



Peri-Operative Risk Evaluation For Non-Cardiac Surgery



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DISCLOSURES

Relevant Financial Relationship(s)

None

Off Label Usage

None

Learning Objectives

1. Understand the preoperative ACC/AHA algorithm and appropriate patient selection
2. Identify the differences between stress tests in the preoperative setting
3. Review published data about management of a positive stress test in the preoperative setting.

Outline

1. ACC/AHA algorithm
2. Stress test options
3. Revascularization and clinical data
4. Conclusions

The problem

- 3.9% risk of surgical site infection
 - 30% of patients with surgical site infection
 - 30% of patients with surgical site infection
- 
- An illustration of a person in a dark blue suit and white shirt walking a tightrope. The tightrope is a thin black line stretched between two dark green, rocky outcrops. The person is holding a long, thin black pole for balance. The background is a light blue, cloud-like shape. The entire scene is set against a dark blue background.

Devereaux PJ, et al. Can Med Assoc J 2005; 173: 627–34.

Devereaux PJ, et al. JAMA 2012; 307: 2295–304.

Devereaux PJ, et al. Anesthesiology 2009; 111: 223–6.

Patient X

- 78 y/o male with a PMHx of CAD s/p anterior MI in 2007 and DM.
- Pt is undergoing knee surgery in 2 weeks.
- Unknown functional capacity.
- II/VI systolic mid to late murmur at RUSB.
- LBBB on ECG.
- Pt is in your office to get “cleared for surgery”.
- What do you do:

- A) Proceed with surgery
- B) Angiogram
- C) Stress ECG study
- D) Pharmacologic myocardial perfusion study
- E) Exercise stress echo study
- F) Cardiology consult
- G) Call your favorite attending
- H) Resign and become a CEO of a “start up” company

1) Who should we stress?

CLINICAL PRACTICE GUIDELINE

2014 ACC/AHA Guideline on Perioperative Cardiovascular Evaluation and Management of Patients Undergoing Noncardiac Surgery



A Report of the American College of Cardiology/American Heart Association
Task Force on Practice Guidelines

Developed in Collaboration With the American College of Surgeons, American Society of
Anesthesiologists, American Society of Echocardiography, American Society of Nuclear Cardiology,
Heart Rhythm Society, Society for Cardiovascular Angiography and Interventions,
Society of Cardiovascular Anesthesiologists, and Society of Vascular Medicine

Endorsed by the Society of Hospital Medicine

Patient scheduled for surgery with known or risk factors for CAD* (Step 1)

Emergency

Yes
Clinical risk stratification and proceed to surgery

No

ACS†
(Step 2)

Yes
Evaluate and treat according to GDMT†

No

Estimated perioperative risk of MACE based on combined clinical/surgical risk (Step 3)

Low risk (<1%)
(Step 4)

No further testing
(Class III:NB)

Proceed to surgery

Elevated risk
(Step 5)

Moderate or greater
(≥4 METs) functional capacity

Excellent
(>10 METs)

No further testing
(Class IIa)

Proceed to surgery

Moderate/G
(≥4-10 METs)

Further testing
(Class IIb)

No or unknown

Poor OR unknown functional capacity (<4 METs): Will further testing impact decision making OR perioperative care? (Step 6)

Yes
Pharmacologic stress testing
(Class IIa)

If normal

If abnormal

Coronary vascularization according to existing CPGs
(Class I)

No
Proceed to surgery according to GDMT OR alternate strategies (noninvasive treatment, palliation)
(Step 7)

*See Sections 2.2, 2.4, and 2.5 in the full-text CPG for recommendations for patients with symptomatic HF, VHD, or arrhythmias.
†See UA/NSTEMI and STEMI CPGs (Table 2).

Revised Cardiac Risk Index
NSQIP MICA
NSQIP

Definition of Urgency

- **Emergency**: life or limb is threatened, typically within <6 hours.
- **Urgent**: life or limb is threatened, typically between 6 and 24 hours
- **Time-sensitive**: of >1 to 6 weeks (i.e: oncologic procedures)
- **Elective**: Procedure could be delayed for up to 1 year.

