Cardiac Pre-Operative Evaluation

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The Consultant's Job…

Objectives of Conference

- Understand “Cardiac Clearance” for noncardiac surgery
- Apply Guidelines for pre-operative evaluation
- Who needs a stress test?
- Who needs a cath?
- Who can go to surgery?

Pre-Op Cardiac Evaluation

Potentially many facets

- Coronary atherosclerosis
  - Myocardial ischemia
- Heart failure
  - Systolic
  - Diastolic
- Arrhythmia
  - Chronic
  - Pacemaker/ICD
  - Peri-operative
- Valvular disease
- Anticoagulation & Antiplatelet issues
- Congenital heart disease

Focus on coronary atherosclerosis

- Most common question with pre-op evaluation
- Easily tested on ABIM board exam
  - High yield topic – 1% of questions on ABIM 2003 will be covered in the next hour

Question 1

A 72-year-old man is referred for evaluation prior to abdominal aortic aneurysm surgery. He smokes and is on an ACE inhibitor for hypertension and is on lovastatin. He has no history of heart disease, and is asymptomatic. Resting heart rate is 86 bpm and BP is 165/90. ECG shows nonspecific T wave changes.
Which of the following is the most appropriate course of action?

A. Operating room with peri-operative Beta blocker
B. Stress test
C. Cardiac Catheterization

Question 2

A 50-year-old woman is referred for evaluation prior to laparoscopic cholecystectomy. Resting BP is 150/85 in the right arm and 162/90 in the left arm. Other than mild obesity, the remainder of the physical examination is unremarkable. She has no prior history of hypertension or other significant illness. EKG shows a Right Bundle Branch Block. Her family history is positive for hypertension and stroke. She works as a salesclerk and exercises on a treadmill for half an hour three times per week.
Which of the following is the most appropriate course of action?

A. Treadmill stress echocardiogram.
B. Adenosine nuclear perfusion study.
C. MRA of renal arteries.
D. Abdominal CT with CT angiography of renal arteries.
E. Prophylactic beta-blocker therapy.

Question 3

A 55-year-old with known ischemic cardiomyopathy, EF 20%, presents with acute appendicitis. Medications include an ACE inhibitor, a beta-blocker, and a diuretic. His cardiac status has been stable, with no paroxysmal nocturnal dyspnea, orthopnea, or chest pain. Coronary angiography two years ago showed proximal occlusion of the LAD coronary artery. ECG shows an old anterior wall MI, unchanged compared to prior tracings. He works as a used car salesman and walks two miles around his neighborhood with his wife at least twice per week. Exam shows no rales, edema, jugular venous distention, or gallop.
Which of the following is the most appropriate course of action?

A. Preoperative coronary angiography and PCI if indicated.
B. Treadmill exercise test with either nuclear perfusion imaging or echocardiography.
C. Resting echocardiogram with EF and wall motion analysis.
D. Pulmonary artery catheter placement for intraoperative monitoring.
E. Postoperative ECG and troponin.

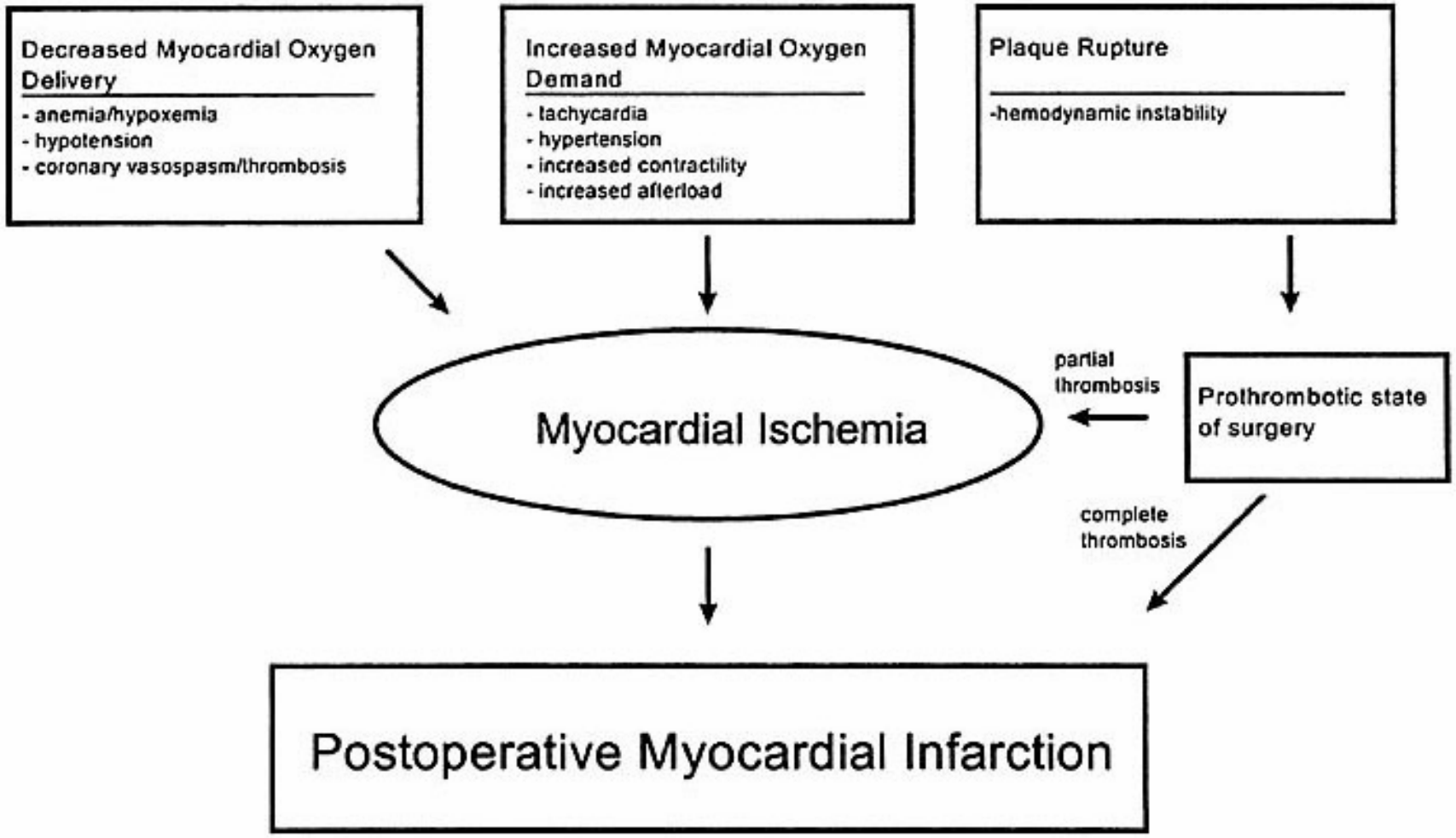
Why assess patients pre-operatively?

- Identify patients at risk for cardiac complications peri-operatively
  - Myocardial infarction
  - Arrhythmia
  - CHF
- Intervene to reduce the cardiac risk
- Pre-op evaluation in US is estimated to cost $3.7 billion/year

Some facts and figures

- 27 million patients undergo surgery annually in US
- 1 million of those will have peri-operative cardiac complication
  - $20 billion/year in extra hospital/long term care costs
- Overall risk of post-op MI is <1%
  - However, it is about 6% if there is hx of MI
  - Risk peaks within about 3 days post op, most MI's are detected within 24 hours

Surgical Stress on the Heart



Topol

The Old Ways of Pre-op Eval

- 1947 – Dripps; assigned physical class to patients prior to anesthesia
  - 1. A healthy patient.
  - 2. A patient with mild systemic disease.
  - 3. A patient with a severe systemic disease that limits activity, but is not incapacitating.
  - 4. A patient with an incapacitating systemic disease that is a constant threat to life.
  - 5. A moribund patient who is not expected to survive 24 hours with or without an operation.

  - Note: In the event of an emergency operation, precede the number with an E.

