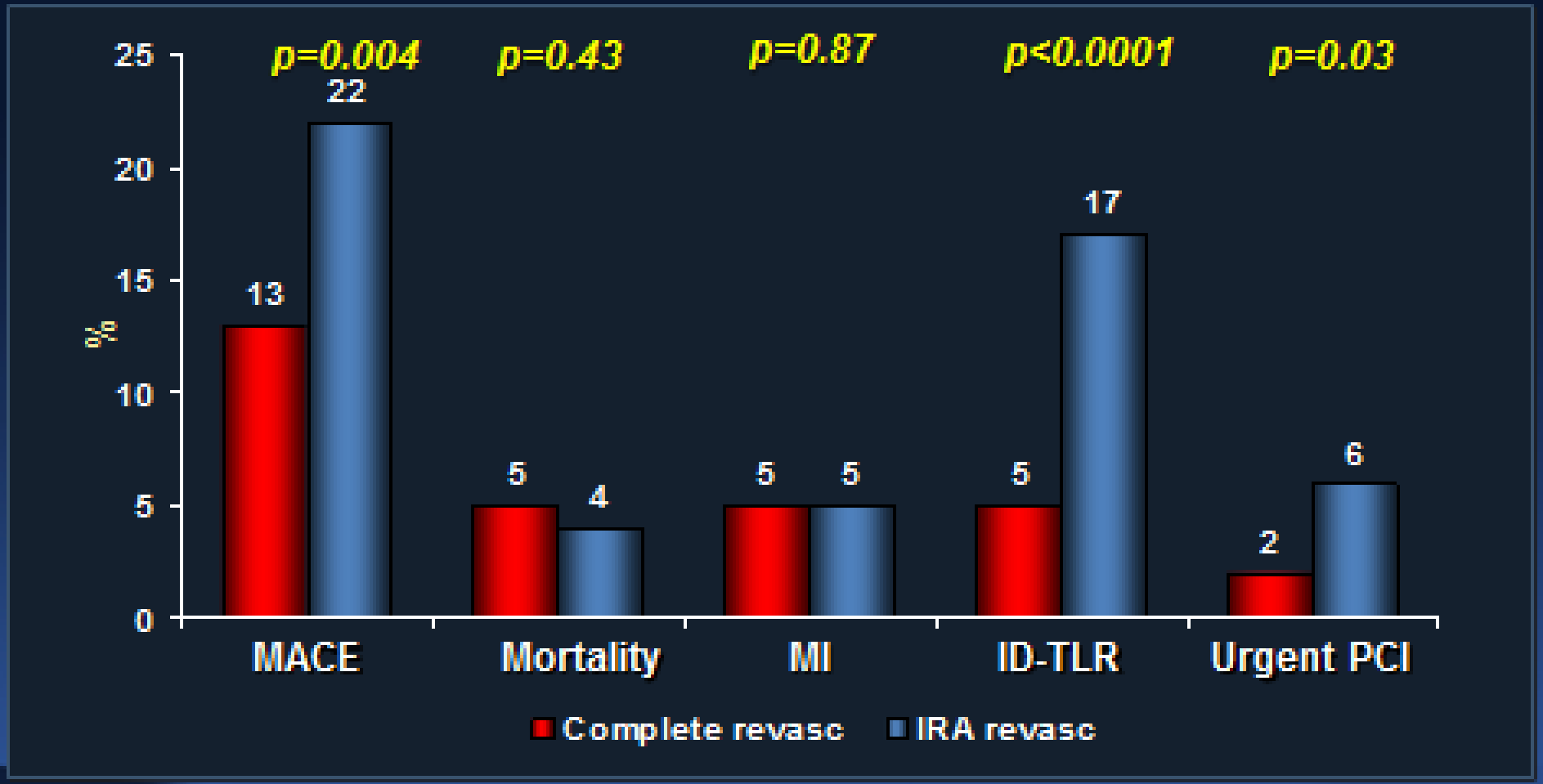
Complete revasc arm: 64% received MVPCI in the same setting, rest were staged before hospital discharge



Gershlick AH. JACC 2015; 65:963-72

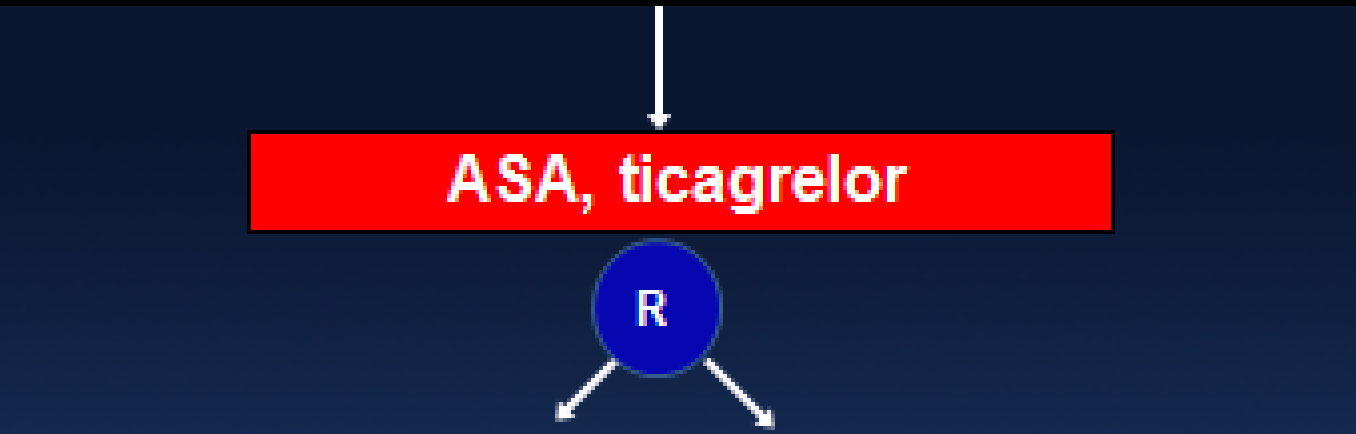
DANAMI3-PRIMULTI: 3 year f/u (n = 627)

FFR-guided complete revasc prior to discharge vs. culprit vessel only (median: 2 days)



COMPLETE

MVD in patients with STEMI undergoing PPCI (n=3,900)



Primary endpoint: CVD/MI

Results expected 2018-19

Primary PCI in STEMI

PCI of a noninfarct artery may be considered in selected patients with STEMI and multivessel disease who are hemodynamically stable, either at the time of primary PCI or as a planned staged procedure

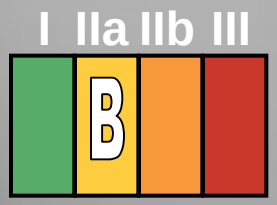
TIMING OF NON-CULPRIT VESSEL PCI IN STABLE STEMI PATIENTS

- Observational study data and meta-analyses suggest that staged MV PCI of non-culprit vessels may be associated with better outcomes than primary MV PCI
- The is insufficient data to inform a recommendation for optimal timing at this time
- Results of the large Multicenter COMPLETE TRIAL are anticipated in 2018 or 2019

Reperfusion at a PCI-Capable Hospital

Aspiration Thrombectomy

2013 Guidelines for Aspiration Thrombectomy



Manual aspiration thrombectomy is reasonable for patients undergoing primary PCI.

Recent Changes in ACC/AHA Guidelines for Treatment of STEMI with Primary PCI

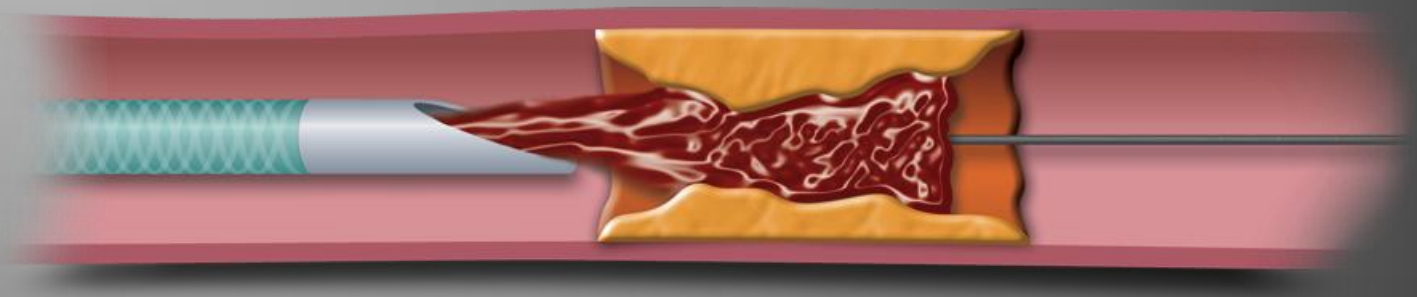
- Non-culprit artery PCI
- Aspiration thrombectomy

Adjunctive Devices That Remove Thrombi and Protect Against Distal Embolization During PCI

- Adjunctive devices have been developed in an attempt to improve clinical outcomes by removing thrombi and to protect against distal embolization during PCI.
- Classes of devices include:
  - Manual end hole aspiration thrombectomy devices
  - Mechanical thrombectomy devices (Angiojet)
  - Embolic protection devices

Thrombectomy Devices

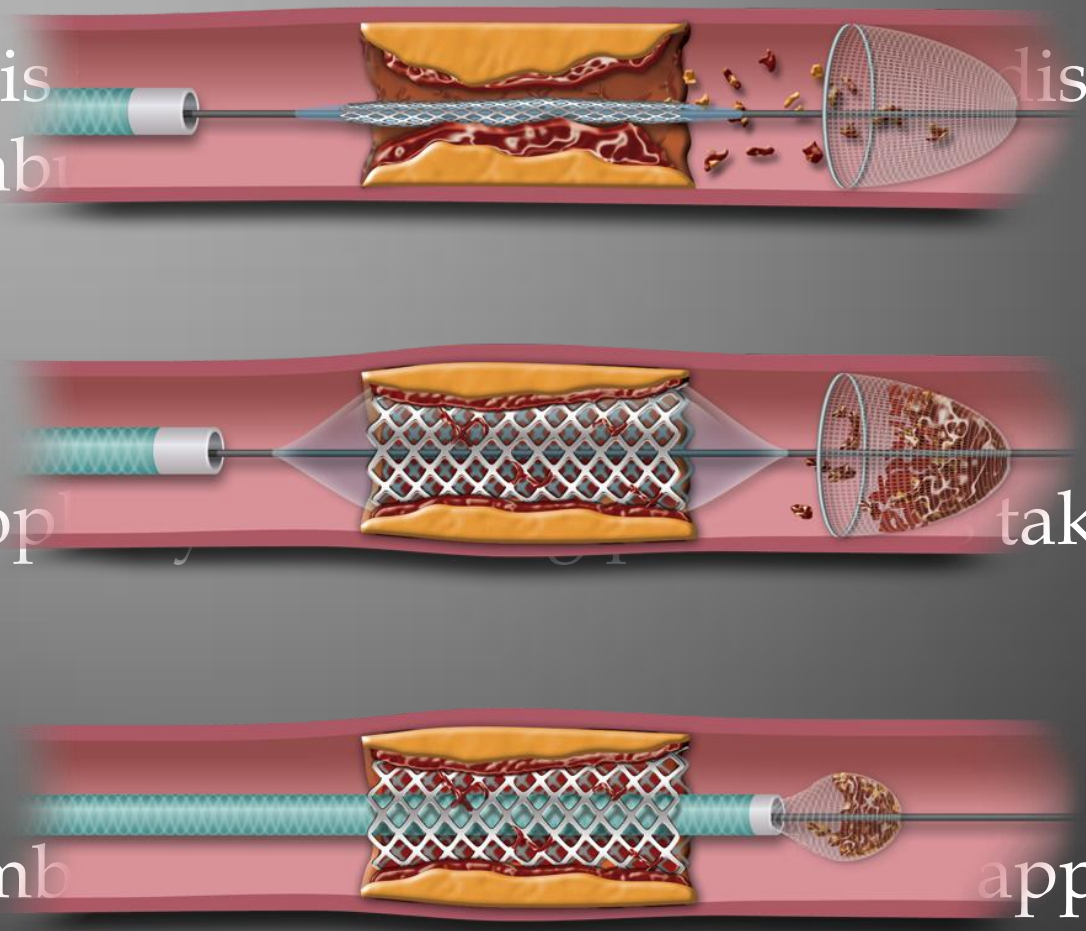
Catheter Aspiration Thrombectomy



Mechanical Thrombectomy

Distal Filter Embolic Protection Devices

- Filter is distal to the thromb
- Angiop take place
- Thromb apped by the filter and removed