Patient scheduled for surgery with known or risk factors for CAD* (Step 1)

Emergency

Yes

Clinical risk stratification and proceed to surgery

No

ACS†

Yes

Evaluate and treat

www.surgicalriskcalculator.com

Estimated perioperative risk of MACE based on combined clinical/surgical risk (Step 3)

Low risk (<1%) (Step 4)

No further testing (Class III:NB)

Proceed to surgery

*See Sections 2.2, 2.4, and 2.5 in the full-text CPG for recommendations for patients with symptomatic HF, VHD, or arrhythmias.

†See UA/NSTEMI and STEMI CPGs (Table 2).

Revised Cardiac Risk Index

1. History of ischemic heart disease
 2. History of congestive heart failure
 3. History of cerebrovascular disease (stroke or transient ischemic attack)
 4. History of diabetes requiring preoperative insulin use
 5. Chronic kidney disease (creatinine > 2 mg/dL)
 6. Undergoing suprainguinal vascular, intraperitoneal, or intrathoracic surgery
- Risk for cardiac death, nonfatal myocardial infarction, and nonfatal cardiac arrest:
0 predictors = 0.4%, 1 predictor = 0.9%, 2 predictors = 6.6%, ≥ 3 predictors = $>11\%$

Estimate risk of perioperative myocardial infarction or cardiac arrest.

Age

Creatinine

▼

ASA Class

▼

ASA 1 = Normal healthy patient

ASA 2 = Patients with mild systemic disease

ASA 3 = Patients with severe systemic disease

ASA 4 = Patients with severe systemic disease
that is a constant threat to life

ASA 5 = Moribund patients who are not expected
to survive without the operation

Preoperative Function

▼

Procedure

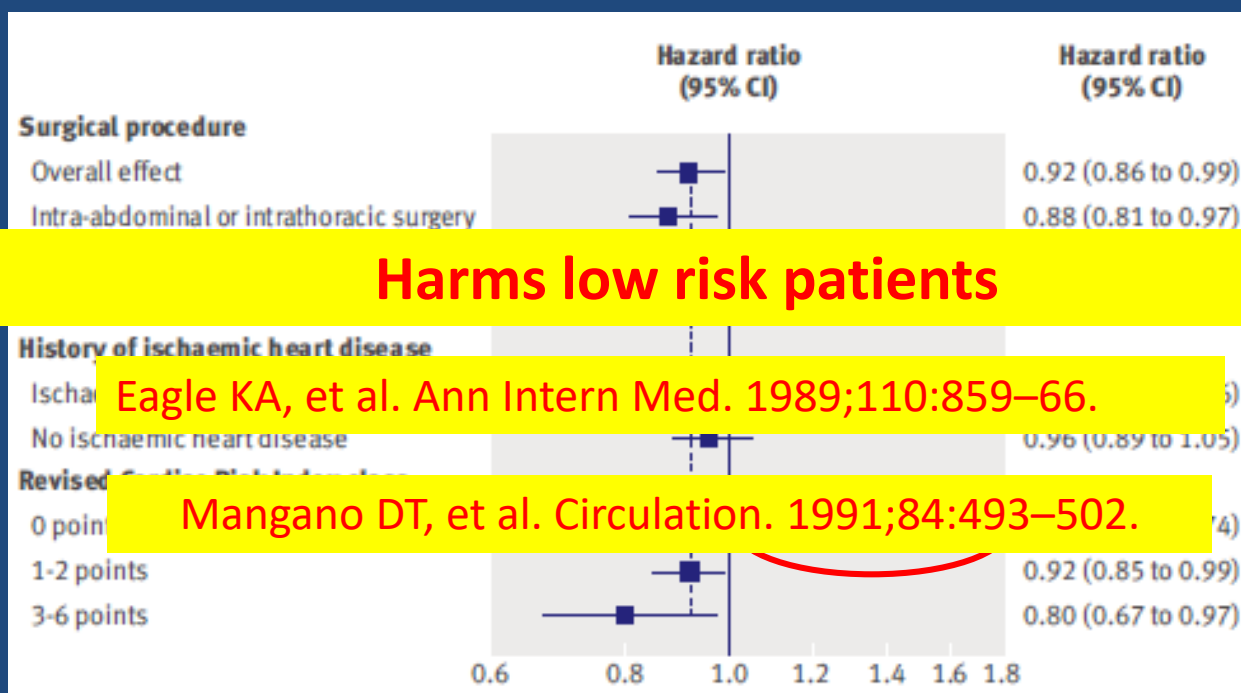
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Submit