1977 Goldman

Criterion	Points
History	
Age>70	5
MI in past 6 months	10
Physical Exam	
3rd Heart sound or JVD	11
Important Aortic stenosis	3
EKG	
Rhythm other than sinus or PAC's	7
>5 PVC's per minute at any time	7
General status	
Hypoxia, renal failure, LFT abnormality	3
Operation	
Intraperitoneal, aortic, or intrathoracic	3
Emergency	4
Total	53

1986 Detsky

- Modified Goldman
- Even more complicated than Goldman

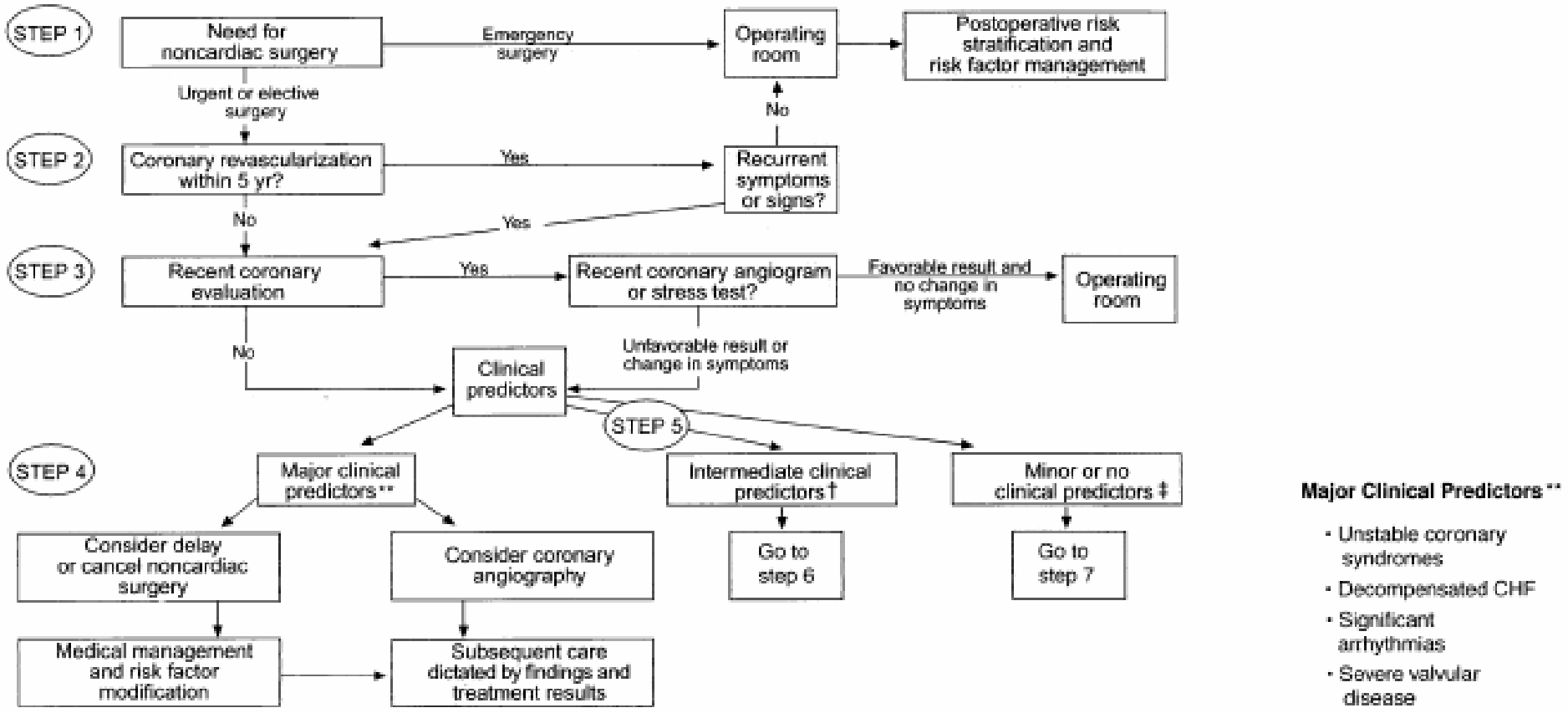
ACC 2002

- Most recent guideline for cardiac pre-operative evaluation
- Stepwise evaluation of patient

History & Physical

- History
  - What surgery?
  - Cardiac history and risk factors
- Physical
  - Neck – JVD, carotid bruits
  - Heart - 3rd or 4th heart sound, rhythm
  - Lungs – crackles
  - Extremities – edema, pulses

ACC 2002



Step 1

- Is this emergency surgery?
  - If yes, go to the OR

Step 2

- Has the patient had coronary revascularization in the last 5 years?
  - If so, does the patient have any recurrent symptoms?
  - If there are no recurrent symptoms, the patient may go to the OR

Step 3

- Has the patient had a coronary evaluation (Cardiac catheterization or stress test) in the past 2 years?
  - If results were favorable and symptoms have not changed, pt may go to OR

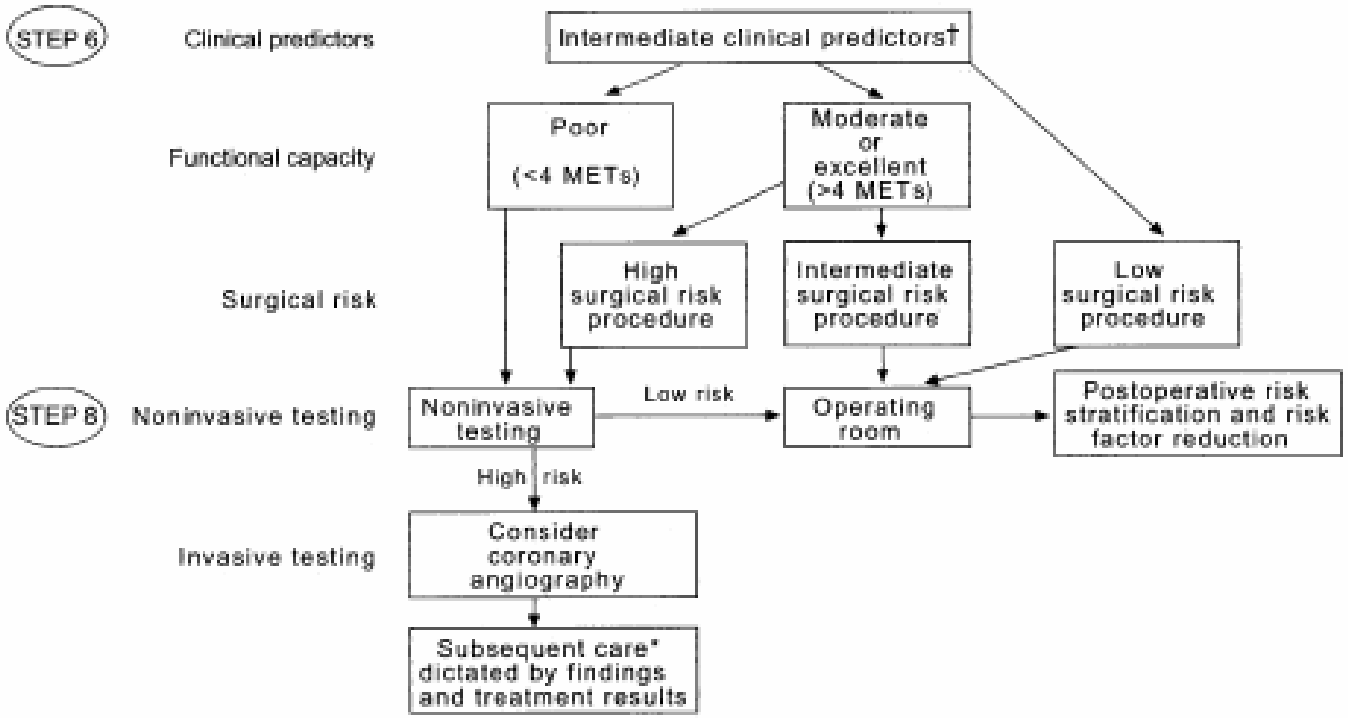
Step 4

- Are there any Major Clinical Predictors?
  - Unstable coronary syndrome
  - Decompensated CHF
  - Significant arrhythmia
  - Significant valvular disease
- If any of these are present then Cardiac Catheterization is a recommended strategy pre-operatively

Step 5

- Are there any Intermediate Clinical Predictors?
  - Mild angina pectoris
  - Prior MI
  - Compensated or prior CHF
  - Diabetes
  - Renal insufficiency
- If any of these are present then must stratify functional status and risk of operation

Intermediate clinical predictors



Intermediate Clinical Predictors†

- Mild angina pectoris
- Prior MI
- Compensated or prior CHF
- Diabetes mellitus
- Renal insufficiency

Step 6

- What is the functional status
  - >=4 Mets or <4 Mets
  - If <4 Mets then stress test

What's a MET?

