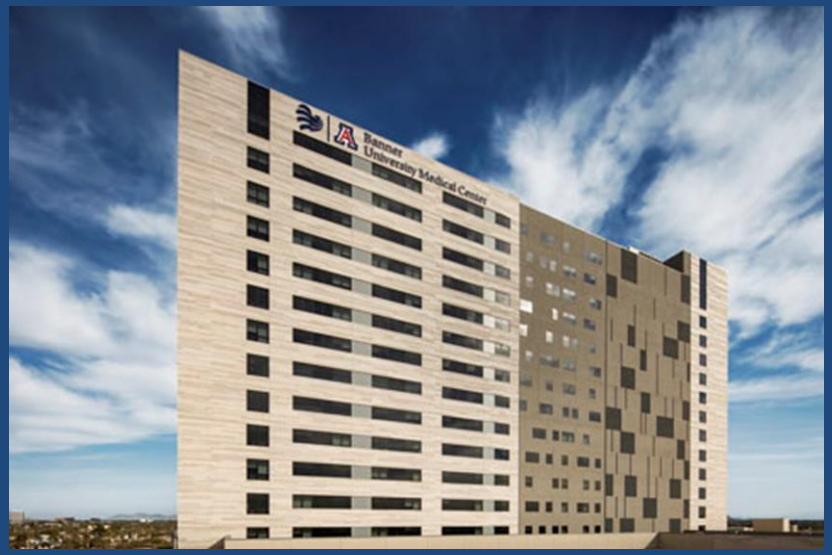


Peri-Operative Risk Evaluation For Non-Cardiac Surgery

Banner University Medicine

Samuel Unzek MD, FACC, FASE, FASNC

08/03/2021

DISCLOSURES

Relevant Financial Relationship(s)

None

Off Label Usage

None

Learning Objectives

1. Describe the internist's role in the evaluation of the patient for preoperative cardiac assessment.
2. Describe the patient who should be seen by a cardiologist before surgery.
3. Describe the patient who is low, intermediate, and high risk for perioperative Major Adverse Cardiac Event (MACE) according to the Revised Cardiac Risk Index (RCRI) and the American College of Surgeons National Quality Improvement Program (NSQIP).
4. List the surgeries that are considered low, intermediate, and high risk.
5. Define emergent, urgent, and elective surgery.
6. Define metabolic equivalent (MET) and describe the activities that require 4 or more METs.
7. Apply the ACC/AHA algorithm to patient cases to determine the correct perioperative plan.

Outline

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

The problem

- 3.9% ri… of su… …ative car…
- 30 … p…
- … r… …f su…

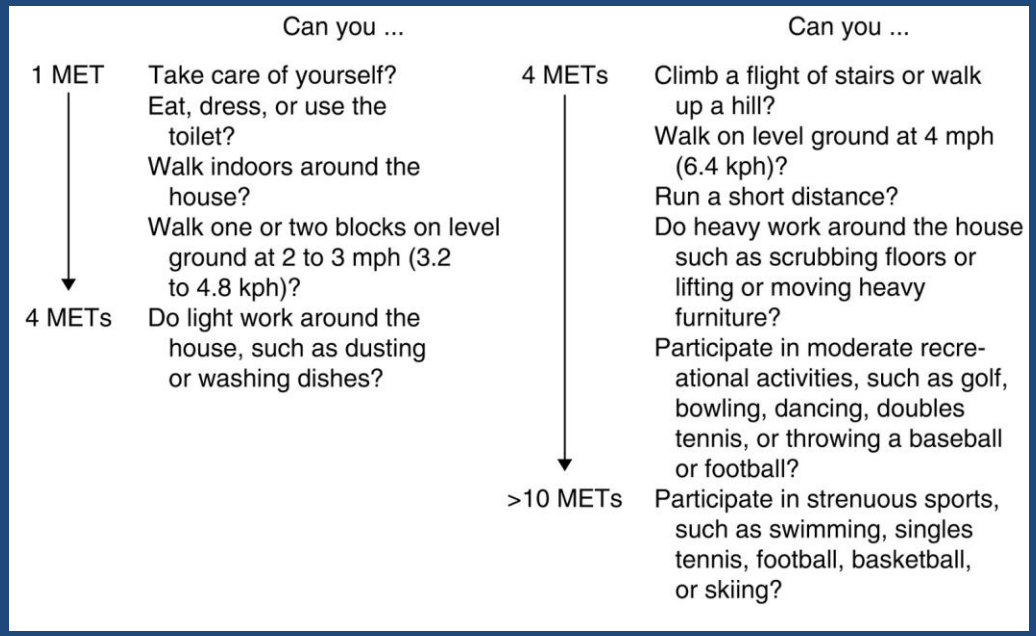
Devereaux PJ, et al. Can Med Assoc J 2005; 173: 627–34.
Devereaux PJ, et al. JAMA 2012; 307: 2295–304.
Devereaux PJ,, et al. Anesthesiology 2009; 111: 223–6.