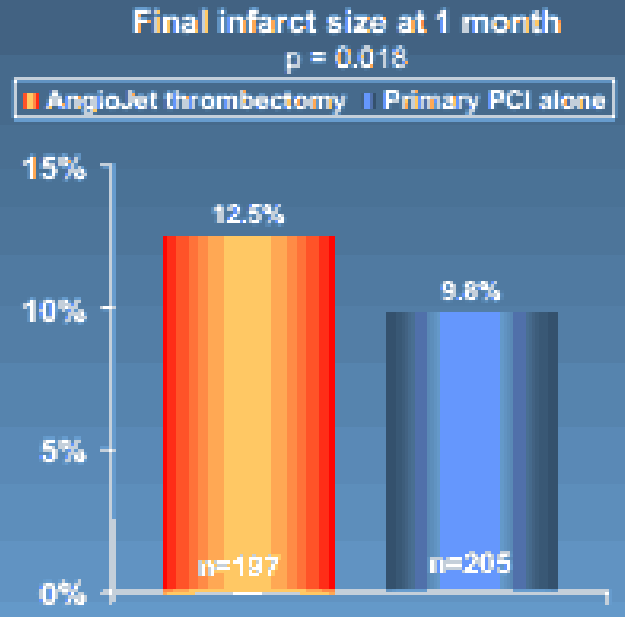


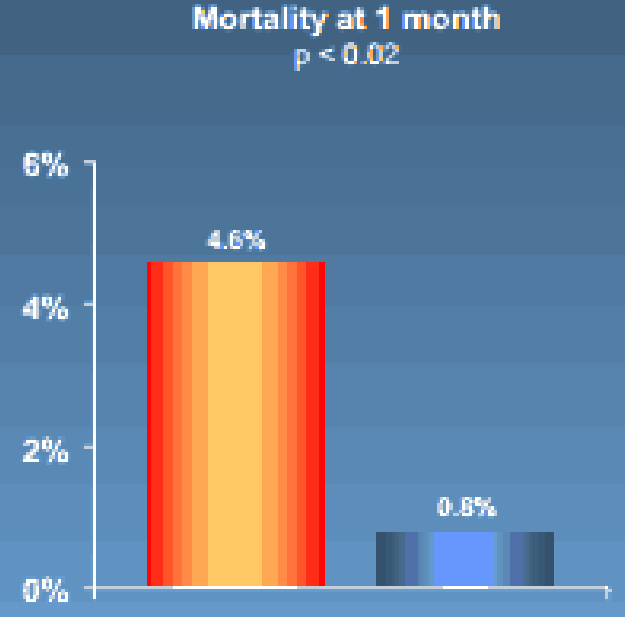
Manual Aspiration Thrombectomy STEMI Trials

- **TAPAS Trial** demonstrated improved blush grade, ST segment resolution and better mortality at 30 days and better cardiac mortality and non-fatal MI at 1 yr (**5.6% vs 9.9%)…**but was a single center trial
- **TASTE Trial** (ESC 2014)…no difference in 30 day or 1 year mortality with thrombus aspiration, but event rate was lower than expected and may be underpowered to demonstrate mortality benefit
- TOTAL Trial…no difference in 180 day CV death, MI, CHF, shock and a small, but significant increased risk of stroke in thrombectomy group
- Meta-analyses of 17 trials…no significant reduction in major cardiac endpoints and NS increase in stroke in thrombectomy group.

AiMI: AngioJet Rheolytic Thrombectomy In Patients Undergoing Primary Angioplasty for Acute MI

- Infarct size at 1 month *larger* and mortality *higher* in AngioJet group





Presented at TCT 2004

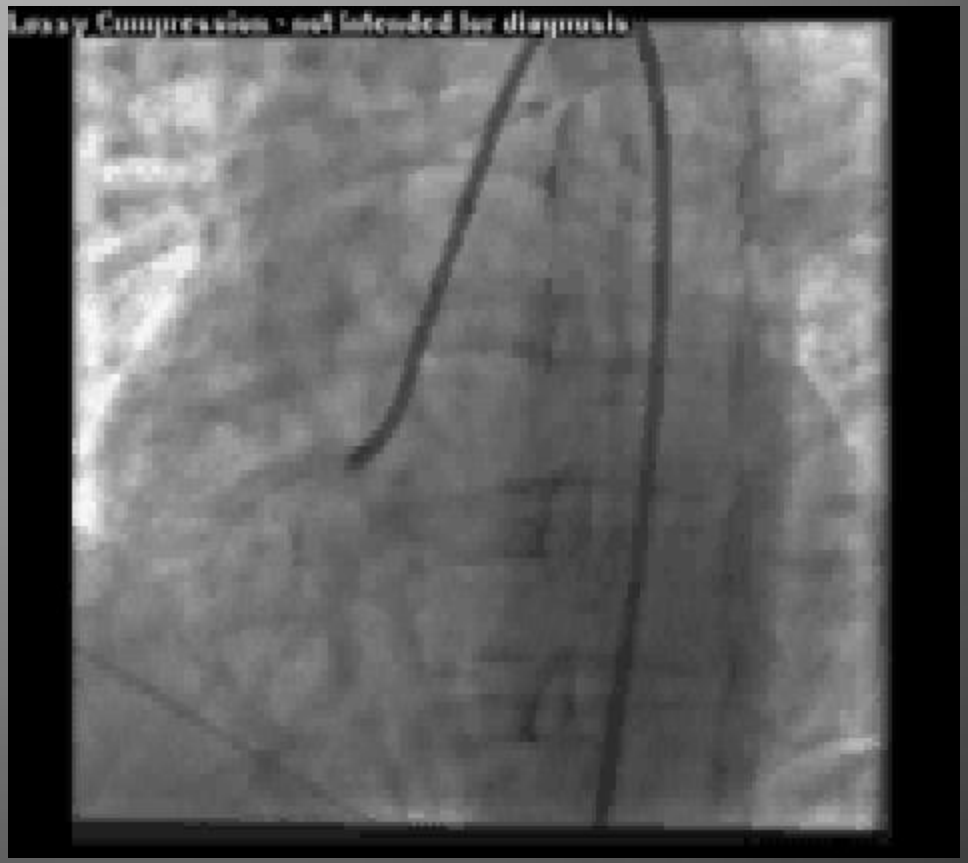
Aspiration Thrombectomy

NEW

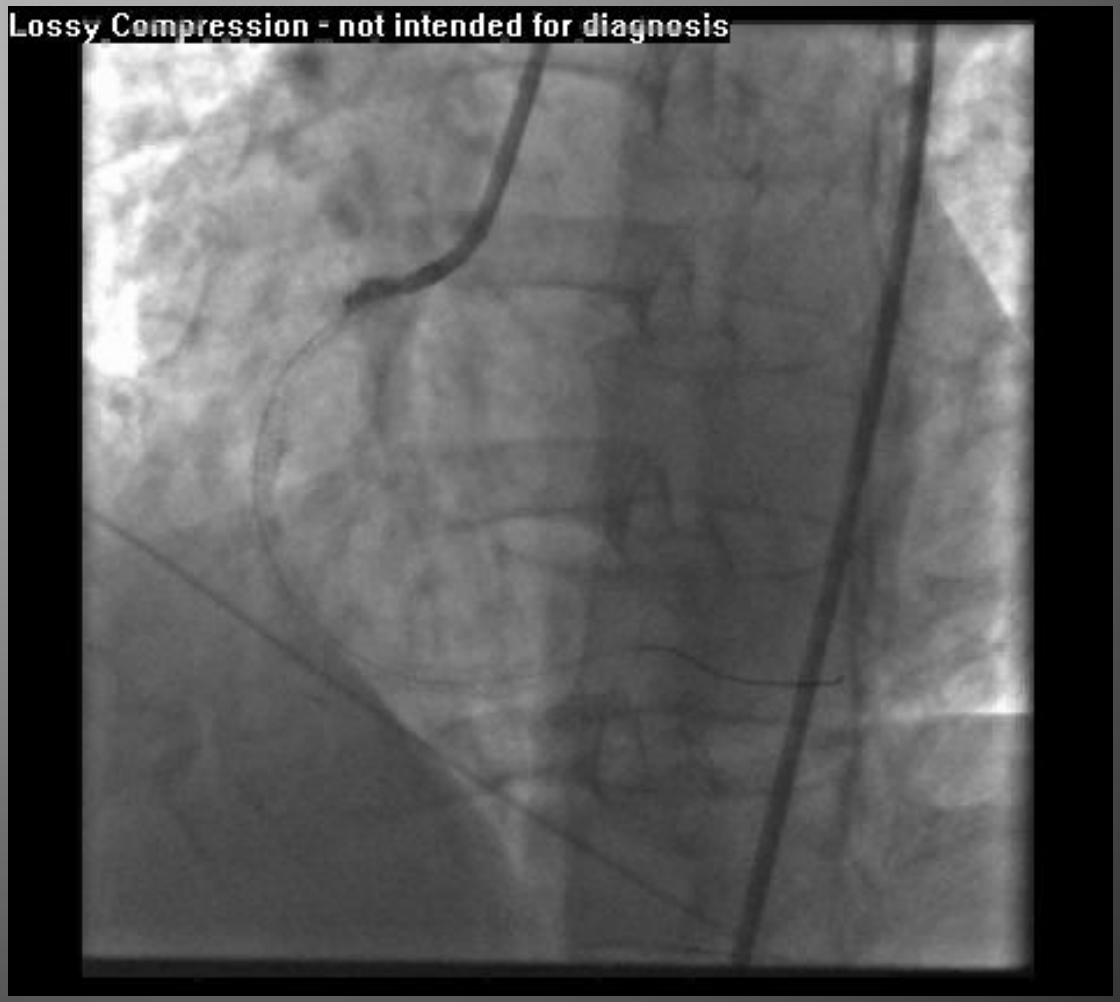
The usefulness of selective and bailout aspiration thrombectomy in patients undergoing primary PCI is not well established.

Routine aspiration thrombectomy before primary PCI is not useful.