Table 2. Estimated Energy Requirements for Various Activities*

1 MET	Can you take care of yourself?	4 METs	Climb a flight of stairs or walk up a hill?
	Eat, dress, or use the toilet?		Walk on level ground at 4 mph or 6.4 km per h?
	Walk indoors around the house?		Run a short distance?
	Walk a block or two on level ground at 2 to 3 mph or 3.2 to 4.8 km per h?		Do heavy work around the house like scrubbing floors or lifting or moving heavy furniture?
	Do light work around the house		Participate in moderate recreational activities like golf, bowling, dancing, doubles tennis, or throwing a baseball or football?
4 METs	like dusting or washing dishes?	Greater than 10 METs	Participate in strenuous sports like swimming, singles tennis, football, basketball, or skiing?

MET indicates metabolic equivalent.
*Adapted from the Duke Activity Status Index (20) and AHA Exercise Standards (96).

Step 6 (Continued)

- What is the functional status
  - >=4 Mets or <4 Mets
  - If <4 Mets then stress test
- What is the surgical risk?
  - Low or intermediate risk, go to OR
  - High risk, go to stress test

Surgical Risk Categories

Table 3. Cardiac Risk* Stratification for Noncardiac Surgical Procedures

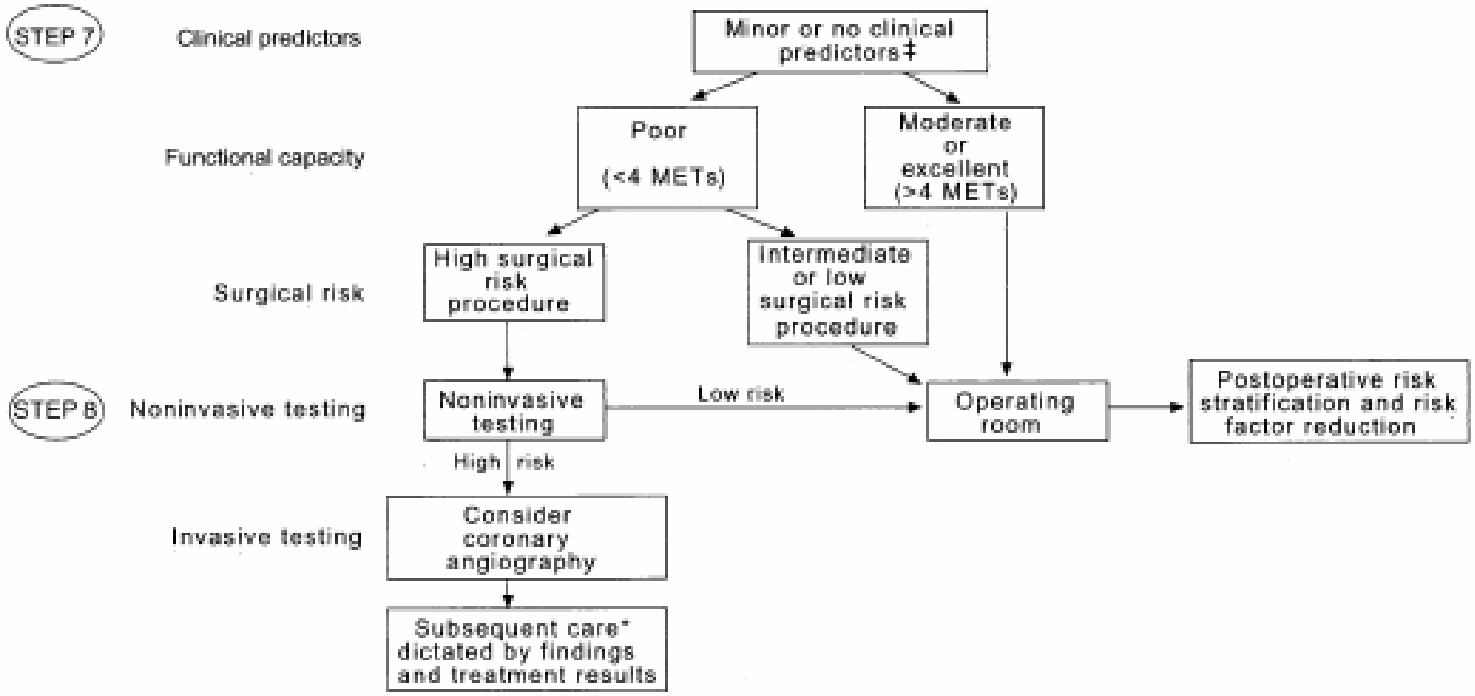
High (Reported cardiac risk often greater than 5%)
- Emergent major operations, particularly in the elderly
- Aortic and other major vascular surgery
- Peripheral vascular surgery
- Anticipated prolonged surgical procedures associated with large fluid shifts and/or blood loss

Intermediate (Reported cardiac risk generally less than 5%)
- Carotid endarterectomy
- Head and neck surgery
- Intraperitoneal and intrathoracic surgery
- Orthopedic surgery
- Prostate surgery

Low† (Reported cardiac risk generally less than 1%)
- Endoscopic procedures
- Superficial procedure
- Cataract surgery
- Breast surgery

*Combined incidence of cardiac death and nonfatal myocardial infarction.
†Do not generally require further preoperative cardiac testing.

Minor Clinical Predictors



Minor Clinical Predictors ‡

- Advanced age
- Abnormal ECG
- Rhythm other than sinus
- Low functional capacity
- History of stroke
- Uncontrolled systemic hypertension

Step 7

- Minor or no clinical predictors
  - Advanced age
  - Abnormal EKG
  - Rhythm other than sinus
  - Low functional capacity
  - History of stroke
  - Uncontrolled hypertension

Functional status (Minor predictors)

- If moderate or excellent then proceed to OR
- If <4 METS
  - Low or intermediate risk procedure can go to OR
  - High risk procedure, go to stress test

Benefits of Revascularization prior to surgery

- Retrospective studies have looked at balloon angioplasty
  - May be beneficial when PTCA is done 90 days prior to surgery
- Retrospective bare metal stent data
  - Surgery should be delayed AT LEAST 4 weeks after stent placement
  - Drug eluting stents?
- CABG prior to surgery has shown morbidity/mortality similar to patients without CAD

CARP

Coronary Artery Revascularization Prophylaxis

- VA study of 510 patients undergoing vascular surgery
  - 33% Abdominal aortic aneurysm
  - 67% Lower extremity arterial occlusive disease
- Avg age 66 years, significant but stable CAD
  - Randomized to revascularization vs. med management
    - 59% PCI; 41% CABG
- Surgery delayed 54 days (vs 18 days) for revascularization

Outcome	Revasc-ularization	Medical Management
Postop MI	11.6%	14.3%
30-day mortality	3.1%	3.4%
2.7-year mortality	22%	23%

Presented AHA 2004

Other Peri-operative measures

- Routine use of Swan-Ganz (pulmonary artery) catheters has not been shown to improve outcome
- Peri-operative (pre- and post-) beta blockade is beneficial (mortality) for higher risk patients
- Nitroglycerin may decrease ischemia, but has not been shown to decrease MI or mortality
- Alpha-2 Agonists (Clonidine) ***may*** be beneficial in patients with CAD