How many METS can you go?

DEFINITION: The metabolic equivalent for task **(MET)** is a unit that estimates the amount of energy used by the body during physical activity, as compared to resting metabolism.

Setting	Activity	MET
Gardening	Clearing light brush, thinning garden, moderate effort	3.5
	Digging, thinning garden, composting, light-to-moderate effort	3.5
	Gardening, using containers, older adults >60 years	2.3
	Mowing lawn (not ride on mower)	5.0
Home activities	General kitchen activity (cooking, washing dishes, cleaning up), moderate effort	3.3
	Vacuuming, moderate effort	3.3
	Scrubbing floors, on hands and knees, scrubbing bathroom, bathtub, moderate effort	3.5
	Sweeping garage, pavement or outside of house	4.0
	Making bed, changing linen	3.3
Locomotor activities	Stair climbing, slow pace	4.0
	Walking, 2.5 mph, level, firm surface	3.0
	Walking, 3.5 mph, level, brisk, firm surface, walking for exercise	4.3
	Walking, household	2.0
	Loading/unloading a car, implied walking	3.5

Adapted from the Compendium of Physical Activities.[15]
MET, metabolic equivalent.



M Jette, et al. Clin. Cardiol 1990;13:555-565.

Surgical risk estimate according to type of surgery or intervention

Low risk: <1%	Intermediate risk: 1–5%	High risk: >5%
Superficial surgery	• Intraperitoneal: splenectomy, hiatal hernia repair, and cholecystectomy	• Aortic and major vascular surgery
Breast	• Carotid symptomatic (CEA or CAS)	• Open lower limb revascularisation or amputation or thromboembolectomy
Dental	• Peripheral arterial angioplasty	• Duodeno-pancreatic surgery
Endocrine: thyroid	• Endovascular aneurysm repair	• Liver resection, bile duct surgery
Eye	• Head and neck surgery	• Oesophagectomy
Reconstructive	• Neurological or orthopaedic: major (hip and spine surgery)	• Repair of perforated bowel
Carotid asymptomatic (CEA or CAS)	• Urological or gynaecological: major	• Adrenal resection
Gynaecology: minor	• Renal transplant	• Total cystectomy
Orthopaedic: minor (meniscectomy)	• Intra-thoracic: non-major	• Pneumonectomy
Urological: minor (transurethral resection of the prostate)		• Pulmonary or liver transplant

Adapted from the European Society of Cardiology and European Society of Anaesthesiology non-cardiac surgery guidelines.[1]
CAS, carotid artery stenting; CEA, carotid endarterectomy.
[a]Surgical risk estimate is a broad approximation of 30-day risk of cardiovascular death and myocardial infarction that takes into account only the specific surgical intervention without considering the patient's comorbidities.