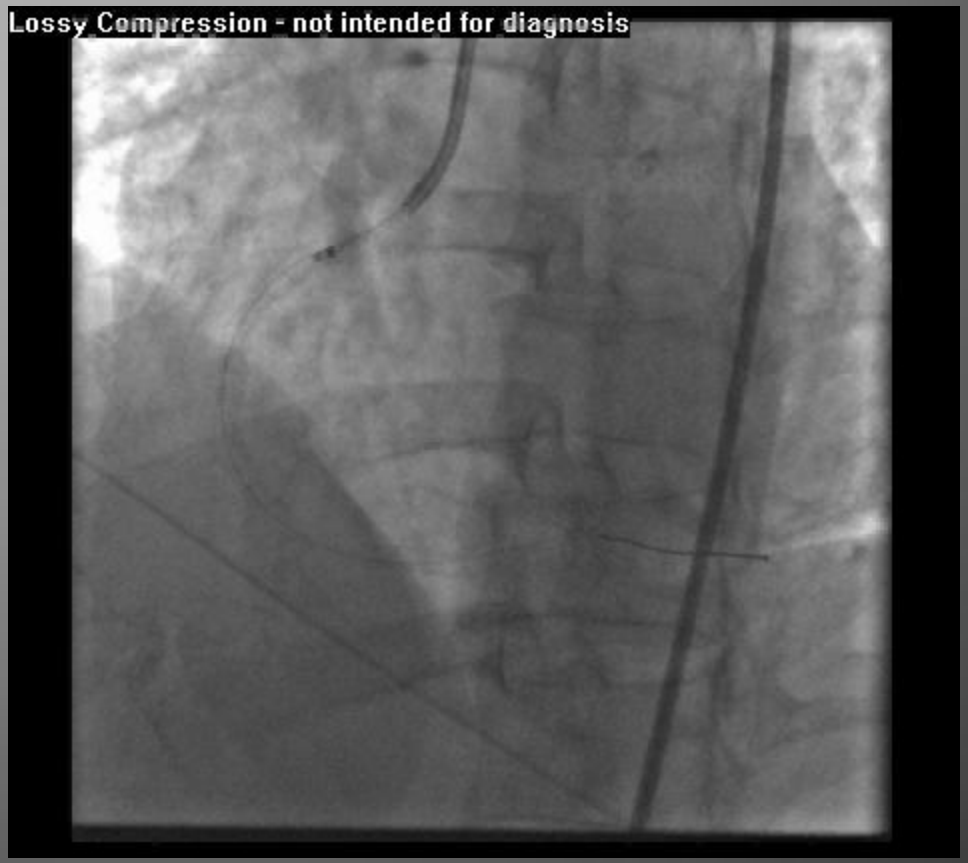
Inferior STEMI d/t stent thrombosis



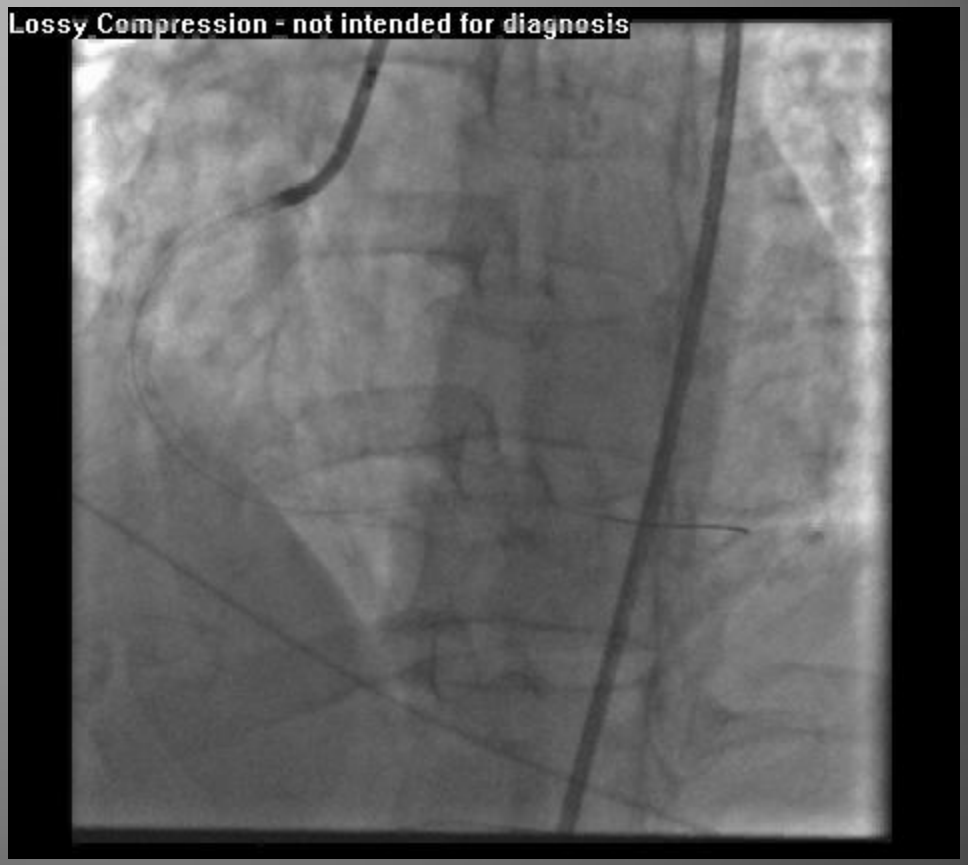
After manual aspiration thrombectomy

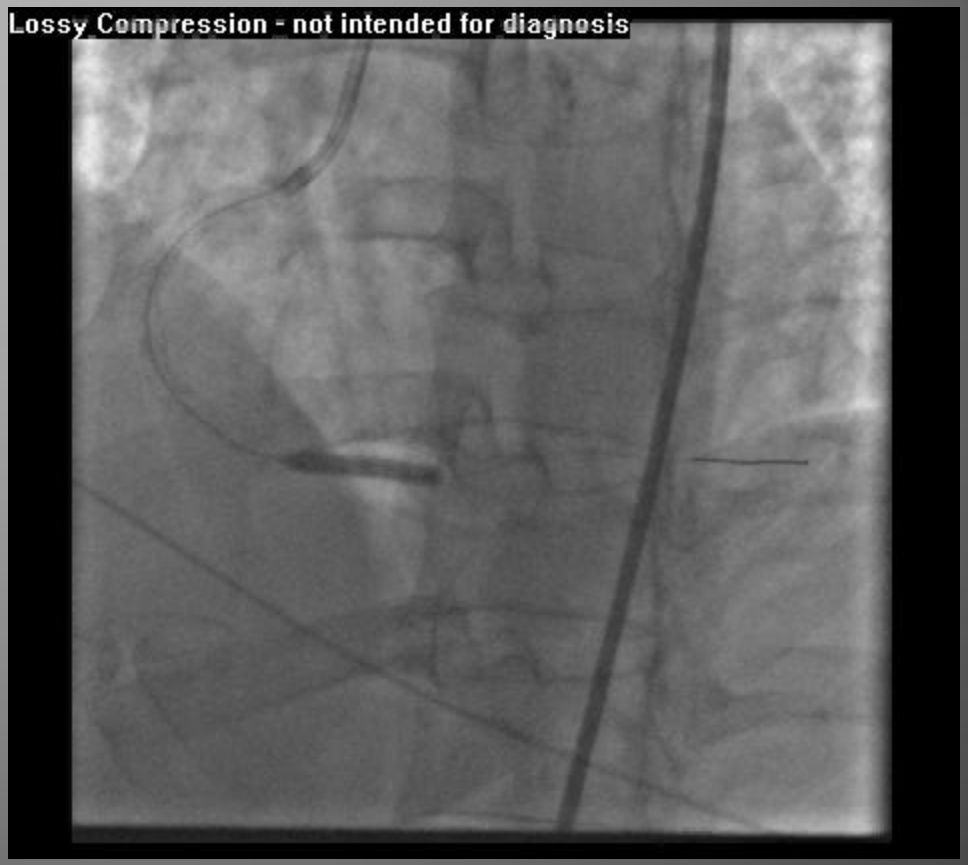


AngioJet

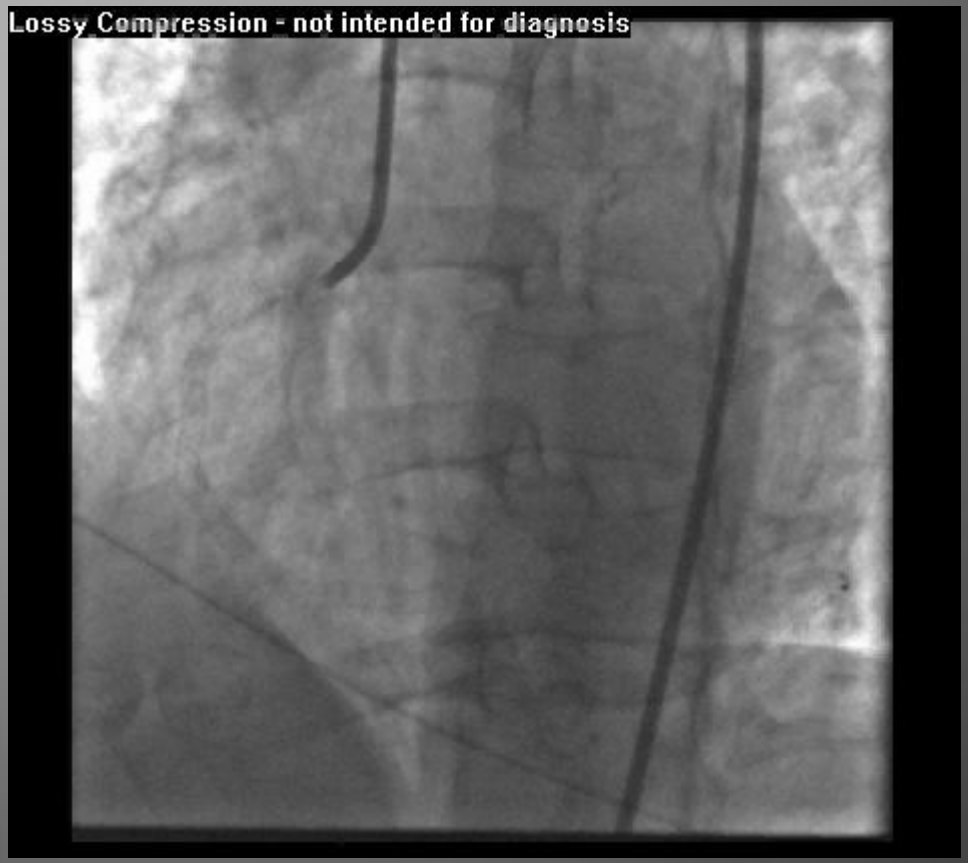


Post-Angiojet




Lossy Compression - not intended for diagnosis

Final



Thrombectomy device can still useful in selective situations

- Large thrombus burden
- No reflow situations after primary PCI due to embolic debris (higher risk in lesions with large thrombotic burden)

Distal Protection Devices

- Routine use is not recommended
- May be useful in large vessels with large thrombus burden where there is concern for distal debris