Non-invasive cardiac stress testing before elective major non-cardiac surgery: population based cohort study

Duminda N Wijeyesundera, lecturer,^{1,2,3} W Scott Beattie, R Fraser Elliot chair in cardiac anaesthesia,² Peter C Austin, senior scientist,^{1,3,4} Janet E Hux, senior scientist,^{1,3,5} Andreas Laupacis, scientist^{1,3,6,7}

n= 271,082 with a 8.9% exposure to stress testing.



Harms low risk patients

Eagle KA, et al. Ann Intern Med. 1989;110:859–66.

Mangano DT, et al. Circulation. 1991;84:493–502.

Patient X

- On physical exam the patient has a mid peaking II/VI SEM at the RUSB with radiation to the neck.
- A) Obtain an echo
 - B) Proceed going down the algorithm
 - C) Proceed directly with surgery
 - D) Obtain a myocardial perfusion study

12-lead ECG

- **Class IIa**
- Preoperative resting 12-lead electrocardiogram (ECG) is reasonable for patients with **known coronary heart disease, significant arrhythmia, peripheral arterial disease, cerebrovascular disease, or other significant structural heart disease**, except for those undergoing low-risk surgery. (*Level of Evidence: B*).
- **Class III: No Benefit**
- Routine preoperative resting 12-lead ECG is not useful for **asymptomatic** patients undergoing **low-risk** surgical procedures. (*Level of Evidence: B*)

LV function

- Class IIa
 - 1. It is reasonable for patients with **dyspnea of unknown origin** to undergo preoperative evaluation of left ventricular (LV) function. (*Level of Evidence: C*)
 - 2. It is reasonable for patients with **heart failure (HF) with worsening dyspnea or other change in clinical status** to undergo preoperative evaluation of LV function. (*Level of Evidence: C*).
- Class III: No Benefit
 - 1. **Routine** preoperative evaluation of LV function is not recommended. (*Level of Evidence: B*)

Patient X

- Based on the ACC/AHA algorithm you decide that a stress test will change your management of the pt.
- Which imaging test is better?