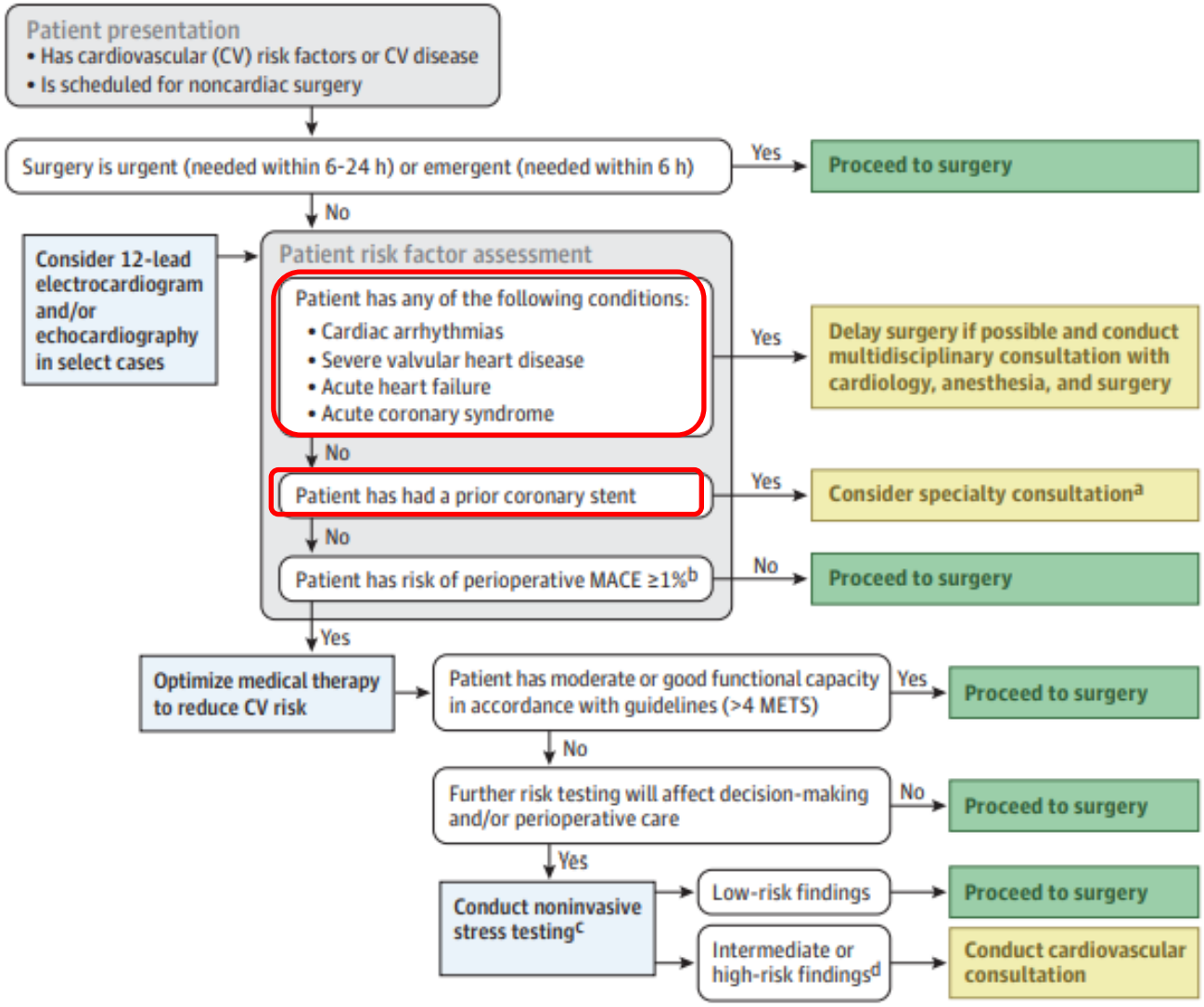
Knuuti J, et al. European Heart Journal. 2014;35: 2383–2431

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.

Who gets to see the Cardiologist?

Figure 1. A Proposed Algorithm for Perioperative Cardiovascular Risk Assessment



The algorithm has not been validated. MACE indicates major adverse cardiovascular events; METs metabolic equivalent tasks.

[a] Perioperative considerations during consulation shown in Figure 2.

[b] Risk of perioperative MACE as determined by a clinical risk calculator.

[c] Testing options include: (1) exercise electrocardiographic stress testing without myocardial imaging; or (2) stress testing (exercise or pharmacological) with imaging such as echocardiography, nuclear perfusion via single-photon emission computed tomography, positron emission tomography, or cardiac magnetic resonance imaging.

[d] Intermediate or high-risk findings by stress testing may include moderate to severe myocardial ischemia, ischemia provoked at a low workload, a hypotensive response to exercise, transient ischemic dilatation, and ventricular arrhythmias during stress testing.

JAMA. 2020;324(3):279-290

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) Cardiology consult

1) **Who should we stress?**

JOURNAL OF THE AMERICAN COLLEGE OF CARDIOLOGY

PUBLISHED BY ELSEVIER INC.