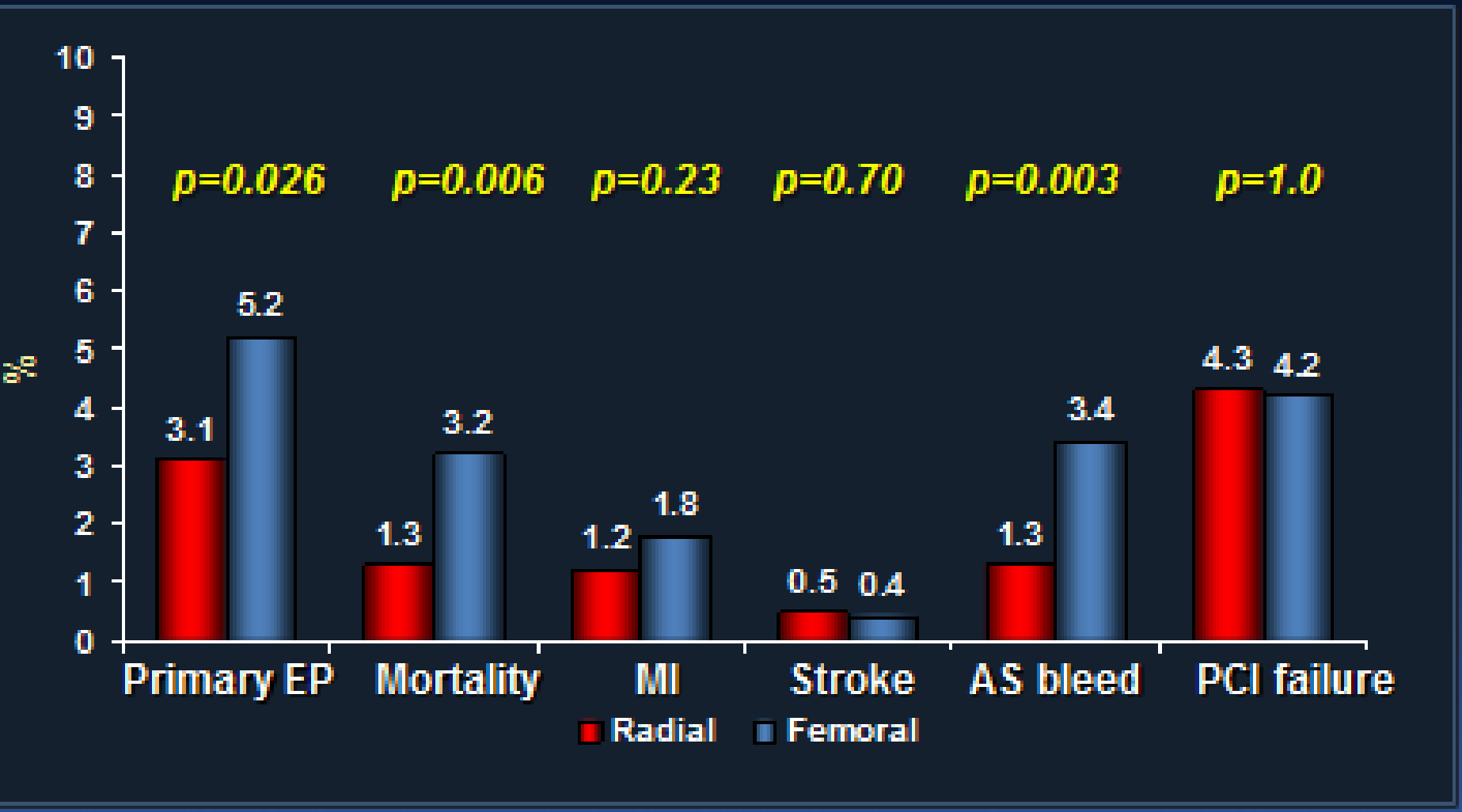
Question: Compared with femoral access, radial access during primary PCI for STEMI is associated with a lower risk of …?

1. Achieving D2B times
2. Stroke
3. PCI success
4. Mortality

Question: Compared with femoral access, radial access during primary PCI for STEMI is associated with a lower risk of …?

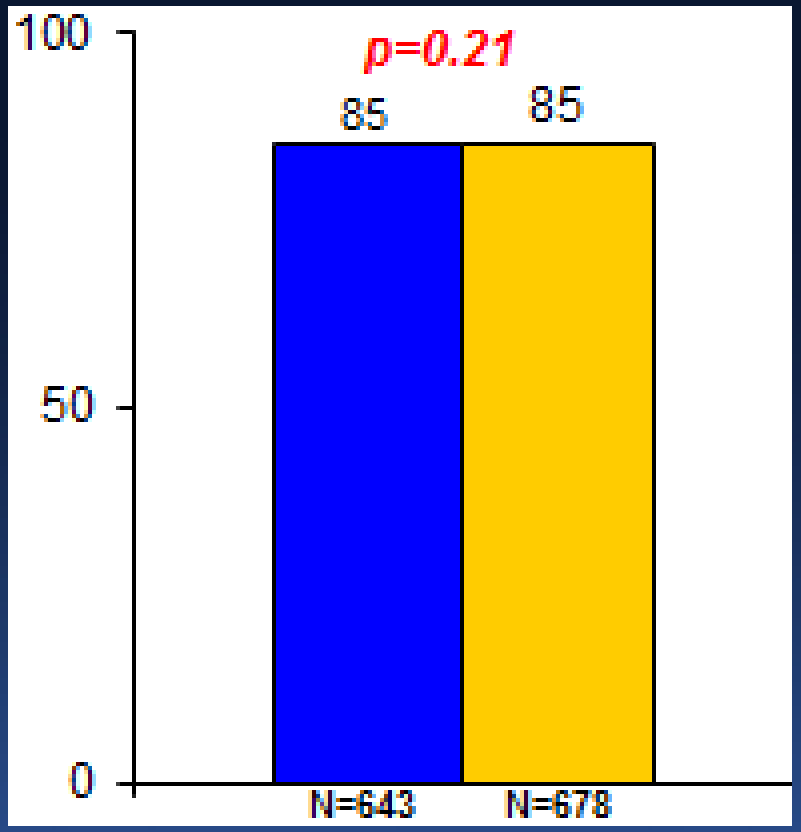
1. Achieving D2B times
2. Stroke
3. PCI success
4. Mortality

RIVAL Trial: STEMI Cohort (n = 1958)