Peri-operative Beta Blockade NEJM, July 2005

- Large retrospective review of 782,969 patients
  - 663,635 (85 percent) had no recorded contraindications to beta-blockers
  - 122,338 (18 percent) received Beta blocker during the first two hospital days
    - 14% with RCRI of 0
    - 44% with RCRI of >=4
  - RCRI 0 or 1- treatment of no benefit, possible harm
  - RCRI of 2, odds ratio of death in hospital 0.88
  - RCRI of 2, odds ratio of death in hospital 0.71
  - RCRI of >=4, odds ratio of death in hospital 0.58

Lindenauer PK, Pekow P, Wang K, Mamidi DK, Gutierrez B, Benjamin EM. Perioperative beta-blocker therapy and mortality after major noncardiac surgery. N Engl J Med. 2005 Jul 28;353(4):349-61

REVISED CARDIAC RISK INDEX
(Circulation 1999; 100:1043-1049)

- Each risk factor is assigned one point.
- **1. High-risk surgical procedures**
- • Intraperitoneal
- • Intrathoracic
- • Suprainguinal vascular
- **2. History of ischemic heart disease**
- • History of myocardial infarction
- • History of positive exercise test
- • Current complain of chest pain considered secondary to myocardial ischemia
- • Use of nitrate therapy
- • ECG with pathological Q waves
- **3. History of congestive heart failure**
- • History of congestive heart failure
- • Pulmonary edema
- • Paroxysmal nocturnal dyspnea
- • Bilateral rales or S3 gallop
- • Chest radiograph showing pulmonary vascular redistribution
- **4. History of cerebrovascular disease**
- • History of transient ischemic attack or stroke
- **5. Preoperative treatment with insulin**
- **6. Preoperative serum creatinine > 2.0 mg/dL**

RISK OF MAJOR CARDIAC EVENT

Points	Class	Risk
0	I	0.4%
1	II	0.9%
2	III	6.6%
3 or more	IV	11%

"Major cardiac event" includes myocardial infarction, pulmonary edema, ventricular fibrillation, primary cardiac arrest, and complete heart block

Unresolved issues

- No randomized trials for PCI
- ? Timing after PCI
  - PTCA
  - Bare metal stent
  - Drug eluting stent
- Optimal timing and duration of Beta blocker therapy
- Role of Alpha-2 agonists?

Question 1

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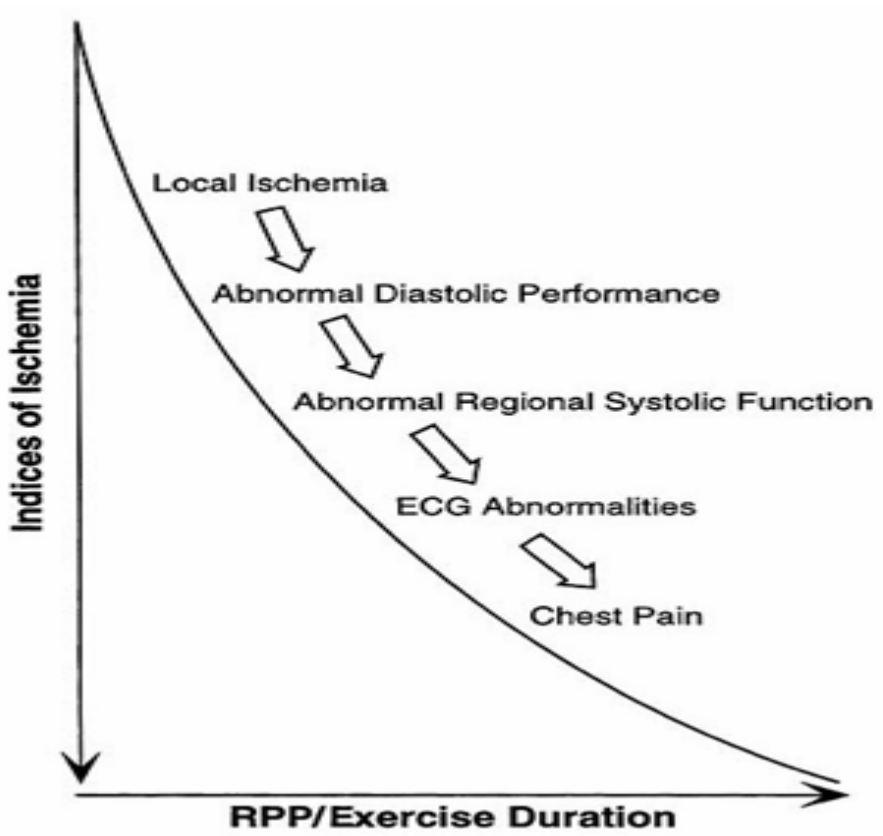
Pearls for the Boards

- Emergencies go straight to OR!
- Remember – Revascularization in past 5 years or favorable stress test/cath in past 2 years with stable symptoms = OR
- Direct path to Catheterization is ONLY indicated with major clinical predictors
- Low risk surgery can usually go to OR
- High risk (vascular) surgery needs a stress test (per guidelines) unless low risk patient with >4 METS of function
- Good functional status + intermediate risk surgery = OR
- Carotid endarterectomy is a moderate risk procedure

Noninvasive options

- Exercise EKG
- Nuclear Imaging
- Stress echocardiography
- PET
- Electron Beam CT
- CT (16/64 slice) & MRI

Ischemic Cascade



Topol

Exercise EKG

The basic “stress test”

- Patient exercises on treadmill or bicycle
  - Bruce protocol common for treadmill
    - Start at 1.7 mph at 10% grade
    - Increase about 0.8 mph and 2% every 3 minutes
- EKG monitoring performed throughout
- Patient must achieve 85% of maximum predicted HR for valid results
  - Max HR = 220 - Age

Patients who should not have EKG only

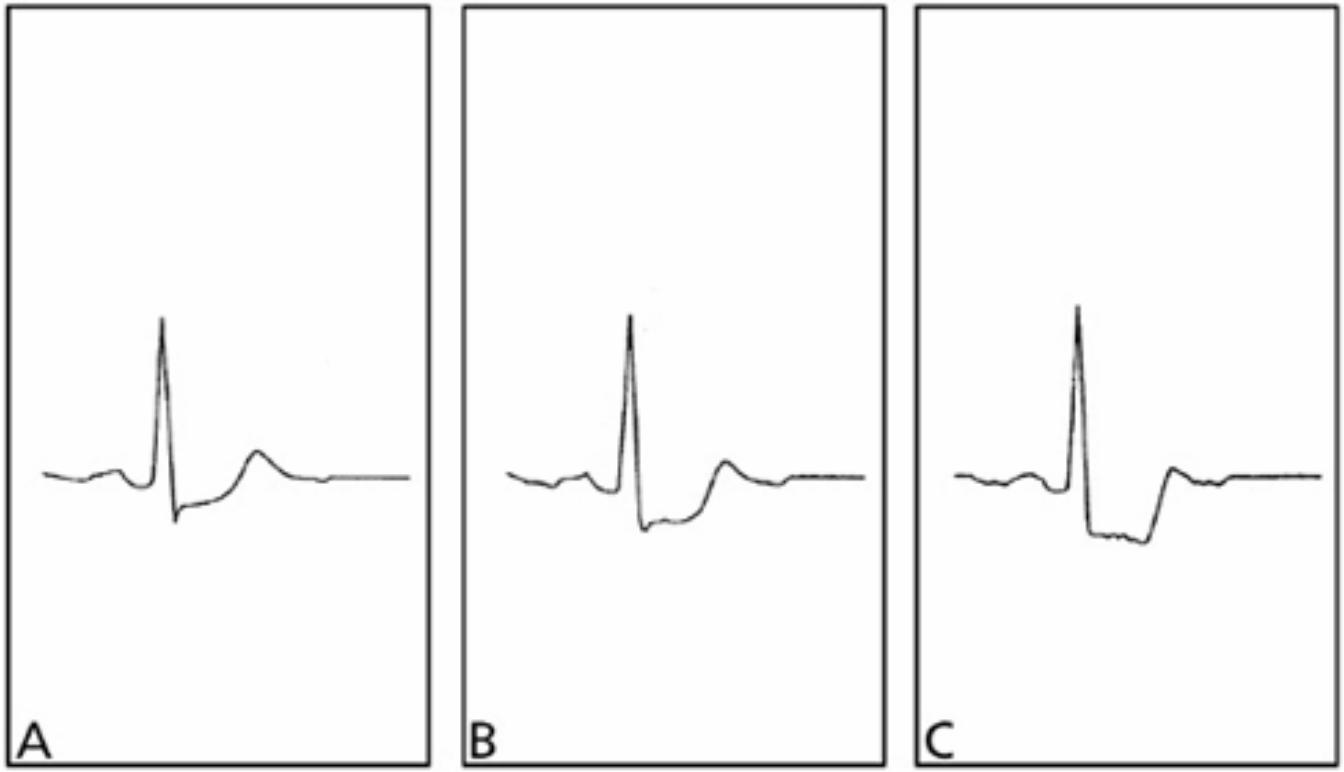
- These lead to uninterpretable EKG or have high rate of false positives
  - Left Bundle Branch Block
  - Wolf-Parkinson-White (Ventricular pre-excitation)
  - Left Ventricular hypertrophy with strain
  - Ventricular pacing
  - Digoxin use