VOL. 64, NO. 22, 2014
ISSN 0735-1097/$36.00
http://dx.doi.org/10.1016/j.jacc.2014.07.944

CLINICAL PRACTICE GUIDELINE

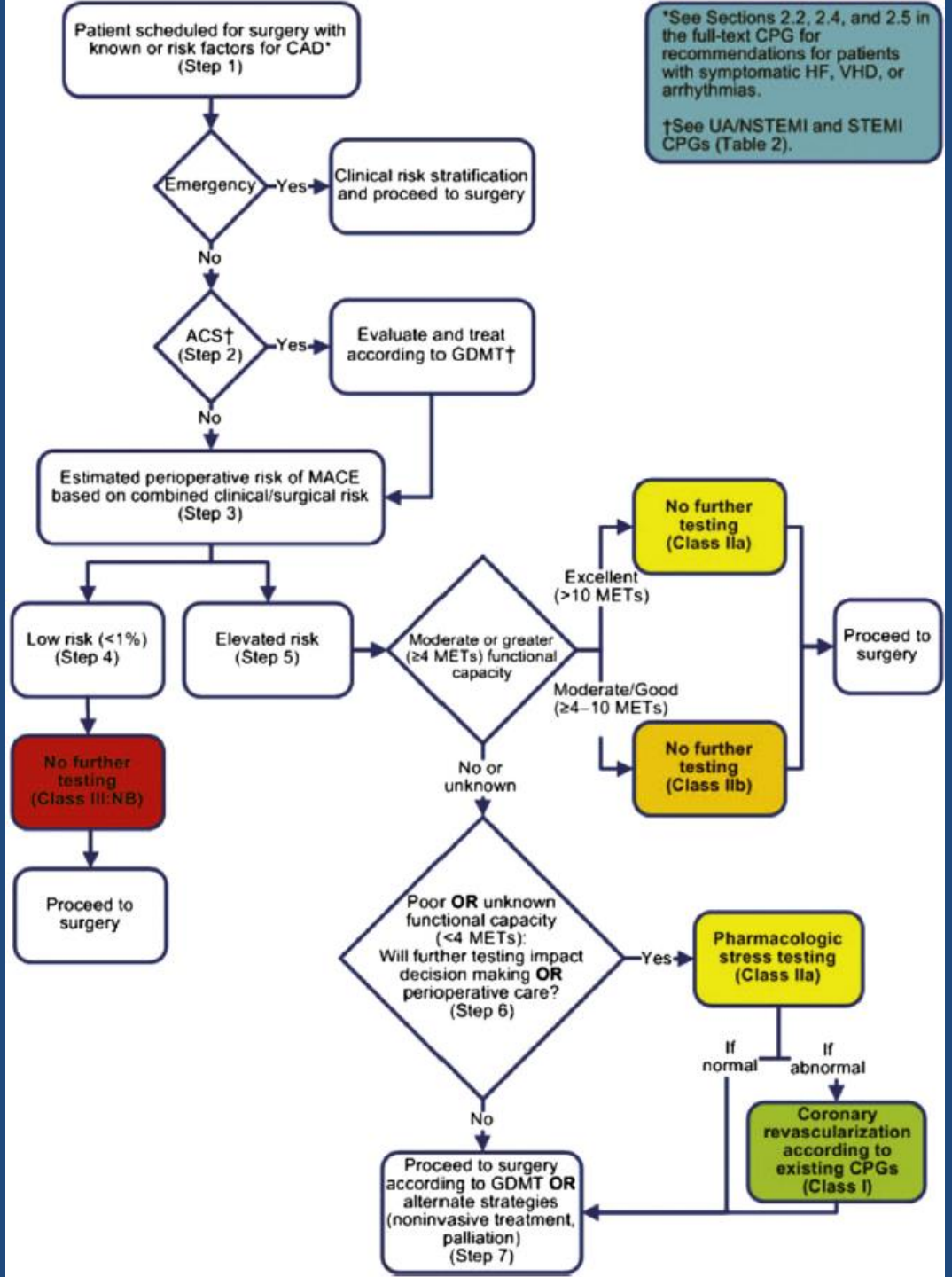
2014 ACC/AHA Guideline on Perioperative Cardiovascular Evaluation and Management of Patients Undergoing Noncardiac Surgery

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

Revised Cardiac Risk Index
NSQIP



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 (176.8 µmol/L)]
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%

ACS NSQIP®

Surgical Risk Calculator

American College of Surgeons
Inspiring Quality: Highest Standards, Better Outcomes

Home | About | FAQ | ACS Website | ACS NSQIP Website

Enter Patient and Surgical Information

Procedure

Clear

Begin by entering the procedure name or CPT code. One or more procedures will appear below the procedure box. You will need to click on the desired procedure to properly select it. You may also search using two words (or two partial words) by placing a '+' in between, for example: "cholecystectomy + cholangiography"

Reset All Selections

Are there other potential appropriate treatment options? ☐ Other Surgical Options ☐ Other Non-operative options ☐ None

Please enter as much of the following information as you can to receive the best risk estimates.
A rough estimate will still be generated if you cannot provide all of the information below.