A) Dobutamine echo

B) Pharmacologic SPECT

C) Stress ECG

D) I don't know

E) I'm going into ID fellowship

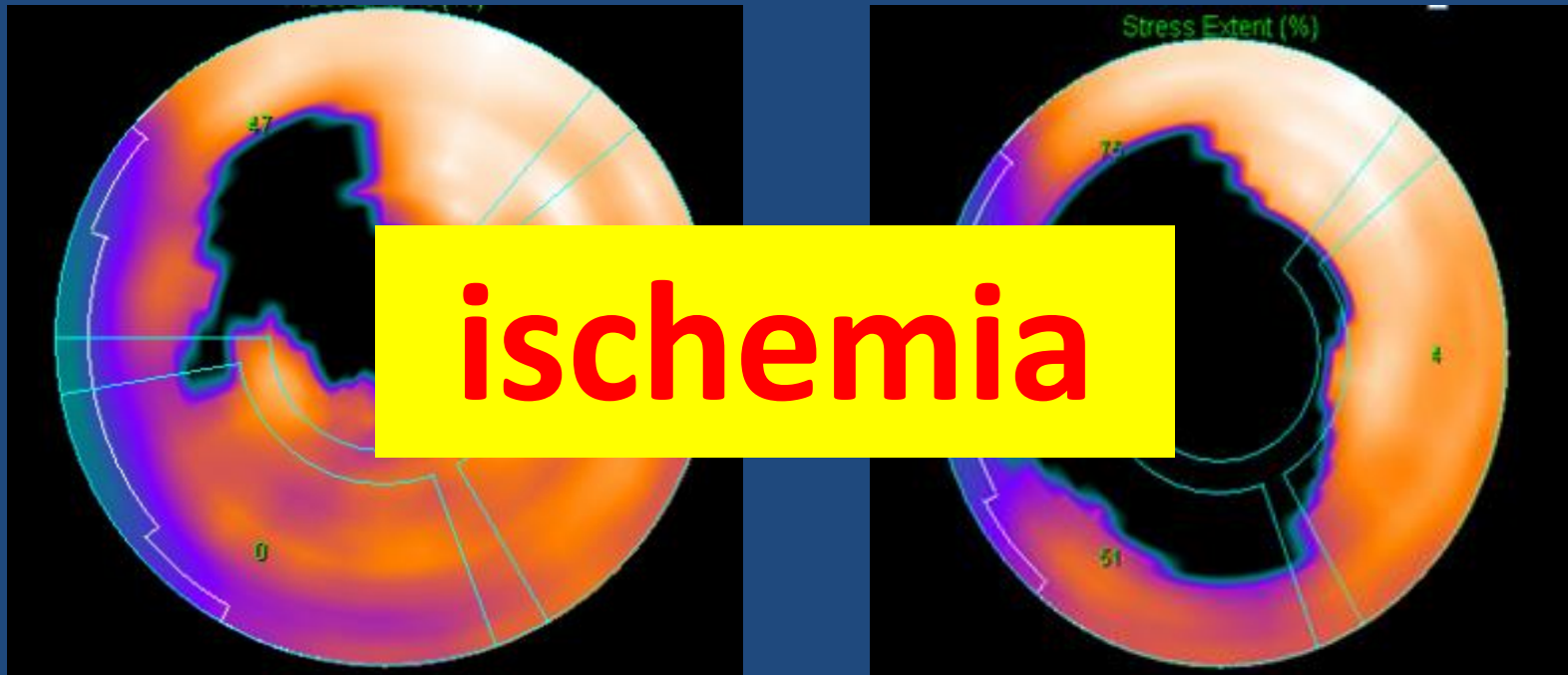
WHAT KIND OF STRESS TEST SHOULD I USE?

My answer: Local expertise may help dictate the choice of test.

Radionuclide MPI

- Moderate to large ischemia, carry the greatest risk of perioperative cardiac death or MI.
- The negative predictive value of a normal MPI study is high for MI or cardiac death.
- Infarct has a low positive predictive value for perioperative cardiac events. However, increased risk for long-term events relative to patients with a normal MPI test.

How much is too much?