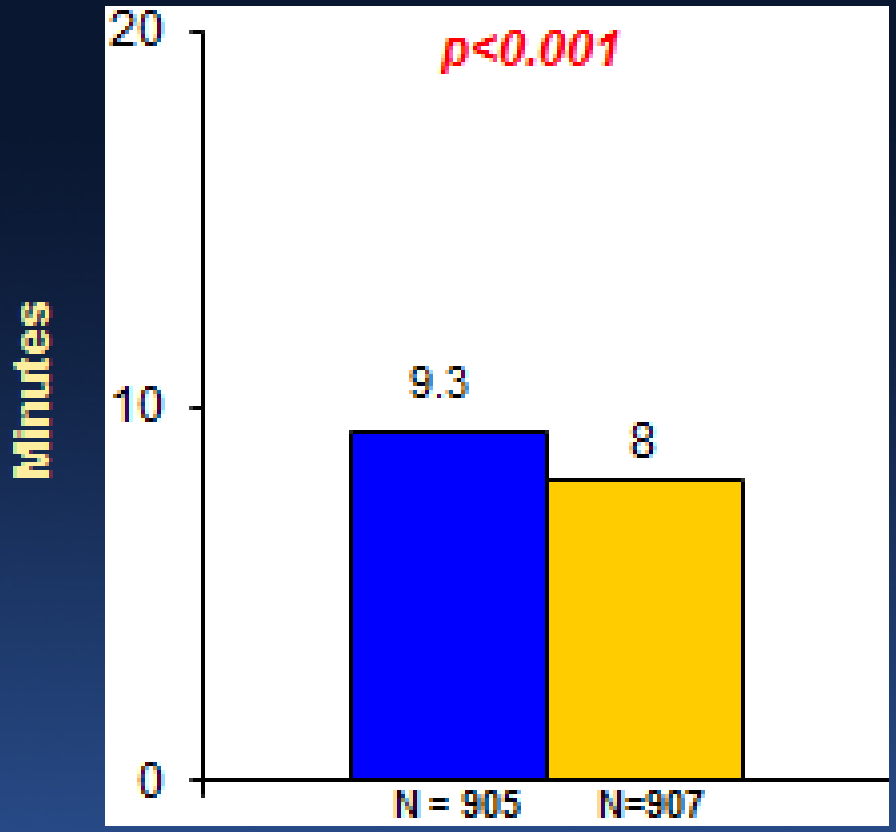


Time Intervals: RIVAL STEMI

D2PCI



Fluoroscopy times

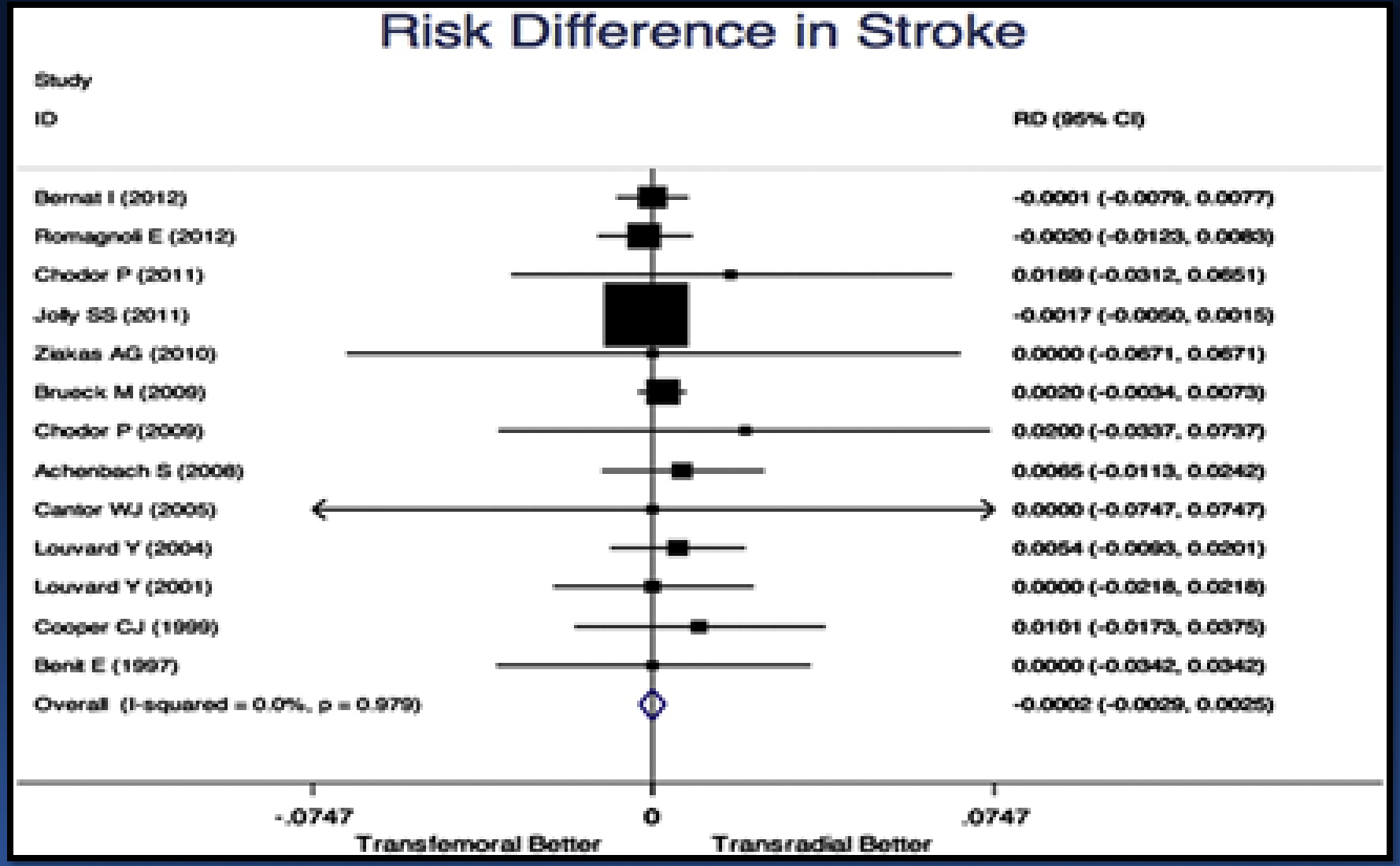


Transradial

Transfemoral

Mehta SR. *JACC* 2012;60:2490-9

Stroke: Meta-analysis



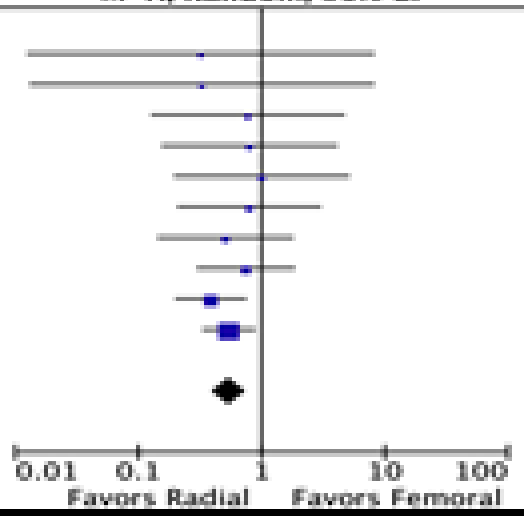
Patel VG, Kumbhani DJ, et al.
Int J Card 2013;6:5234-8

All-cause Mortality: Meta-analysis

Study or Subgroup	Radial Events	Radial Total	Femoral Events	Femoral Total	Weight	Odds Ratio M-H, Random, 95% CI
RADIAMI II 2011	0	49	0	59		Not estimable
RADIAL-AMI 2005	0	25	1	25	1.0%	0.32 [0.01, 8.25]
RADIAMI 2009	0	50	1	50	1.0%	0.33 [0.01, 8.21]
Gan 2009	2	90	3	105	3.1%	0.77 [0.13, 4.73]
Yan 2008	3	57	3	46	3.7%	0.80 [0.15, 4.14]
FARMI 2007	3	57	3	57	3.8%	1.00 [0.19, 5.18]
Hou 2010	4	100	5	100	5.6%	0.79 [0.21, 3.04]
TEMPURA 2003	4	77	7	72	6.3%	0.51 [0.14, 1.82]
STEMI-Radial 2012	8	348	11	359	11.9%	0.74 [0.30, 1.87]
RIVAL 2012	12	955	32	1003	22.7%	0.39 [0.20, 0.75]
RIFLE-STEACS 2012	26	500	46	501	41.0%	0.54 [0.33, 0.89]
Total (95% CI)		**2308**		**2377**	**100.0%**	**0.55 [0.40, 0.76]**
Total events	62		112			

Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 2.83$, df = 9 (P = 0.97); $I^2 = 0\%$

Test for overall effect: Z = 3.66 (P = 0.0003)

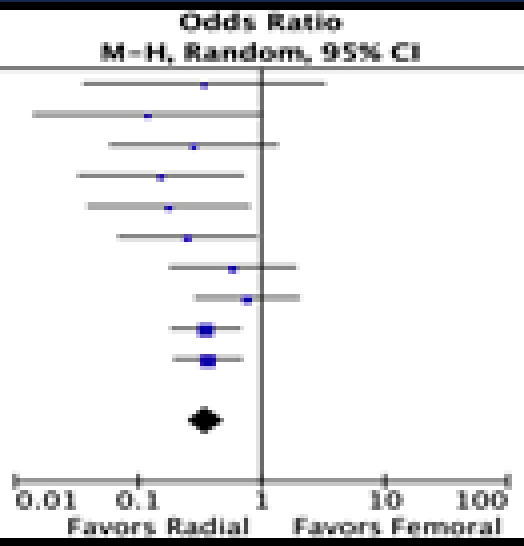


Access-site Bleeding: Meta-analysis

Study or Subgroup	Radial Events	Radial Total	Femoral Events	Femoral Total	Weight	Odds Ratio M-H, Random, 95% CI
STEMI-Radial 2012	1	348	3	359	2.3%	0.34 [0.04, 3.30]
Yan 2008	1	57	6	46	2.5%	0.12 [0.01, 1.03]
Li 2007	2	184	7	186	4.6%	0.28 [0.06, 1.37]
FARMI 2007	2	57	11	57	4.8%	0.15 [0.03, 0.72]
Gan 2009	2	90	12	105	5.0%	0.18 [0.04, 0.81]
Hou 2010	3	100	11	100	6.8%	0.25 [0.07, 0.93]
RADIAMI 2009	5	50	8	50	8.2%	0.58 [0.18, 1.92]
RADIAMI II 2011	8	49	12	59	11.9%	0.76 [0.28, 2.05]
RIVAL 2012	12	955	35	1003	26.6%	0.35 [0.18, 0.68]
RIFLE-STEACS 2012	13	500	34	501	27.4%	0.37 [0.19, 0.70]
Total (95% CI)		**2390**		**2466**	**100.0%**	**0.35 [0.25, 0.50]**
Total events	49		139			

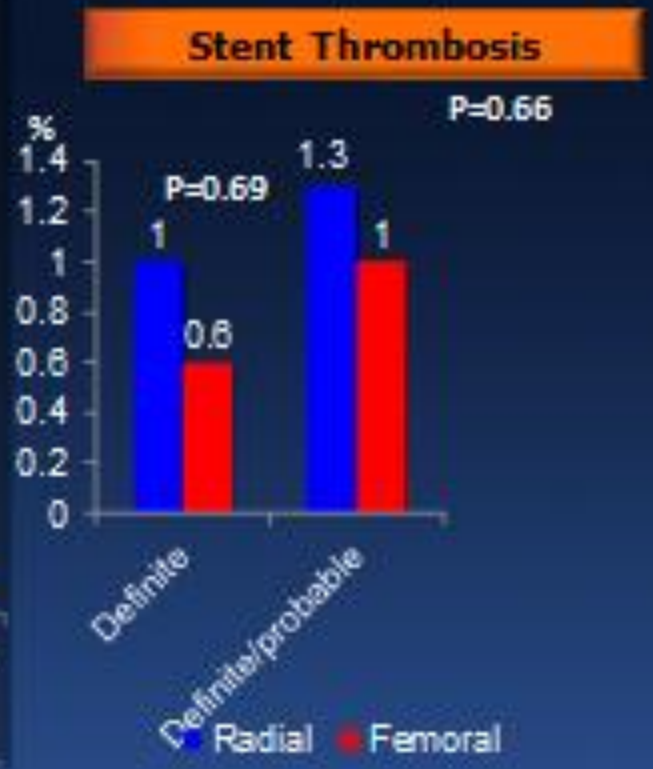
Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 6.33$, df = 9 (P = 0.71); $I^2 = 0\%$

Test for overall effect: Z = 5.95 (P < 0.00001)



Fatal and ST Endpoints:

All-Cause, Cardiac, non-CV mortality, type of stent thrombosis



iASSESS

Cardiovascular Research Foundation

ACC/AHA Guidelines for Cardiogenic Shock

Emergency revascularization with either PCI or CABG is recommended in suitable patients with cardiogenic shock due to pump failure after STEMI irrespective of the time delay from MI onset

In the absence of contraindications, fibrinolytic therapy should be administered to patients with STEMI and cardiogenic shock who are unsuitable candidates for either PCI or CABG

The use of intra-aortic balloon pump (IABP) counterpulsation can be useful for patients with cardiogenic shock after STEMI who do not quickly stabilize with pharmacological therapy

CARDIOGENIC SHOCK IN AMI

- Mortality is extremely high even with successful PCI
- Warrants emergent echo, if feasible, to assess for mechanical complications and exclude LV mural thrombus if intraventricular support is anticipated
- Circulatory support can be beneficial in stabilizing hemodynamics
- Emphasis shifts from D2B (door to balloon) to D2S (door to support), then PCI.

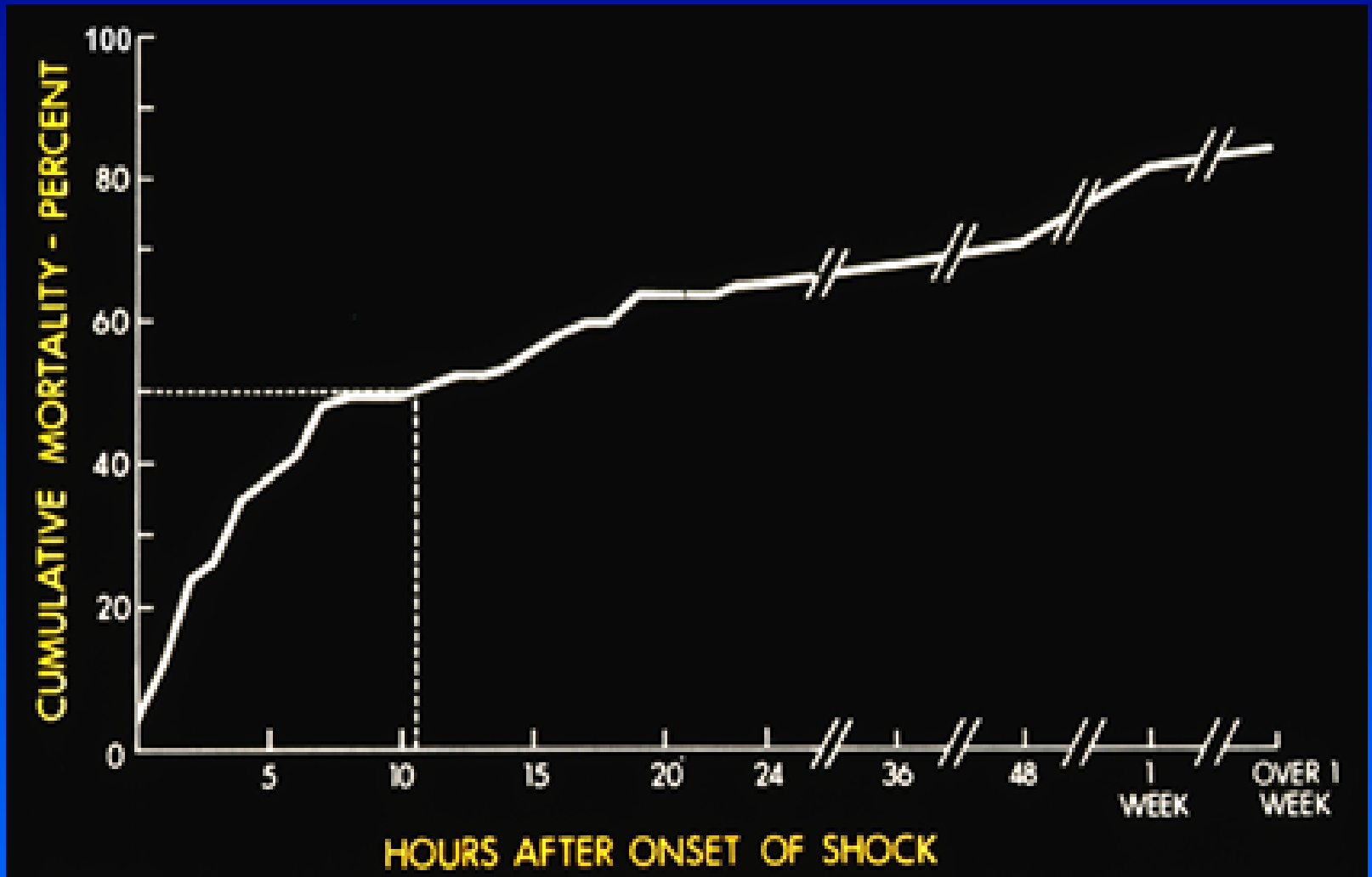


Figure 7. Cumulative mortality from the time of onset of shock. Half the group are dead within 10.2 hr (**thin dashed line**). Overall mortality is 86 percent.