Age Group: Under 65 years

Sex: Female

Functional Status: Independent

Emergency Case: No

ASA Class: Healthy patient

Steroid use for chronic condition: No

Ascites within 30 days prior to surgery: No

Systemic Sepsis within 48 hours prior to surgery: None

Ventilator Dependent: No

Disseminated Cancer: No

Diabetes: No

Hypertension requiring medication: No

Congestive Heart Failure in 30 days prior to surgery: No

Dyspnea: No

Current Smoker within 1 Year: No

History of Severe COPD: No

Dialysis: No

Acute Renal Failure: No

BMI Calculation:

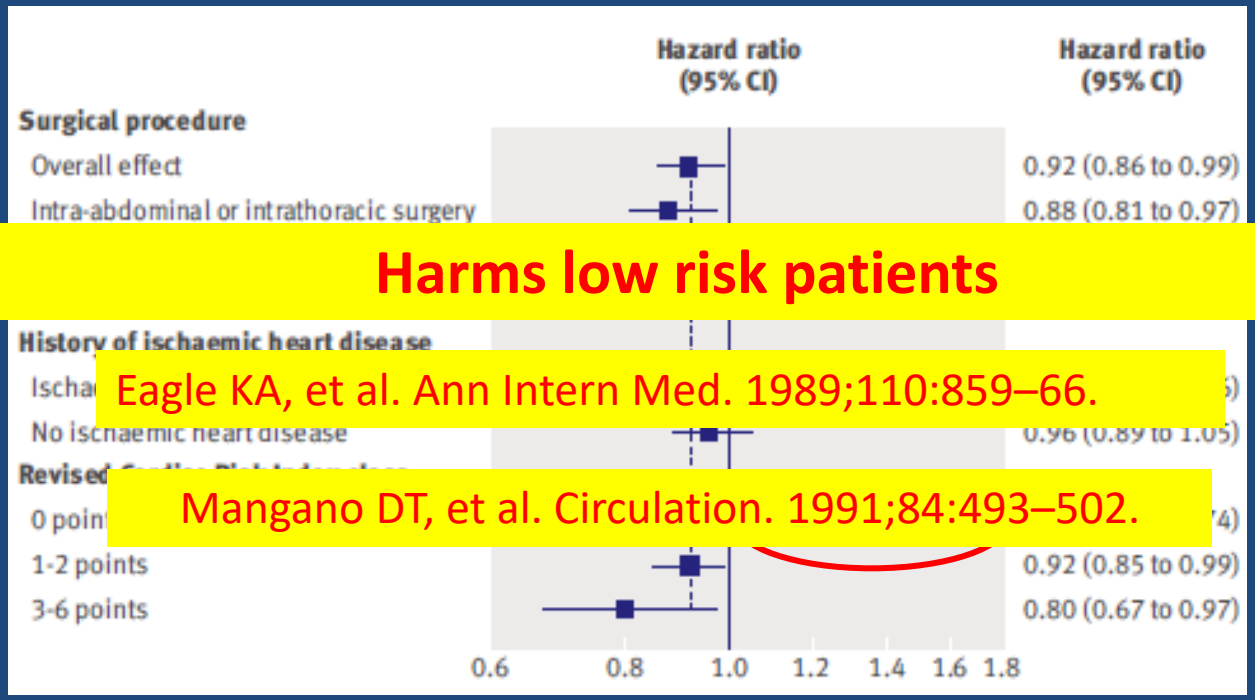
Height: in / cm

Weight: lb / kg

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

Duminda N Wijeysundera, 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.

Br Med J. 2010;340:b5526.