Positive EKG Stress

- PQ segment used as reference baseline
- Identify J point as junction of QRS complex and ST segment
- Measure ST changes 60-80 ms after J point
- ≥1mm of ST depression that is horizontal or downsloping
- 1mm ST depression with upsloping may be equivocal

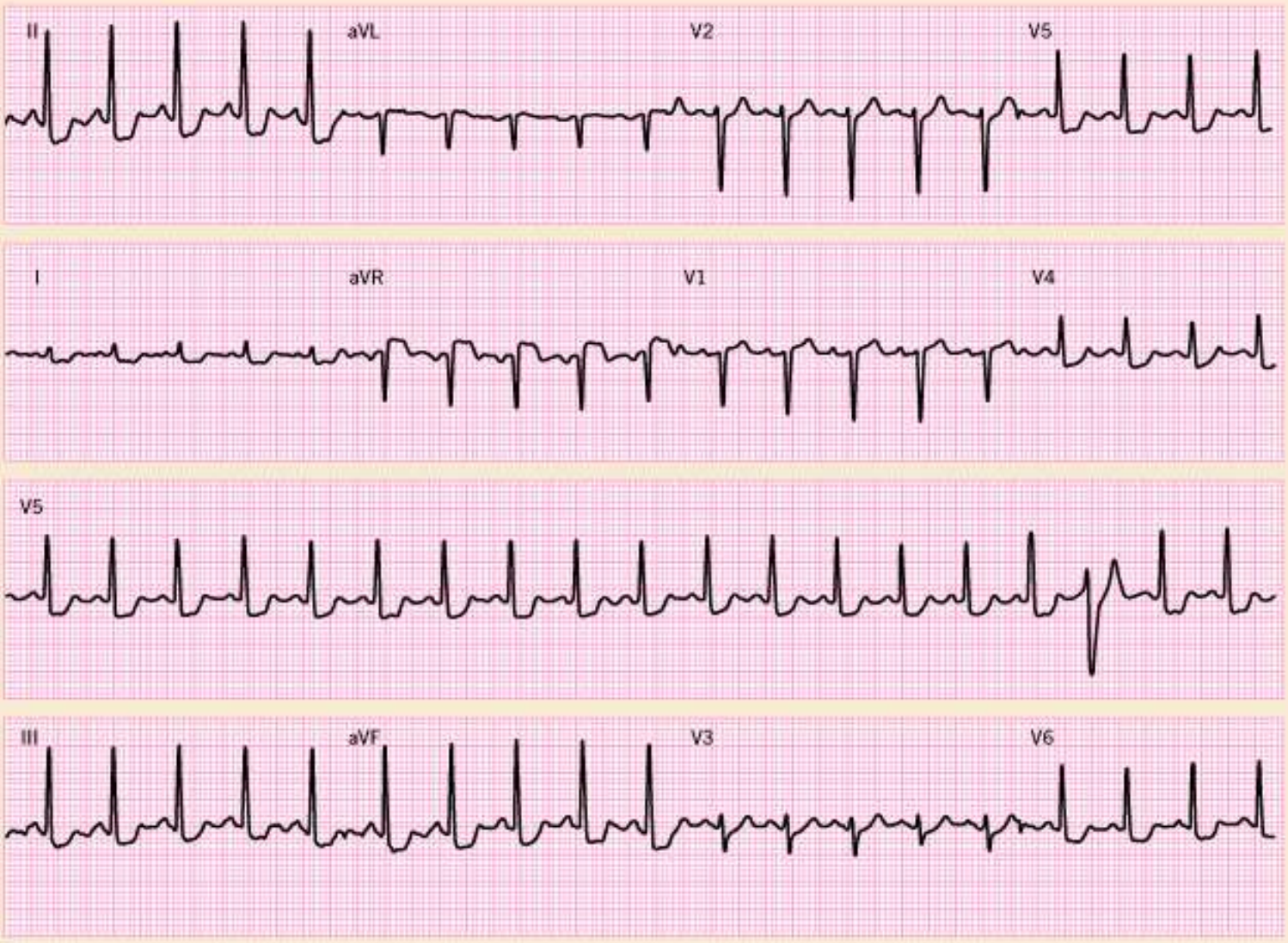
Topol
ACC 2002

Comparison of ST segment response



- A = Slowly Upsloping ST segment depression
- B = Horizontal ST segment depression
- C = ST depression with downsloping

ABNORMAL EXERCISE ECG WITH MARKED HORIZONTAL ST-SEGMENT DEPRESSION



DiMarco

Exercise EKG

- 1 in 2500 risk of death or MI[1]
- Sensitivity about 68%, Specificity about 77%[2] (using 50% stenosis by cath as gold standard)
- Functional capacity assessed by METS
- BP expected to rise with exercise
- Poor heart rate recovery (HR decrease <12bpm 2 minutes after peak exercise) has negative prognosis
- Location of ST depressions does not anatomically localize coronary lesions

1 DiMarco
2 Gianrossi

Exercise testing in Females

- Increased incidence of false positives compared to males[1]
  - CASS data shows sensitivity similar for women (76%) and men (78%)
  - However, specificity for women (64%) lower than for men (73%)
- Functional information is important
  - Females achieving 7.5 METS have same 20 year mortality prognosis with or without ST depression[2]

1 Wiener
2 Mora

Nuclear Stress Test

- Basic concepts
  - Images the heart at rest and stress
  - Compare images to determine if coronary perfusion is reduced with stress
  - Scar areas revealed by lack of perfusion at rest
  - Gating techniques allow calculation of ejection fraction