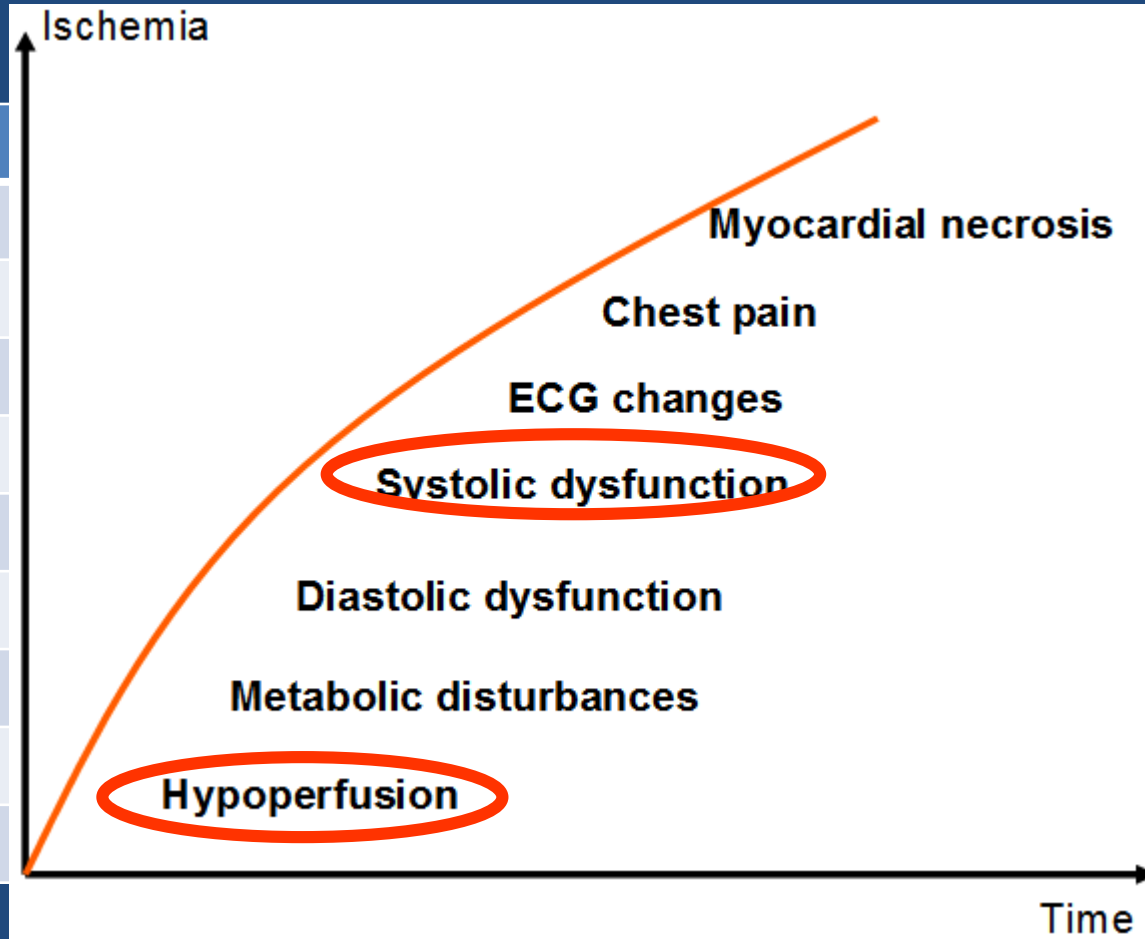
<20% LV myocardium = nonsignificant increased risk of perioperative death or MI.
>20% LV myocardium = a significantly higher risk of perioperative cardiac death or MI
that increased progressively as the extent of reversible defects increased

Dobutamine Stress Echocardiography

- Abnormal stress echocardiogram
 - new wall motion abnormalities with stress (ischemia),
 - akinetic segments at baseline (MI).
- Several studies:
 - Overall: (+) stress result is 5-50%.
 - Event rate: 0-15%
 - Predict non fatal MI or death: 0-37%
 - Negative predictive, typically 90-100%.

- In general, stress echocardiography has a:
 - High NPV
 - Low PPV (25% and 45%);
- This means that the postsurgical probability of a cardiac event is low, despite wall motion abnormality detection during stress echocardiography.
- A negative DSE without resting wall motion abnormalities has excellent negative predictive value, regardless of the heart rate achieved.
- Patients with resting wall motion abnormalities are at increased risk for perioperative events, even if ischemia cannot be induced.

DSE vs Radionuclide MPI



| Study |
|-----------|
| Marwick |
| Marwick |
| Senior |
| Ho |
| Huang |
| Santoro |
| San Roman |
| Santoro |
| San Roman |

| Echo | Nuclear |
|------|---------|
| 87 | 71 |
| 83 | 67 |
| 94 | 71 |
| 73 | 73 |
| 77 | 81 |
| 96 | 81 |
| 88 | 70 |
| 96 | 89 |
| 94 | 70 |

Pearls

- Abn resting ECG (e.g., LBBB, V paced, LV hypertrophy with “strain” pattern, digitalis effect), concomitant stress imaging with echo or MPI may be an appropriate alternative.
- In LBBB, exercise MPI low specificity because of septal perfusion defects that are not related to CAD. Use pharmacological stress MPI over exercise stress imaging.
- In patients unable to perform adequate exercise, pharmacological stress testing with either DSE or MPI may be appropriate.

Pearls

- All stress agents should be avoided in unstable patients.
- Avoid vasodilators (dipyridamole, adenosine, regadenoson) with significant heart block, bronchospasm.
- Dobutamine should be avoided in patients with severe arrhythmias, significant hypertension, large thrombus-laden aortic aneurysms, or hypotension.
- An echocardiographic stress test is favored if an assessment of valvular function or pulmonary hypertension is clinically important.