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

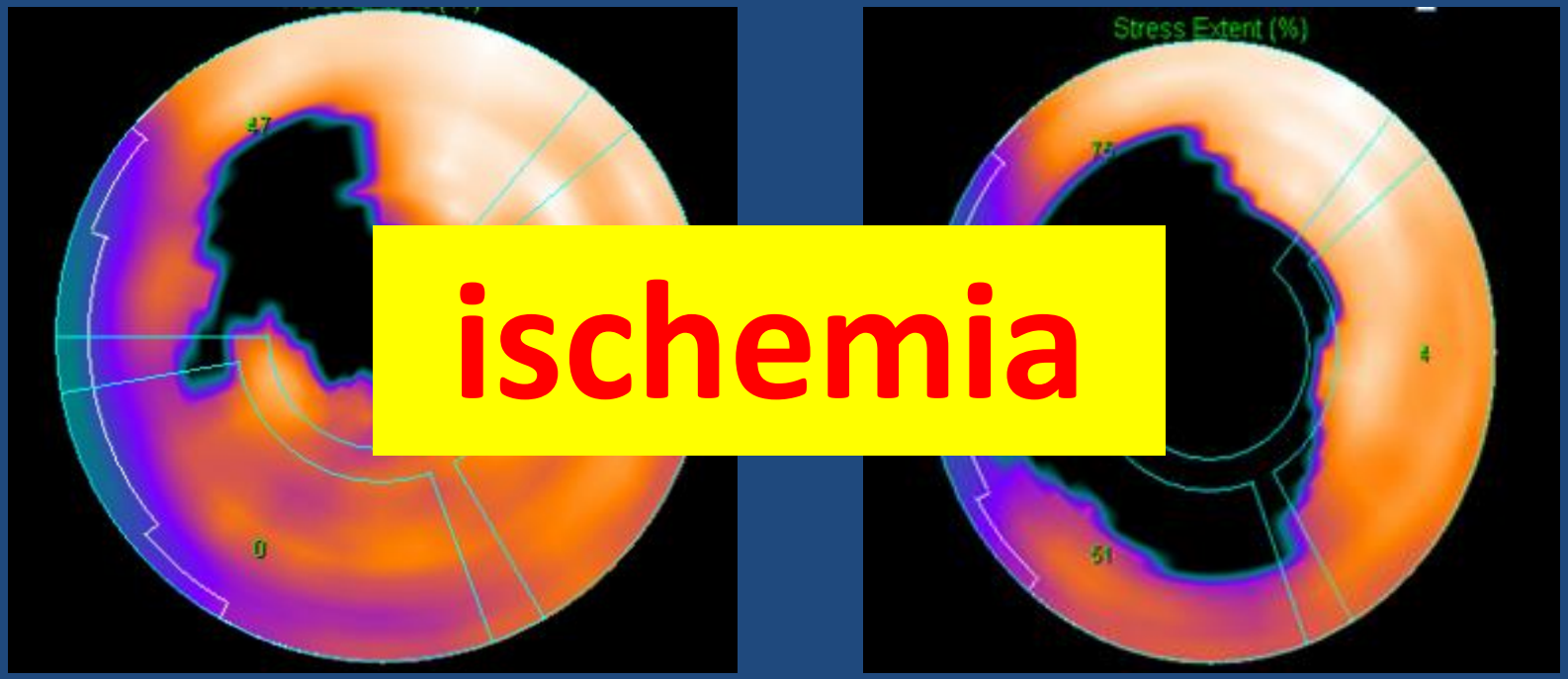
D)I don’t know

E)I’m going into ID fellowship

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?