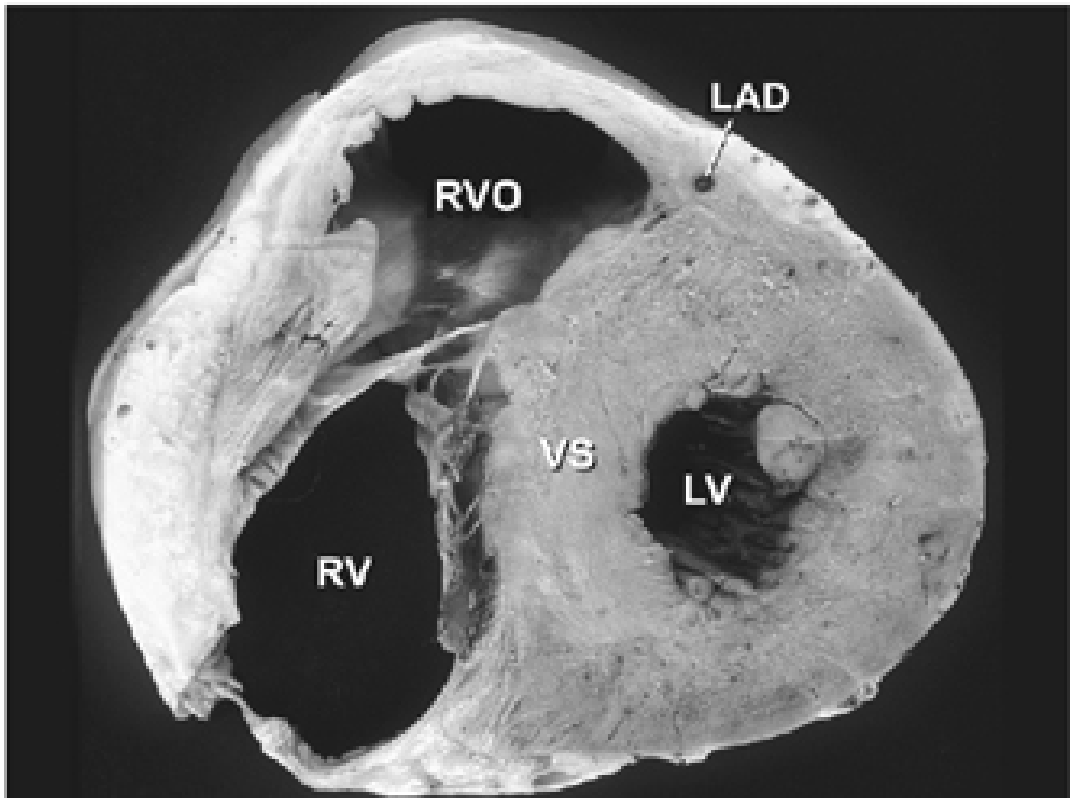
Nuclear Stress Testing

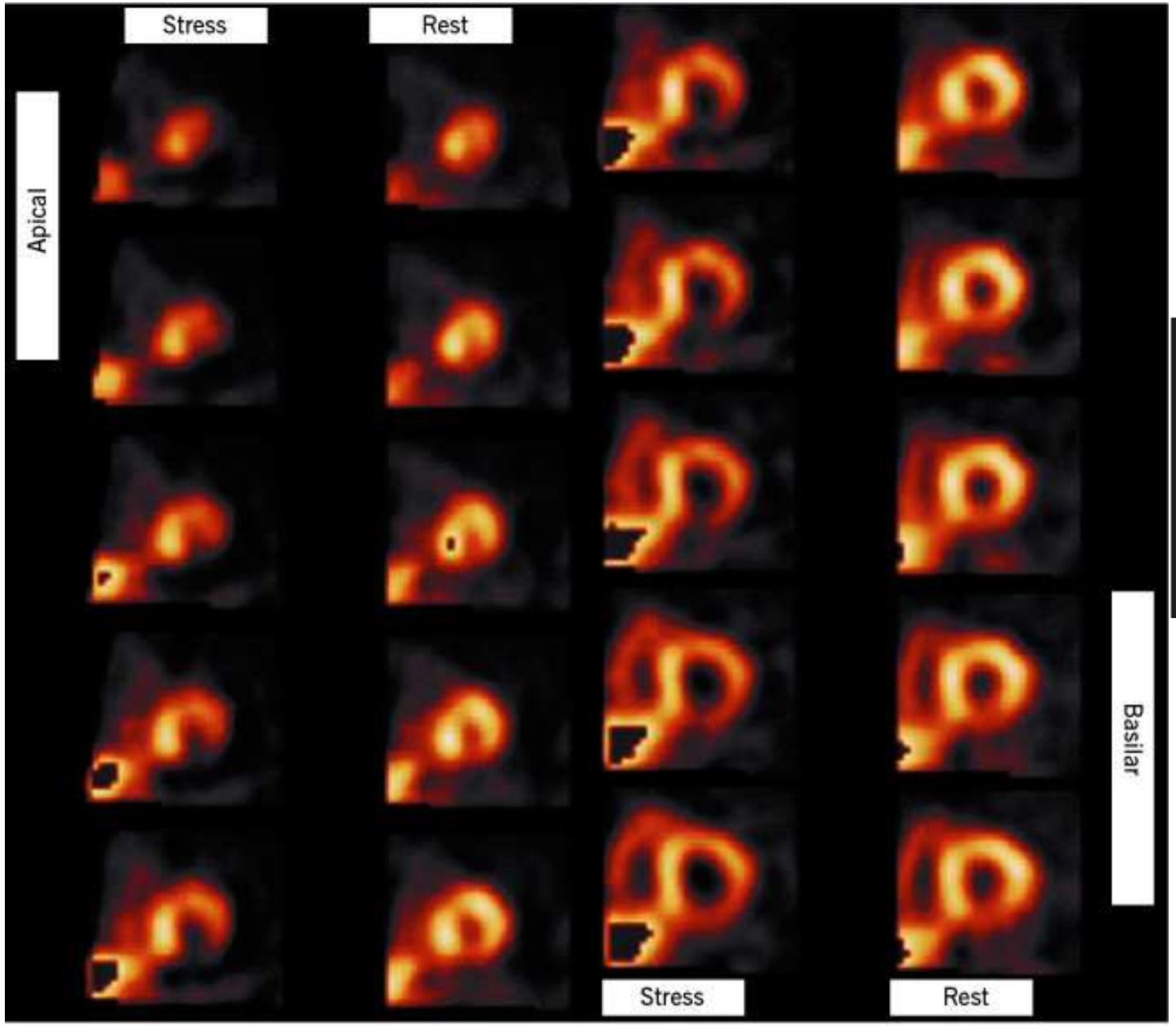
- Choice of stress agents
  - Exercise
  - Pharmacological
    - Dobutamine
      - β-1 agonist which increases contractility, cardiac index, and oxygen consumption
    - Vasodilators
      - Adenosine
        - » Direct vasodilator
      - Dipyridamole (Persantine)
        - » Indirect vasodilator (enhances endogenous adenosine)

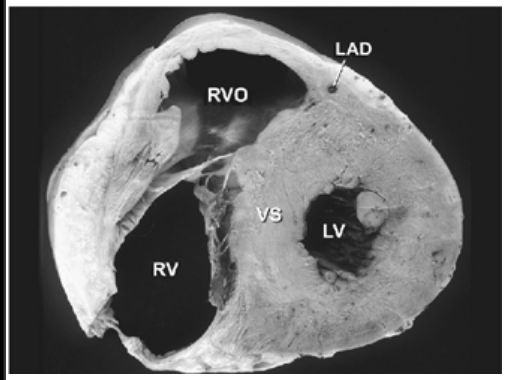
Nuclear Stress Testing

- Choice of Imaging Agents
  - Thallium-201
    - K+ analogue
  - Technitium-99m
    - Sestamibi (Cardiolite)
    - Tetrofosmin (Myoview)
    - Improved image resolution due to higher energy
      - Obesity