3) WHAT ABOUT OTHER TESTING MODALITIES?

Stress ECG

- In most ambulatory patients, ECG testing can provide both an estimate of functional capacity and detection of myocardial ischemia through changes in the electrocardiographic and hemodynamic response.
- Ischemic response at low exercise workloads = increased risk of perioperative and long-term cardiac events.
- Ischemia at high workloads = minor risk increase, but higher than a totally normal test.

Cardiopulmonary Exercise Testing

- A consistent finding among the studies was that a low anaerobic threshold (AT) was predictive of perioperative cardiovascular complications, postoperative death, or midterm and late death after surgery.
- AT of approximately 10 mL O₂/kg/min was proposed as the optimal discrimination point.

Coronary Computed Tomographic Angiography (CCTA)

- Prospective cohort study. n=955 pts.
- Primary outcome of CV death and nonfatal MI.
- Compared with the RCRI alone, CCTA improved risk estimation of patients who suffered primary outcome ($p=0.014$; C index= 0.66), but overestimated (5X) risk among patients who did not suffer the primary outcome.

Cardiovascular Magnetic Resonance (CMR)

- There are limited data on CMR in the pre-operative setting.
- Dobutamine stress CMR was used in 102 patients undergoing major non-cardiac surgery; in multivariate analysis, myocardial ischemia was the strongest predictor of perioperative cardiac events (death, myocardial infarction, and heart failure).
- No data are available in the setting of pre-operative risk stratification.

Patient X

- A pharmacologic MPI test was performed and there was a moderate size perfusion defect consistent with ischemia (25%).
- What do you do now?.

1. Angiogram
2. Proceed to surgery
3. Cancel surgery
4. Call Dr. Shinar
5. Call Dr. Oz

- Mild abnormality = OMT and surgery.
- Mod-large ischemia = Angiogram.

Is revascularization the key to success?

Coronary revascularization before noncardiac surgery

| | COR | LOE |
|----------------------------------------------------------------------------------------------------------------------------|-----|-----|
| Revascularization before noncardiac surgery is recommended when indicated by existing CPGs | I | C |
| Coronary revascularization is not recommended before noncardiac surgery exclusively to reduce perioperative cardiac events | III | B |

COR: Class of Recommendation
LOE: Level of Evidence

Pearls

- Patients undergoing risk stratification before elective noncardiac procedures and whose evaluation recommends CABG surgery should undergo coronary revascularization before an elevated-risk surgical procedure
- The cumulative mortality and morbidity risks of both the coronary revascularization procedure and the noncardiac surgery should be weighed carefully in light of the individual patient's overall health, functional status, and prognosis.
- The indications for preoperative surgical coronary revascularization are identical to those recommended in the CABG CPG and the PCI CPG and the accumulated data on which those conclusions were based

Hills LD, et al. JACC 2011;58:e123-210.

Levine GN, et al. JACC 2011; 58: e44-122.