ischemia

<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

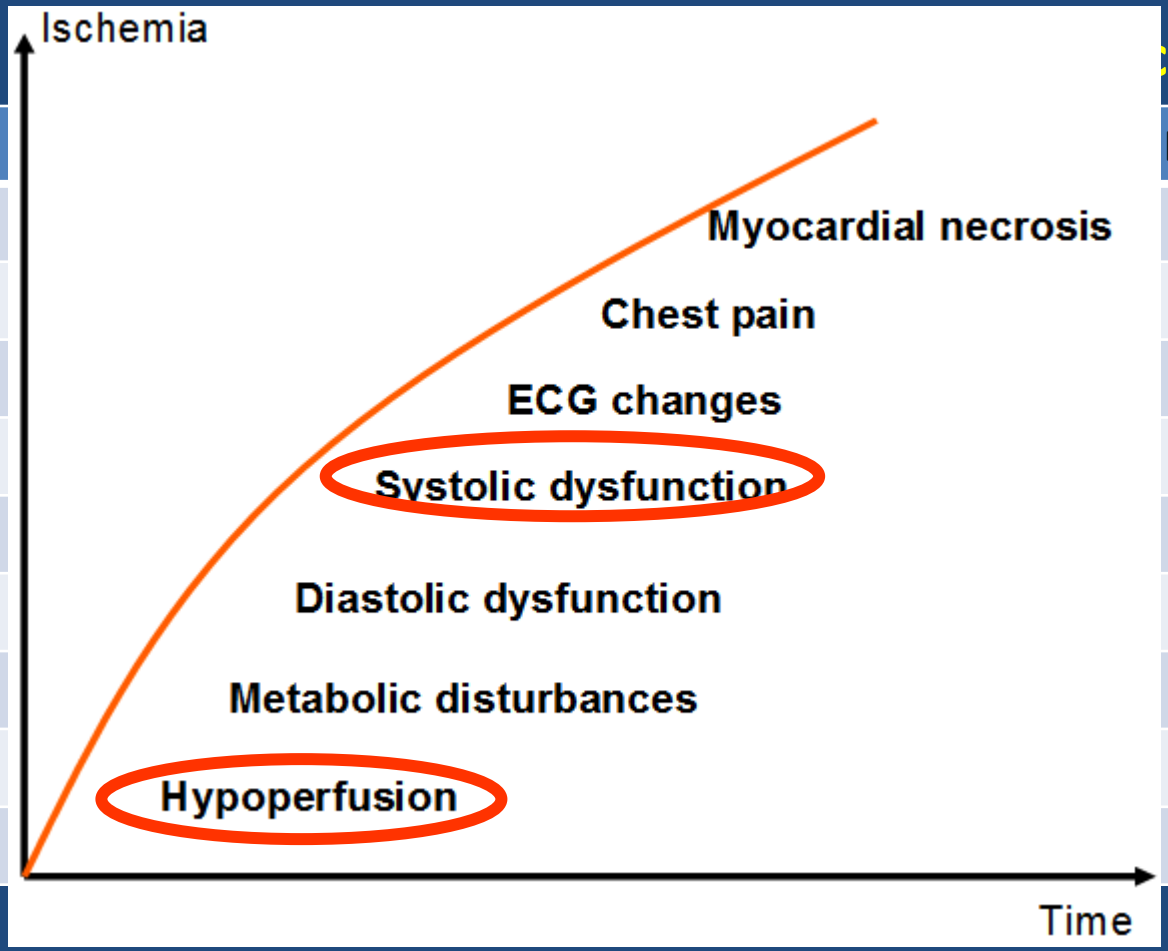
Etchells E, et al. J Vasc Surg. 2002;36:534–40.

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%.

Raux M, et al. Br J Anaesth 2006;97:770–776. Labib SB, et al. JACC 2004;44:82–87.

DSE vs Radionuclide MPI



Study	Echo	Nuclear
Marwick	87	71
Marwick	83	67
Senior	94	71
Ho	73	73
Huang	77	81
Santoro	96	81
San Roman	88	70
Santoro	96	89
San Roman	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.

WHAT KIND OF STRESS TEST SHOULD I USE?

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

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.

McPhail N, et al. J Vasc Surg 1988;7:60-8. Carliner NH, et al. Am J Cardiol 1985;56:51-8.
Sgura FA, et al. Am J Med 2000;108:334-6.Montalescot G, et al. Eur Heart J 2013;34:2949–3003.

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 O_2/kg/min was proposed as the optimal discrimination point.

Junejo MA, et al. Br J Surg. 2012;99:1097–104. Hartley RA, et al. Br J Surg. 2012;99:1539–46. Prentis JM, et al. J Vasc Surg. 2012;56:1564–70. Carlisle J, et al. Br J Surg. 2007;94:966–9. Older P, et al. Chest.1993;104:701–4.Older P, et al. Chest. 1999;116:355–62. Snowden CP, et al. Ann Surg. 2010;251:535–41.Snowden CP, et al. Ann Surg. 2013;257:999–1004.

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.

Sheth T, et al. BMJ 2015;350:h1907

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.

Rerkpattanapipat P, et al. Am J Cardiol 2002;90:416–419.

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

- 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.