Short axis View of the Heart



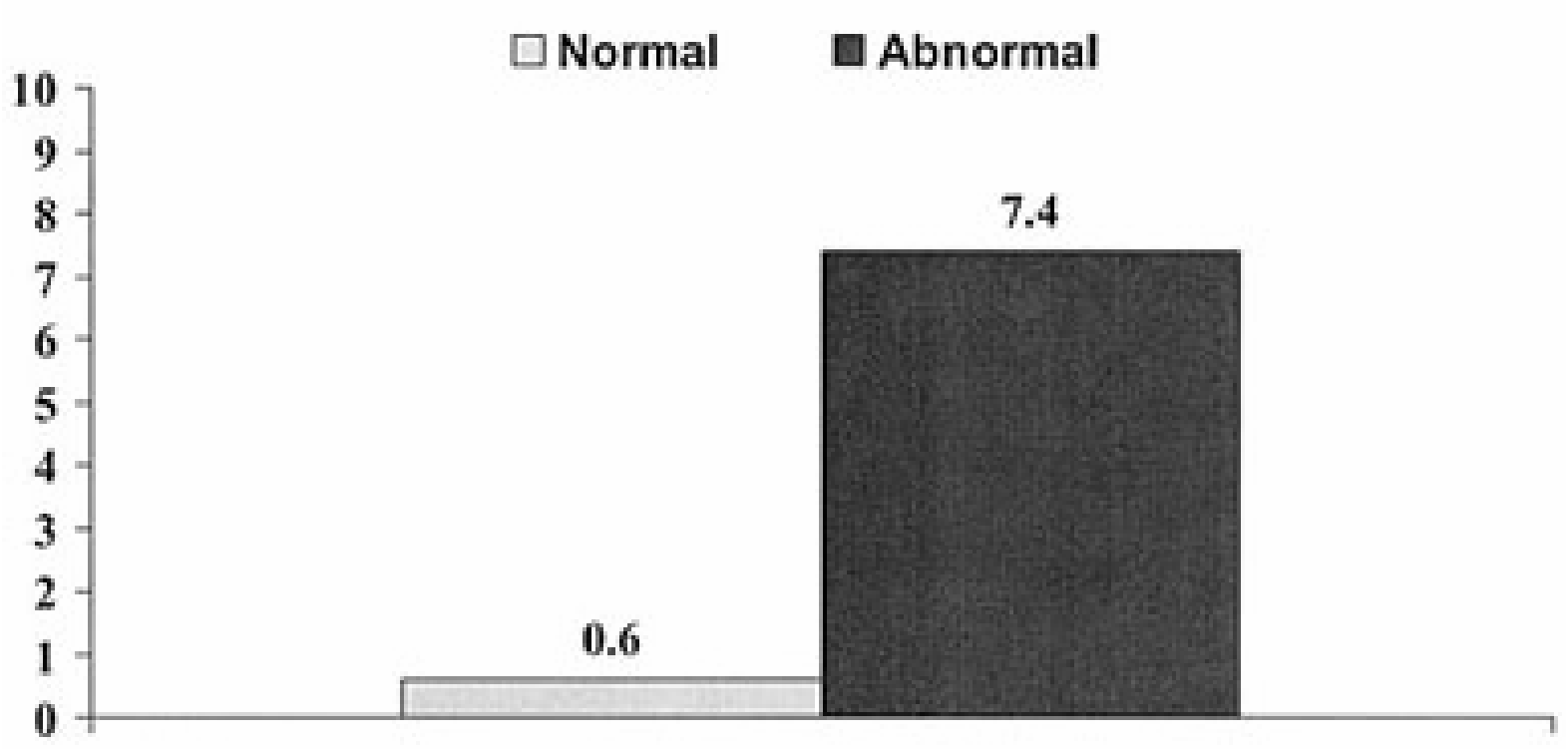




DiMarco
Hurst

Reversible ischemia of anterior, lateral, and inferior walls with LV dilitation

Prognosis



Annual Rate of Death or MI with Normal and Abnormal SPECT scans using Tc-99m

Nuclear Stress Testing

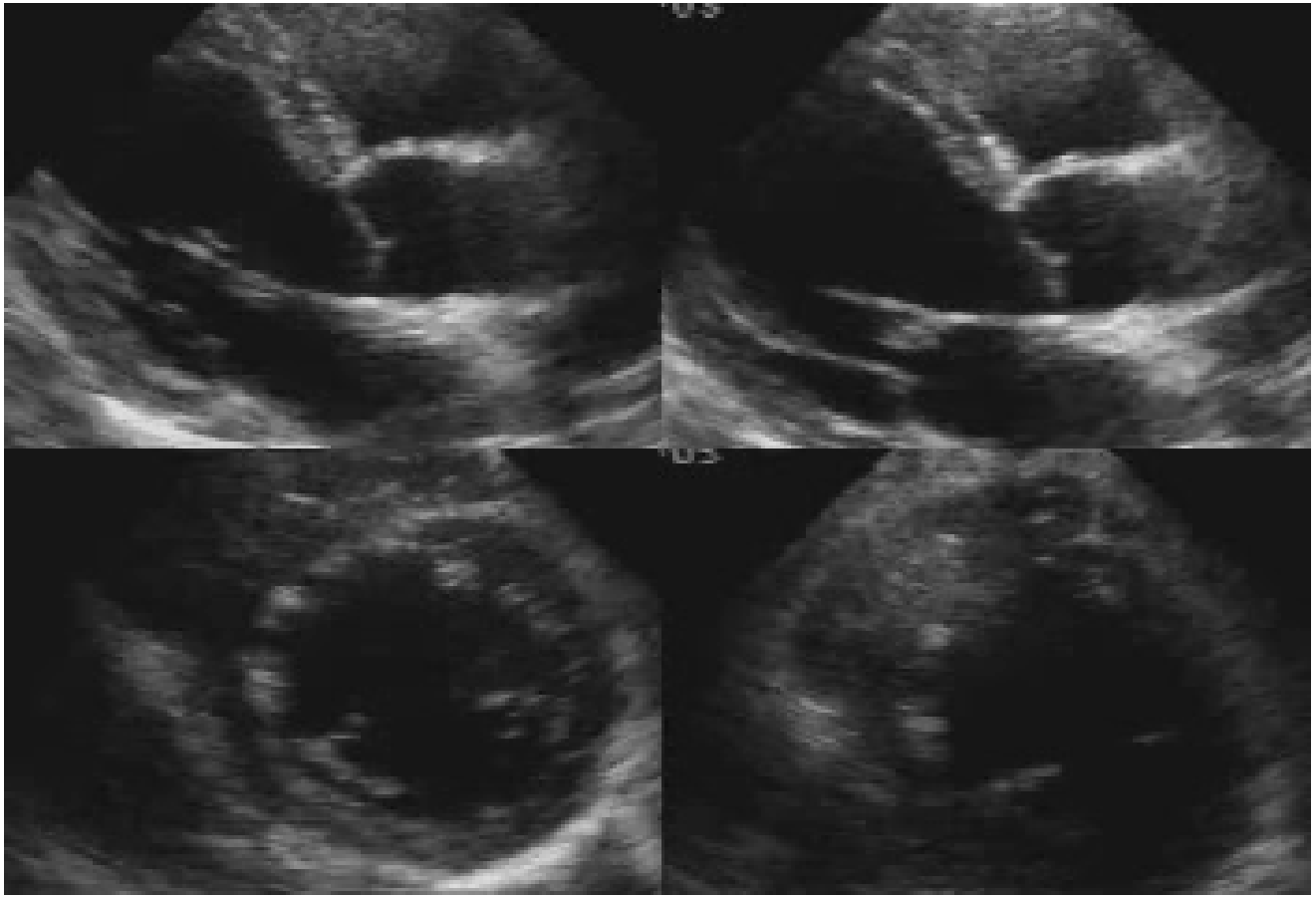
- Overall sensitivity 88%, specificity 85%
- Adenosine and dipyrimadole are contraindicated in bronchospastic disease