CAUSES OF CARDIOGENIC SHOCK IN AMI

1. LV dysfunction d/t myocardial necrosis and stunning
2. Rhythm disturbances including bradycardia, complete heart block, VT
3. Hypovolemia, anemia, bleeding
4. Vagal reactions
5. Mechanical complications:

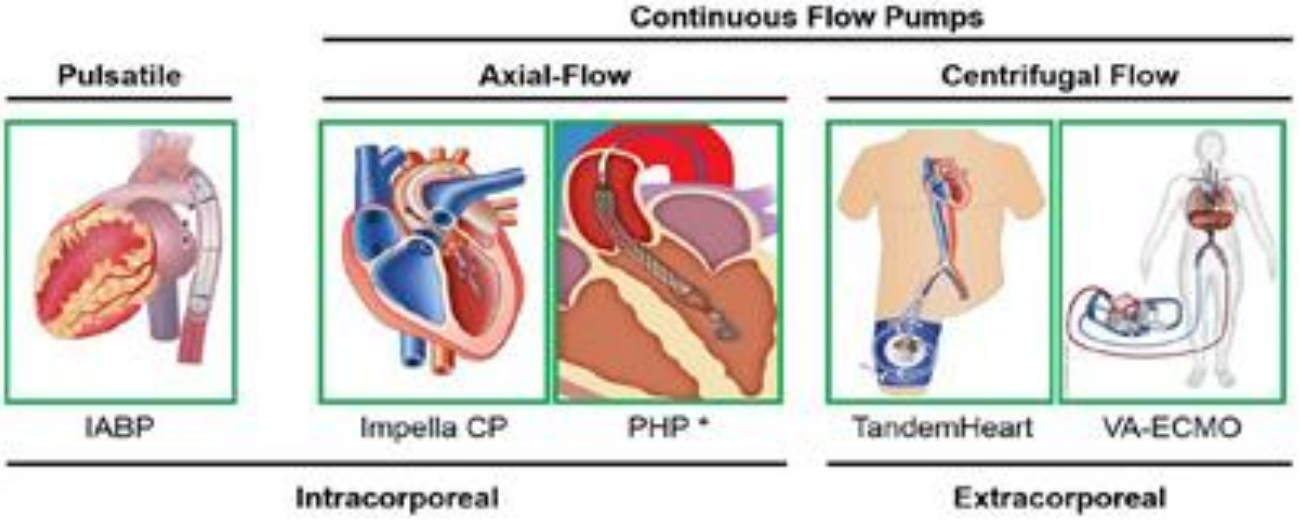
   a. myocardial free wall rupture with tamponade

   b. Acute VSD (septal rupture into RV)

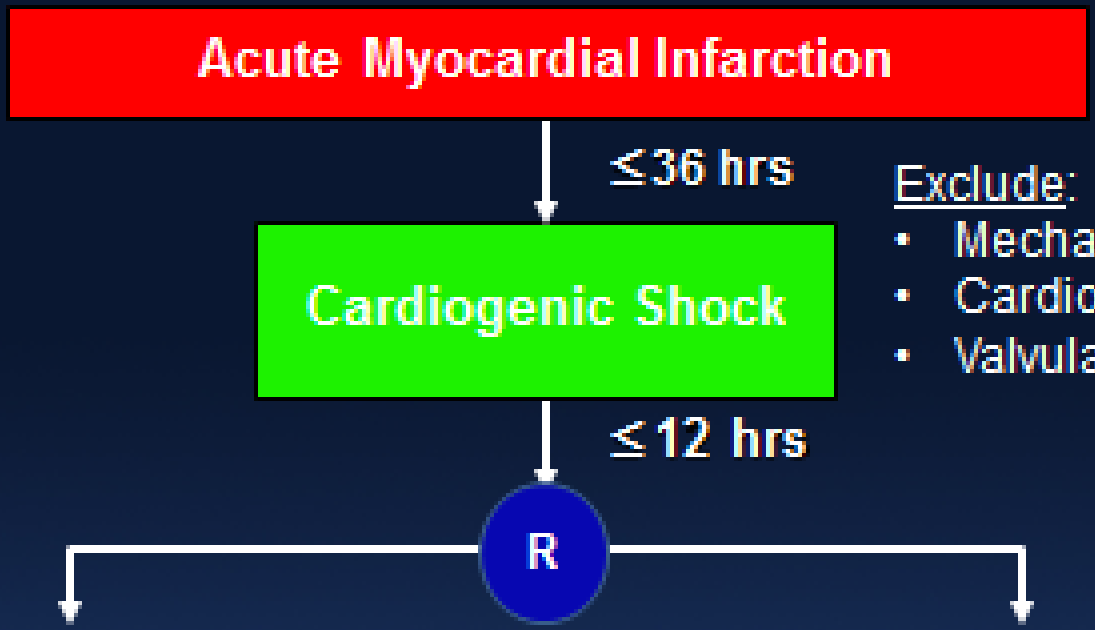
   c. Acute MR d/t papillary muscle dysfunction or rupture.

Percutaneous Mechanical Support Devices

- IABP
- Impella (2.5, CP, 5.0, and RP)
- TandemHeart
- VA-ECMO



SHOCK Trial



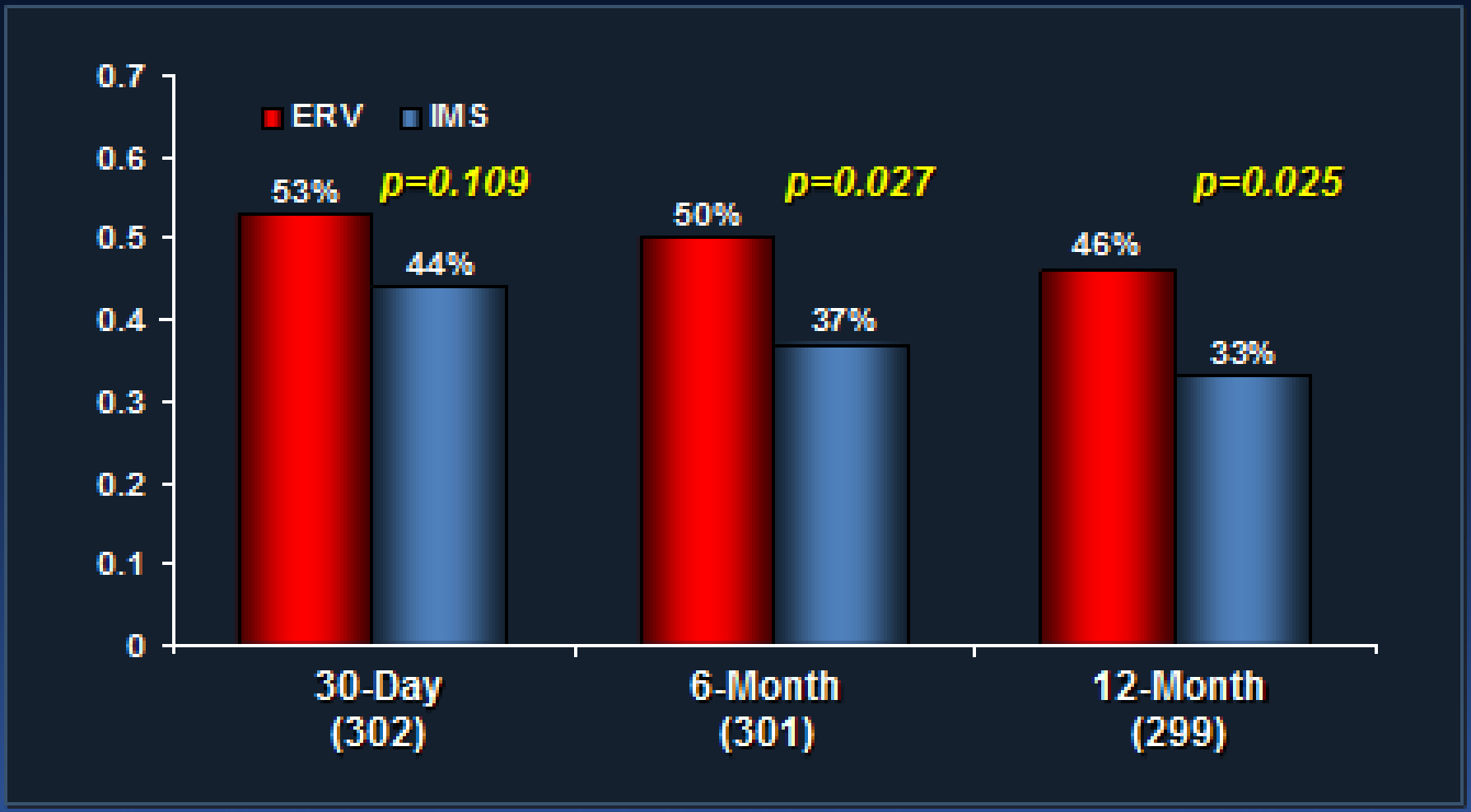
Exclude:
- Mechanical shock
- Cardiomyopathy
- Valvular disease

- IABP Support (86%)
- Possible Prior Thrombolysis (49%)
- Emergency Early PTCA/CABG ≤ 6 hrs (87%; 55% PCI)

- IABP (86%)
- Thrombolysis Unless Absolute Contraindication (63%)
- Possible Delayed Revascularization > 54 hrs (21.3%)