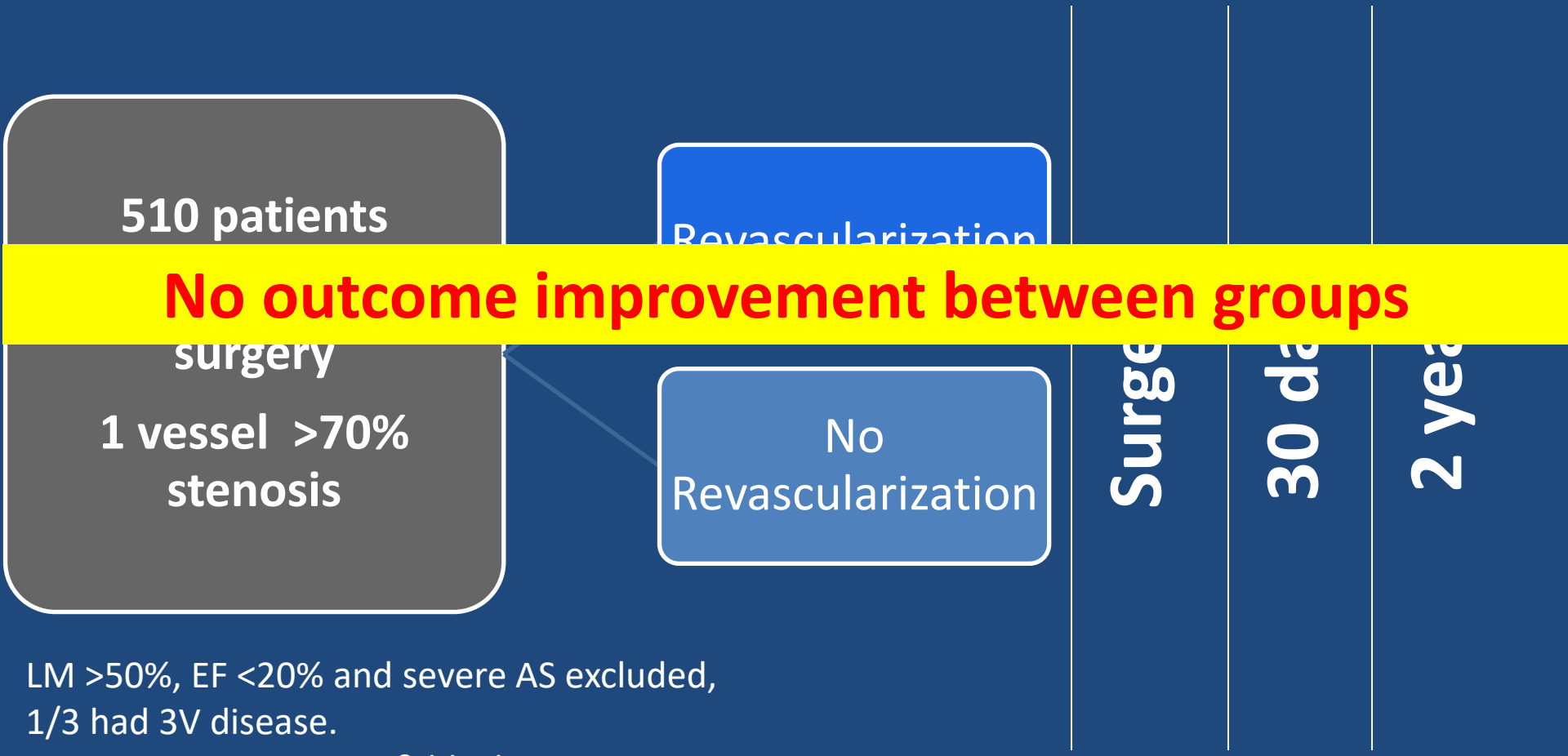
Pearls

- 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.

McFalls EO, et al. *NEJM*. 2004;351:2795–2804.

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

Poldermans D, et al. *JACC*. 2007;49:1763–1769.

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

A Prospective, Randomized Study

208 patients
Major vascular surgery
RCRI ≥2

Selective strategy (cath performed based on stress results)

Systematic strategy
(cath performed automatically)

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

Monaco M. et al. JACC 2009;54:989–96

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.**

Boden WE, et al. *N Engl J Med*. 2007;356:1503–1516.

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.

Wong EY, et al. Can J Anesth. 2007;54:705–717

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