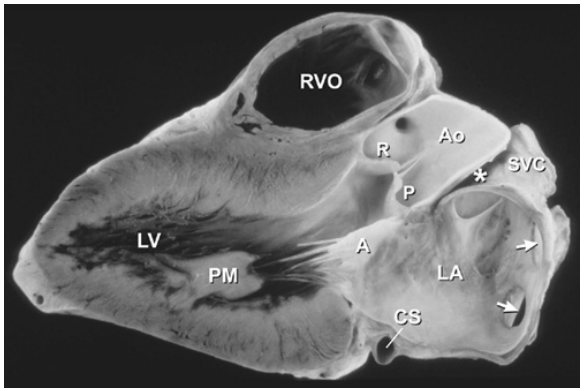
Stress Echocardiography

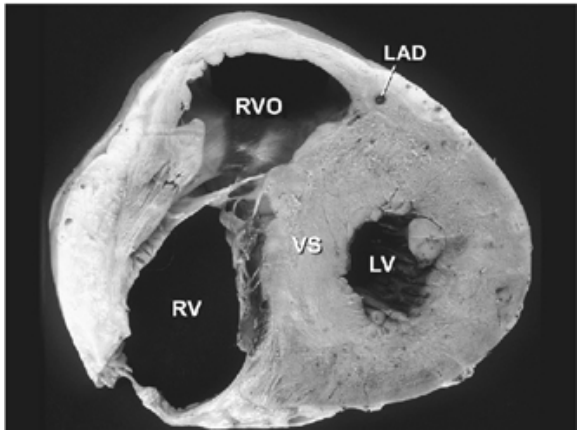
- Basic Principles
  - Imaging the heart at stress and rest
  - Evaluate for wall motion abnormalities at stress
  - Can identify akinetic scar areas
  - Dependent on adequate acoustic windows

Stress Echocardiography

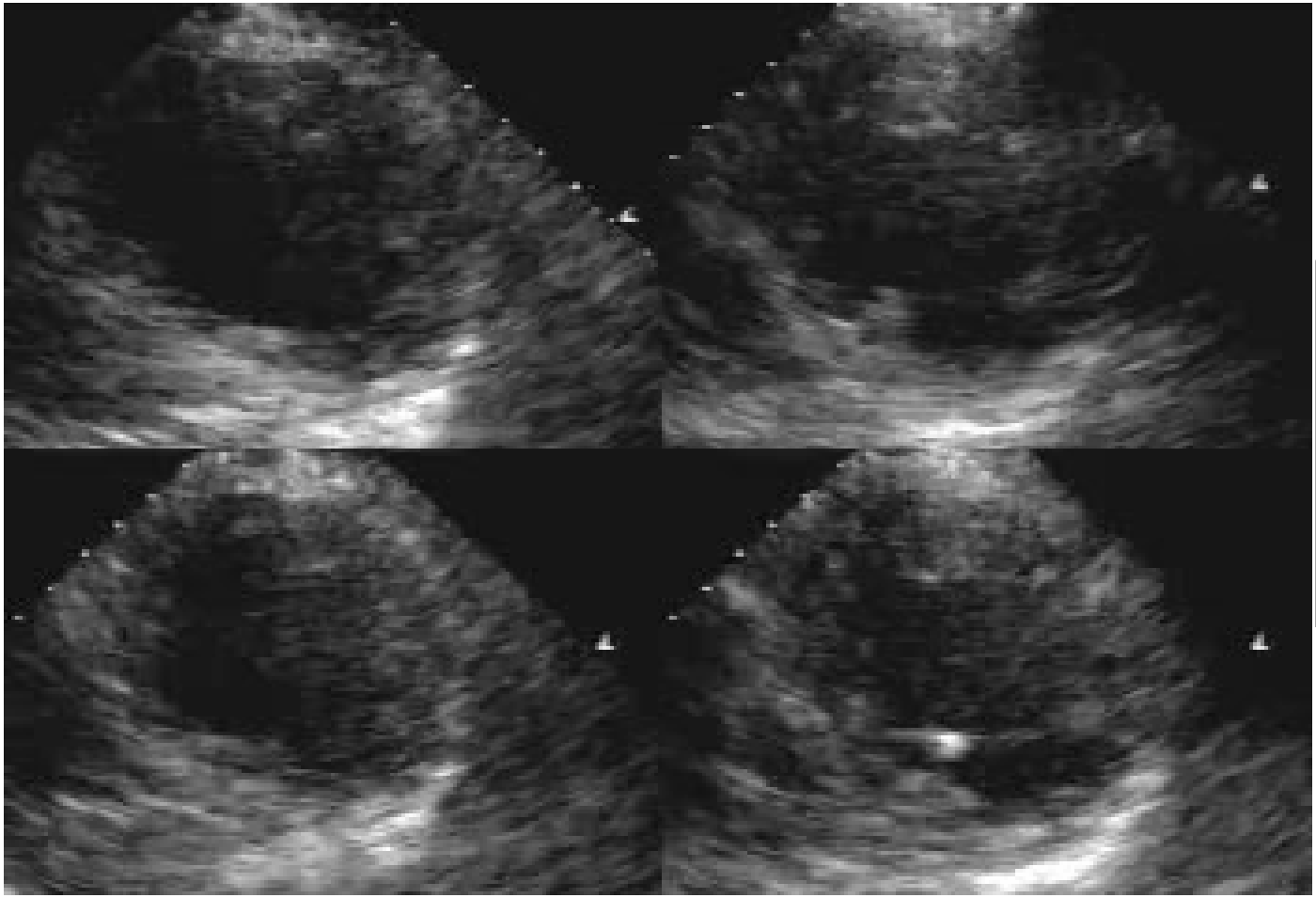
- Pick a method of stress
  - Exercise
  - Dobutamine
- 81% Sensitivity, 92% specificity for at least 50% stenosis by angiography

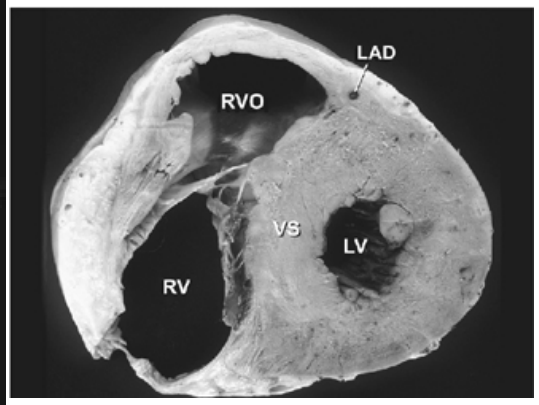






Topol
Hurst





Topol
Hurst

Overall performance of stress tests

	Sensitivity	Specificity
Stress EKG	68%	77%
Stress Echo	81%	92%
Nuclear	88%	90%

Other Methods of Stress Imaging

- MRI
  - Dobutamine MRI similar to Dobutamine echo in premise
  - Better imaging, does not depend on acoustic windows
- PET
  - Similar to other nuclear imaging
  - Not widely available

Non Stress Imaging

Protocols for evaluation of coronary and bypass graft stenoses

- Multidetector CT anigiography
  - 16 and 64 slice detectors in use
  - Iodinated contrast, ionizing radiation
- MRI (coronary)
  - Not widely available
  - Long acquisition times
- Both susceptible to artifacts during tachycardia
- Both techniques are in further development
- Compared to angiography (>50% stenosis)
  - MRI 75% sensitivity, 77% specificity
  - CT (16 slice) 82% sensitivity, 79% specificic

Kefer et al. Head to Head Comparison of Three-Dimensional Navigator Gated Resonance Imaging and 16-Slice Computed Tomography to Detect Coronary Artery Stenosis in Patients. J Am Coll Cardiol. 2005 Jul 5; 46(1): 92-100.

Electron Beam CT

- Not a stress test
- Noninvasive evaluation of coronary calcification
- ACC 2000 guidelines essentially do not recommend use of EBCT
- USPSTF recommends against using EBCT to screen asymptomatic patients
- Probably best employed in asymptomatic patients – but studies not conclusive on indications or long term prognosis

J Am Coll Cardiol 2000;36:326-40

ACC 2002 Guideline for Exercise Testing

- Gibbons RJ, Balady GJ, Bricker JT, Chaitman BR, Fletcher GF, Froelicher VF, Mark DB, McCallister BD, Mooss AN, O'Reilly MG, Winters WL, Gibbons RJ, Antman EM, Alpert JS, Faxon DP, Fuster V, Gregoratos G, Hiratzka LF, Jacobs AK, Russell RO, Smith SC; American College of Cardiology/American Heart Association Task Force on Practice Guidelines. Committee to Update the 1997 Exercise Testing Guidelines. ACC/AHA 2002 guideline update for exercise testing: summary article. A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee to Update the 1997 Exercise Testing Guidelines).
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