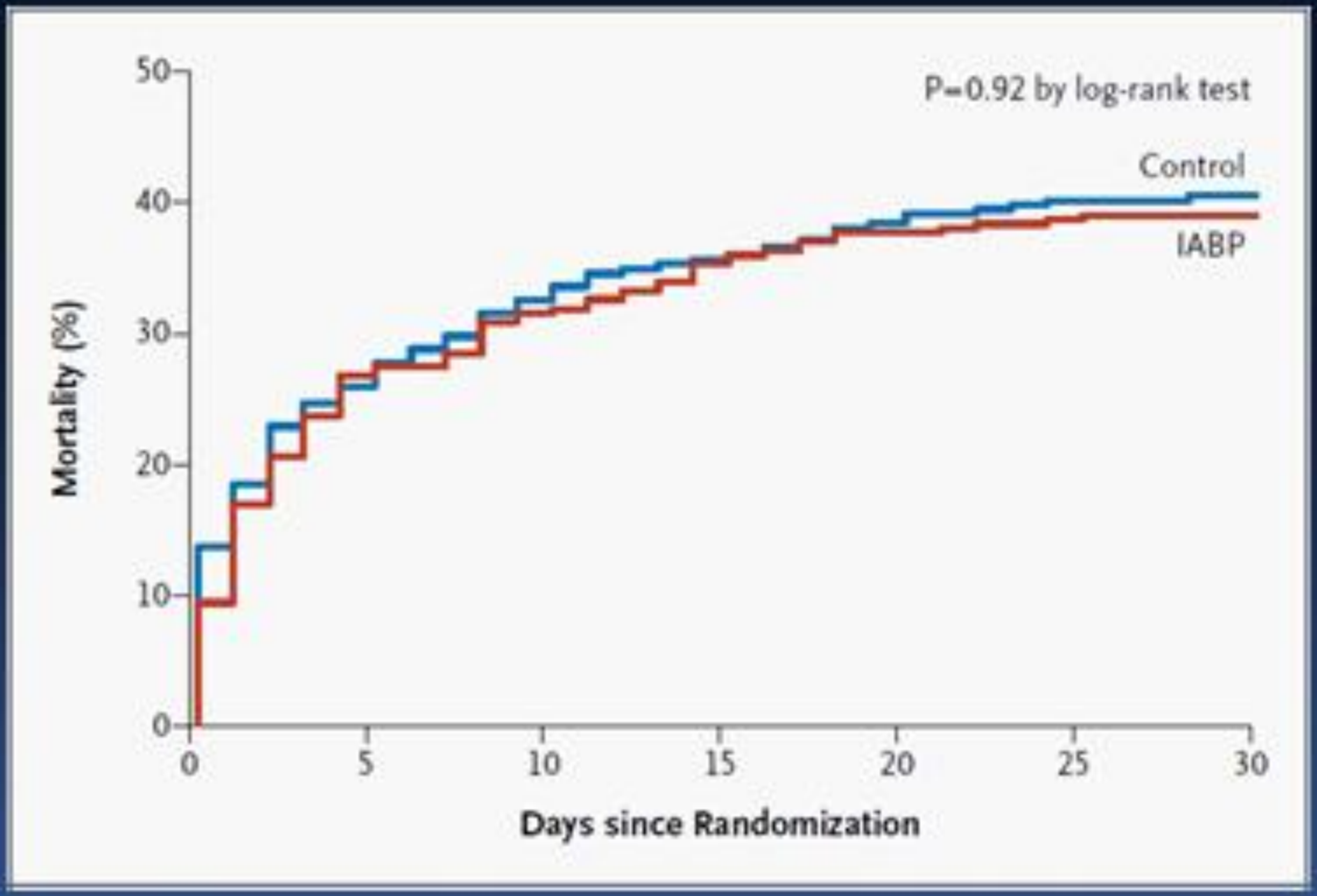
Hochman JS. *NEJM* 1999;341:625-34

SHOCK Trial: 12-Month Survival



Hochman JS. *NEJM* 1999;341:625-34

IABP-SHOCK II Trial



Thiele H. *NEJM* 2012;367:1287-96

Impella

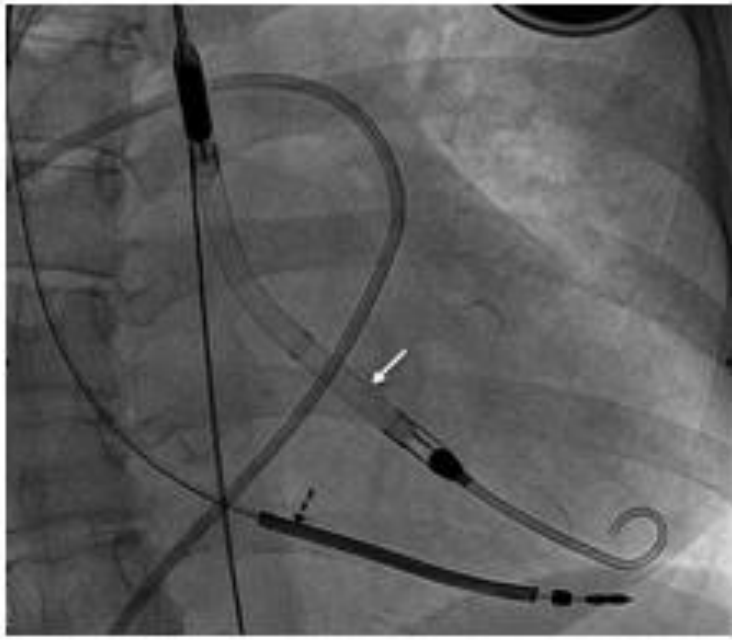
Want inlet ~3.5cm distal to the aortic valve

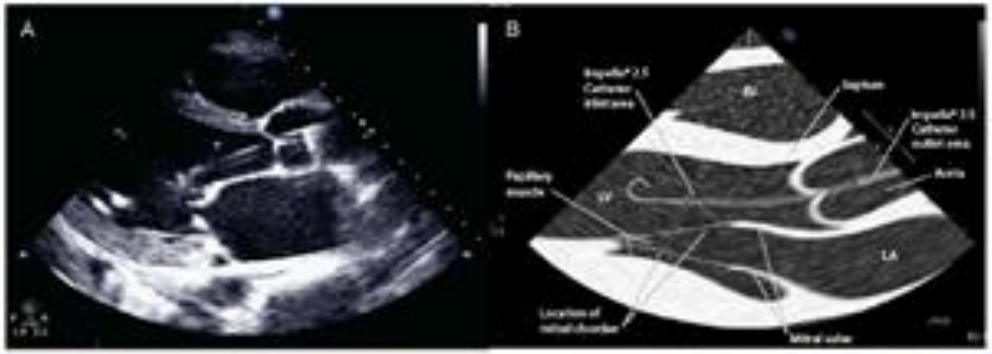
Want device in apex so that its not stuck in papillary muscles or interfering with the anterior mitral leaflet

Remove excess slack from the catheter

Get echo afterward to check positioning

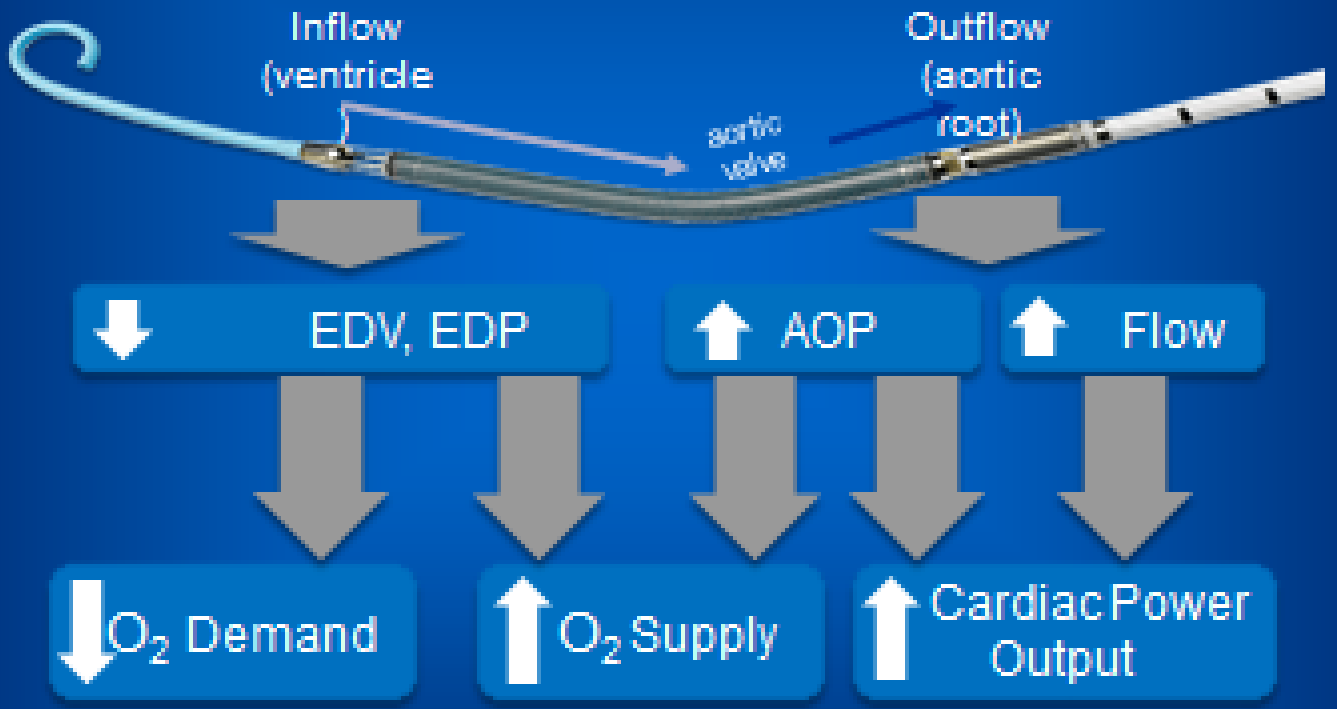
Several alarms to notify you of incorrect positioning or suction/purge problems