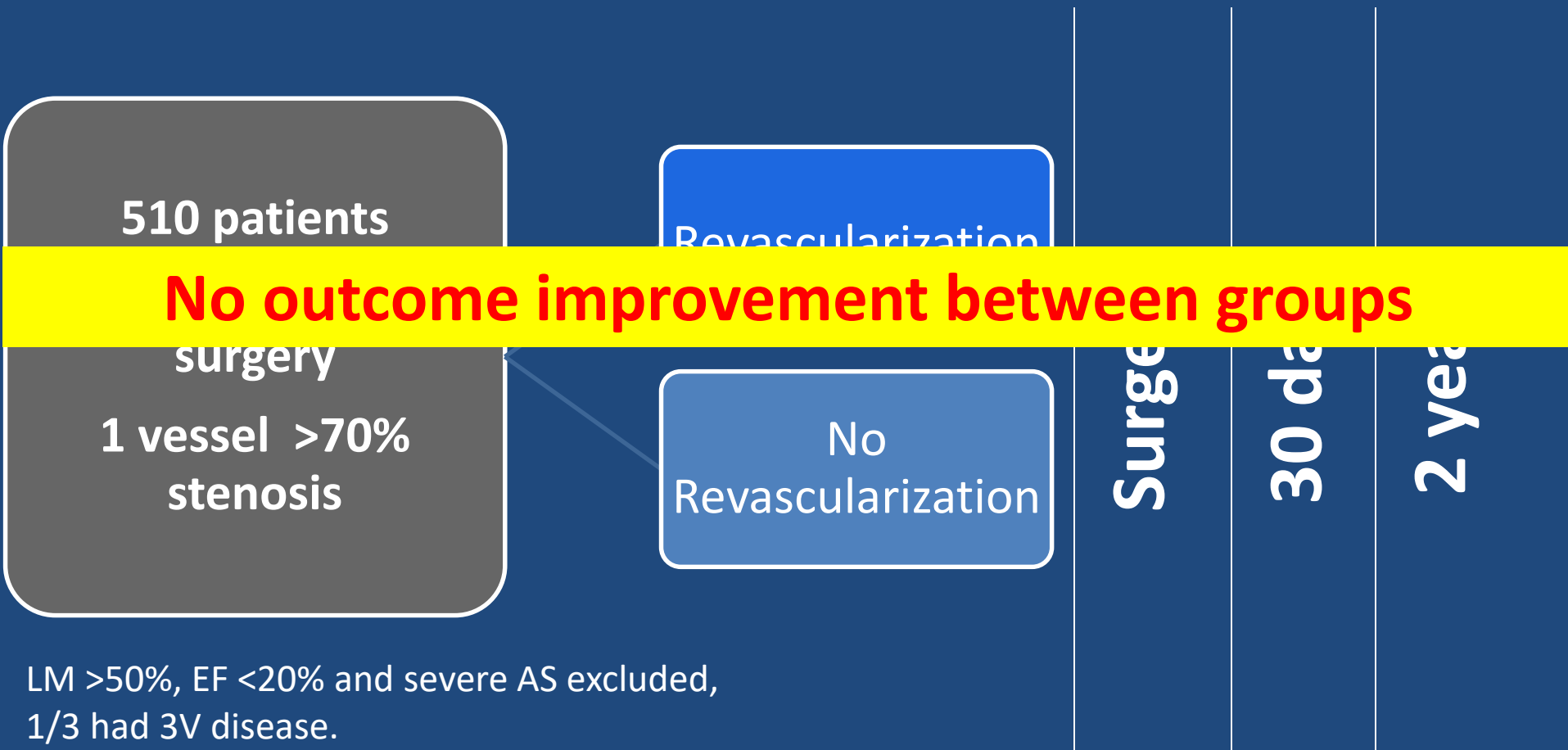
Pearls

- The role of preoperative PCI in reducing untoward perioperative cardiac complications is uncertain given the available data.
- Performing PCI before noncardiac surgery should be limited to
 - 1) patients with left main disease whose comorbidities preclude bypass surgery without undue risk and
 - 2) patients with unstable CAD who would be appropriate candidates for emergency or urgent revascularization

Hills LD, et al. JACC 2011;58:e123-210.

Levine GN, et al. JACC 2011; 58: e44-122.

Coronary-Artery Revascularization before Elective Major Vascular Surgery



LM >50%, EF <20% and severe AS excluded,
1/3 had 3V disease.
Most patients were on β -blockers.

A Clinical Randomized Trial to Evaluate the Safety of a Noninvasive Approach in High-Risk Patients Undergoing Major Vascular Surgery

The DECREASE-V Pilot Study

101 pts

Major Vascular Surgery

Most pts had 3VD
Half had EF<35%.

No improved outcomes in revascularization group at 1 month or 1 year after surgery.

Limited statistical power due to small study.

30 day death or MI: 43% revasc group vs 33% control group.