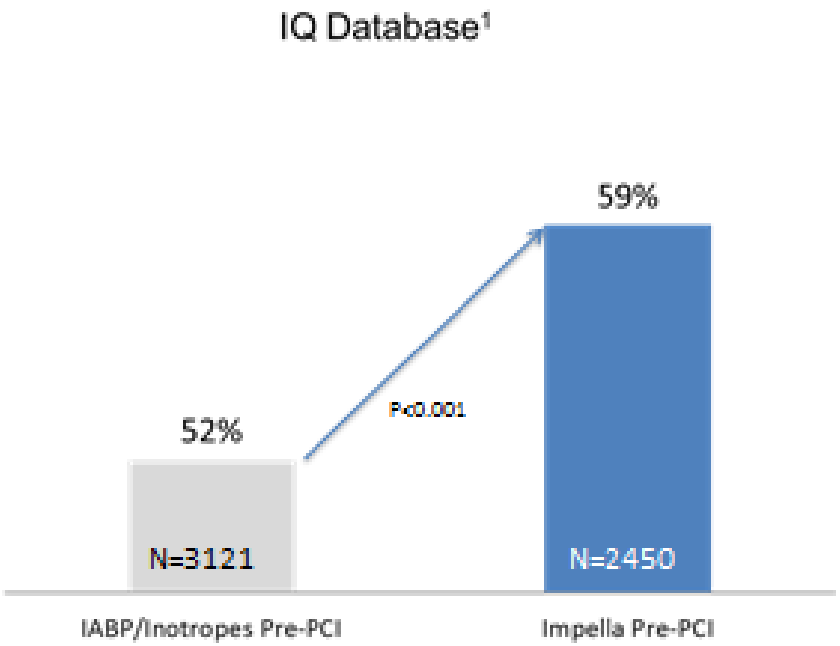
Principles of Impella Design

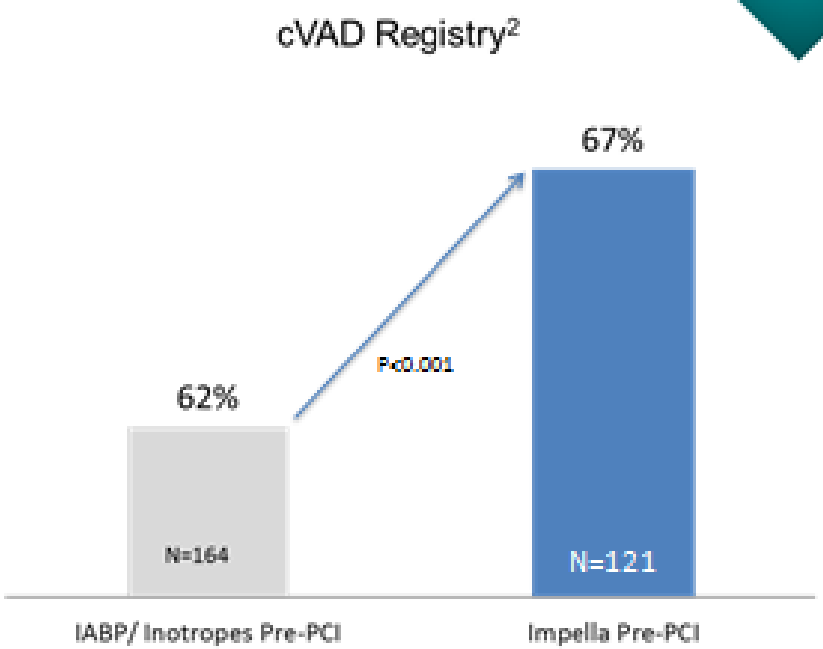
Mimic Heart's Natural Function



Impella Pre-PCI associated with Improved Survival in AMI/CGS

ACC.17

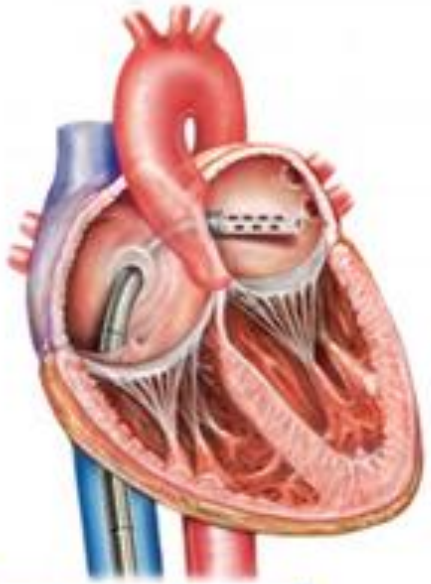




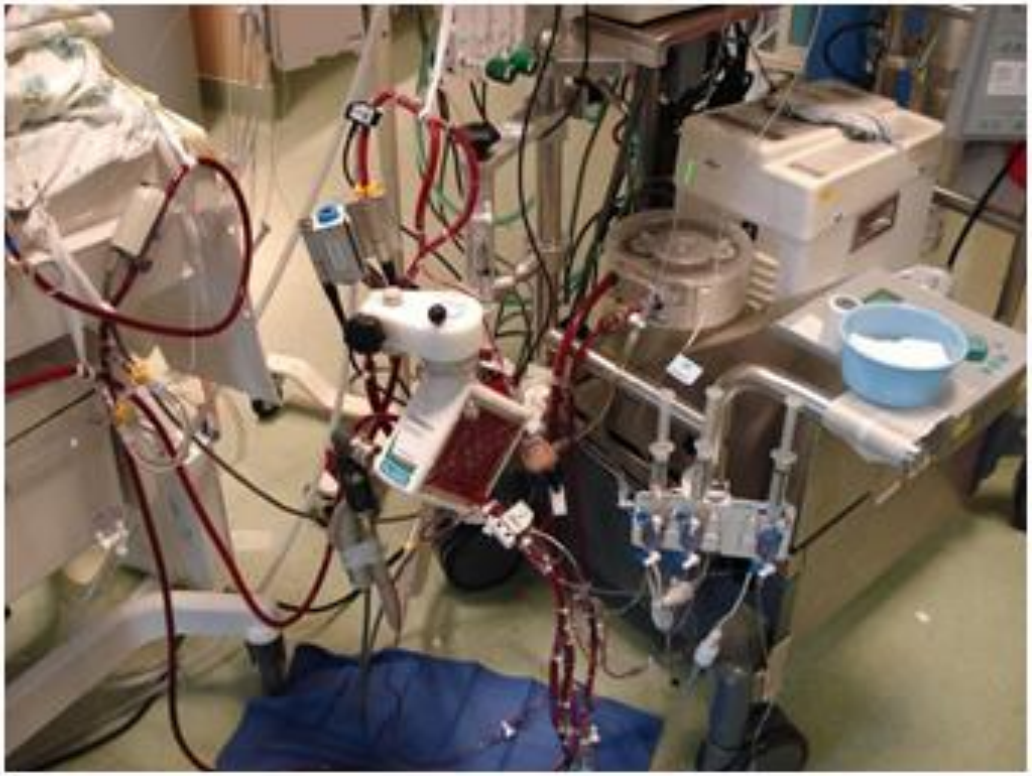
1. *Abiomed Impella Quality (IQ) Database, US AMI/CGS Apr 2009– Jan 2017. Survival to Explant. Danvers, MA: Abiomed.*
2. *Basir M, Schreiber T, Grines C, et al. Effect of Early Initiation of Mechanical Circulatory Support on Survival in Cardiogenic Shock. Am. J. of Cardiology; 2016*

TandemHeart

- Extracorporeal centrifugal flow pump that provides up to 5L/min
- Oxygenated blood is aspirated from the LA (21F inflow cannula) and injected into the lower abdominal aorta or iliac arteries via a 15-19F femoral artery cannula
- Requires a transseptal puncture
- Need some RV function to generate the necessary LA volume
- An oxygenator can be added (and inflow cannula can be pulled back) to convert to cardiopulmonary bypass



ECMO



ECMO Physiology

- Essentially a mini-bypass offering full cardiopulmonary support
- Reduces both right and left ventricular volumes with a concomitant increase in mean arterial pressure
- Reduces LV preload, but increases afterload—increases myocardial oxygen demand
- Rapidly improves tissue oxygenation

Guideline for STEMI

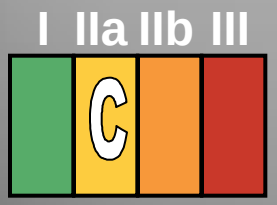
Reperfusion at a Non–PCI-Capable Hospital

Reperfusion at a Non–PCI-Capable Hospital

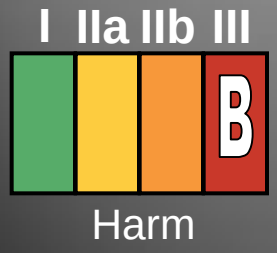
Fibrinolytic Therapy When There Is an Anticipated Delay to Performing Primary PCI Within 120 Minutes of FMC

Fibrinolytic Therapy When There Is an Anticipated Delay to Performing Primary PCI Within 120 Minutes of FMC

In the absence of contraindications, fibrinolytic therapy should be given to patients with STEMI and onset of ischemic symptoms within the previous 12 hours when it is anticipated that primary PCI cannot be performed within 120 minutes of FMC.



In the absence of contraindications and when PCI is not available, fibrinolytic therapy is reasonable for patients with STEMI if there is clinical and/or ECG evidence of ongoing ischemia within 12 to 24 hours of symptom onset and a large area of myocardium at risk or hemodynamic instability.



Fibrinolytic therapy should not be administered to patients with ST depression except when a true posterior (inferobasal) MI is suspected or when associated with ST elevation in lead aVR.

Indications for Fibrinolytic Therapy When There Is a >120-Minute Delay From FMC to Primary PCI

	COR	LOE
Ischemic symptoms <12 h	I	A
Evidence of ongoing ischemia 12 to 24 h after symptom onset and a large area of myocardium at risk or hemodynamic instability	IIa	C
ST depression, except if true posterior (inferobasal) MI is suspected or when associated with ST elevation in lead aVR	III: Harm	B

Fibrinolytic Agents

- Alteplase (tPA): Given as infusion
- Reteplase (Retavase): Given as double bolus
- Tenecteplase (TNK): Given as a weight adjusted bolus (preferred agent)

FIBRINOLYTIC Rx for STEMI

- Efficacy/benefit falls quickly after onset of symptoms
- Best w/i 70 min of symptom onset
- Good efficacy up to 4 hours
- Waning benefit after 4 hours
- Limited, but potential benefit after 7 hours
- After 12 hours only for hemodynamic instability or ongoing ischemic symptoms w/o option for PCI

Reperfusion at a Non–PCI-Capable Hospital

Transfer of Patients With STEMI to a PCI-Capable Hospital for Coronary Angiography After Fibrinolytic Therapy

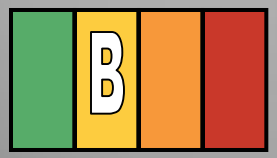
Transfer of Patients With STEMI to a PCI-Capable Hospital for Coronary Angiography After Fibrinolytic Therapy

Immediate transfer to a PCI-capable hospital for coronary angiography is recommended for suitable patients with STEMI who develop cardiogenic shock or acute severe HF, irrespective of the time delay from MI onset.

Urgent transfer to a PCI-capable hospital for coronary angiography is reasonable for patients with STEMI who demonstrate evidence of failed reperfusion or reocclusion after fibrinolytic therapy.

Transfer of Patients With STEMI to a PCI-Capable Hospital for Coronary Angiography After Fibrinolytic Therapy

I IIa IIb III



Transfer to a PCI-capable hospital for coronary angiography is reasonable for patients with STEMI who have received fibrinolytic therapy even when hemodynamically stable* and with clinical evidence of successful reperfusion. Angiography can be performed as soon as logistically feasible at the receiving hospital, and ideally within 24 hours, but should not be performed within the first 2 to 3 hours after administration of fibrinolytic therapy.

*Although individual circumstances will vary, clinical stability is defined by the absence of low output, hypotension, persistent tachycardia, apparent shock, high-grade ventricular or symptomatic supraventricular tachyarrhythmias, and spontaneous recurrent ischemia.

D2B Time Issues

- Longer D2B times are associated with worse outcomes
- Cath Registry data suggests that improvement in D2B times have not led to significant improvement in STEMI survival rates
- Mean D2B decreased from **83** min (2005-6) to **68** min (2008-9)
- Unadjusted mortality **decreased from 4.8% to 4.7% (NS)**
- Risk adjusted mortality **decreased from 5% to 4.7% (NS)**

D2B Issues

- Time delay from symptom onset to reperfusion appears to impact benefit of shorter D2B times
- Early presenters (< 3hrs from sx onset) benefit from D2B < 2hrs vs > 2 hours (**7 year mortality 15% vs 24.7%)**
- Late presenters (> 3rs from onset) did not demonstrate significant decrease in 7 year mortality from D2B <2hrs vs >2 hrs (**18.5% vs 21% NS)**

D2B Issues

- High risk pts with **Killip class 3 or 4 heart failure , age > 70 or anterior MI** benefit more from shorter D2B time with lower 7 year mortality
- Longer D2B time may be also a marker for sicker patients with inherently higher mortality risk, due to the fact that they require more precath care for stabilization

Conclusion

- Despite the noted D2B time issues trying to achieve the quickest D2B time is a laudable and potentially beneficial goal for most STEMI patients particularly for pts who present early < 3hrs from symptom onset and for sicker patients (CHF, Anterior MI).
- We may have reached the limits of improving D2B time any more than a few minutes at PCI centers
- More benefit may be achieved by improving DIDO time at referral hospitals, transfer time and symptom onset to first medical contact time

CONCLUSION

- Cardiogenic shock likely warrants urgent echo and paradigm shift from Door 2 Balloon to Door 2 Support, then PCI.

Thank You

Questions?