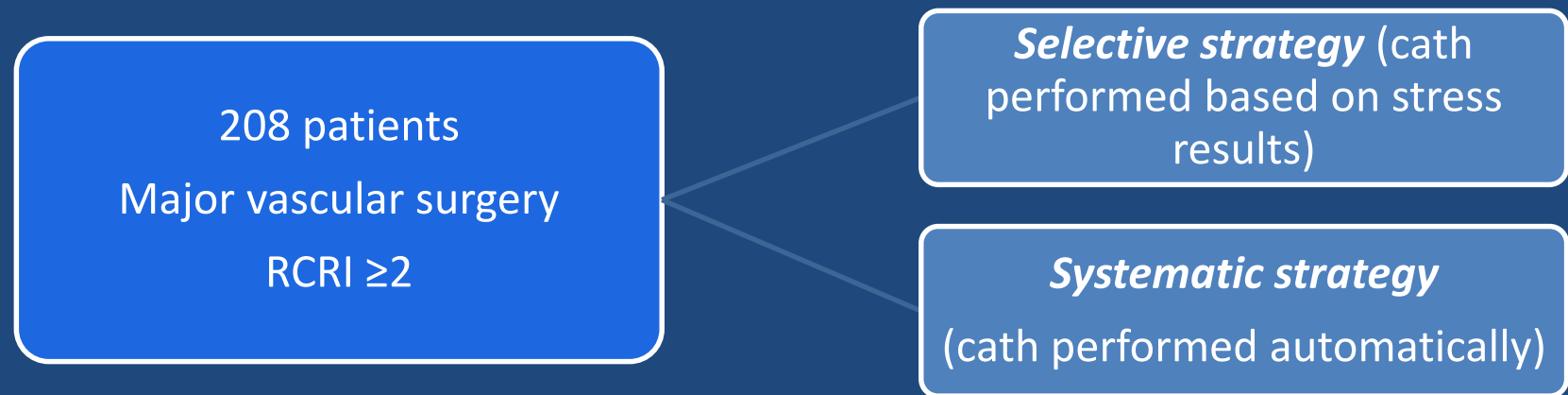
Revascularization

Revascularization

Conduct of the trial was questioned

Systematic Strategy of Prophylactic Coronary Angiography Improves Long-Term Outcome After Major Vascular Surgery in Medium- to High-Risk Patients

A Prospective, Randomized Study



RESULTS:

Revascularization: Higher in systematic strategy ($p=0.01$)

In-hospital MACE: similar ($p=0.07$).

Follow up (58 ± 14 mo): better survival ($p=0.01$)
freedom from death/CV events ($p=0.003$).

} systematic strategy

Optimal Medical Therapy with or without PCI for Stable Coronary Disease

- Stable CAD (including 2-3VD)
- PCI + OMT or OMT alone.
- Mortality and MI are virtually **identical**.

The effects of prophylactic coronary revascularization or medical management on patient outcomes after noncardiac surgery - a meta-analysis

- n=3949
- There was no significant difference between coronary revascularization and medical management groups with regards to postoperative mortality and MI.
- There were no long-term outcome benefits associated with prophylactic coronary revascularization for long-term mortality and late adverse cardiac events.

International Study Of Comparative Health Effectiveness With Medical And Invasive Approaches (ISCHEMIA)

- ISCHEMIA included people who had an abnormal stress test showing moderate to severe ischemia of the heart.
- Compared
 - Medical therapy and lifestyle changes along with revascularization.
 - Medical therapy and lifestyle changes.
- Revascularization, medical therapy and lifestyle changes did not reduce the overall rate of MI or death compared with medicines and lifestyle changes alone.

CONCLUSIONS

- Follow guidelines
- Use best judgment.
- Individualize care.

Stress test

1. No adequate test.
2. Culprit lesion are insignificant lesions.
3. Stress tests are for **risk stratification**.

Hypoxia

prolonged sympathetic stimulation and
tachycardia

hypercoagulability

hypothermia

increased coronary vasomotor tone

physiological stress

blood loss

potential atheromatous plaque rupture leading to
thrombus formation

*“Prediction is very difficult,
especially about the future”*

Niels Bohr, Danish Physicist
Nobel Prize in Physics (1922)

THANK YOU

Consistency

- Single-site studies using either DSE or MPI have shown consistent findings:
 1. The presence of moderate to large areas of myocardial ischemia is associated with increased risk of perioperative MI and/or death.
 2. A normal study for perioperative MI and/or cardiac death has a very high negative predictive value.
 3. The presence of an old MI identified on rest imaging is of little predictive value for perioperative MI or cardiac death.