

# 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?

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- B. Adenosine nuclear perfusion study.
- C. MRA of renal arteries.
- D. Abdominal CT with CT angiography of renal arteries.
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# 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.

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- C. Resting echocardiogram with EF and wall motion analysis.
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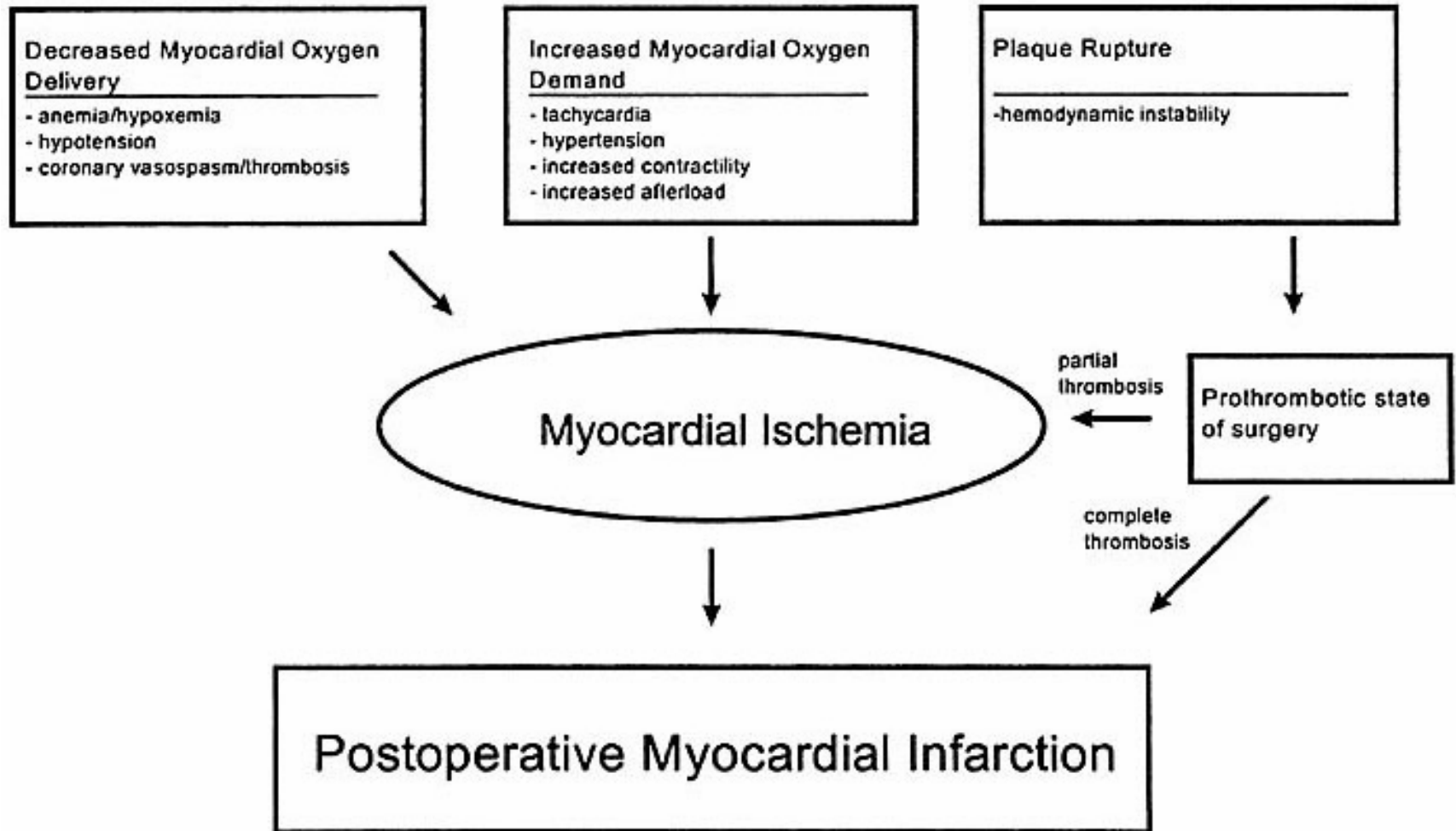
# Why assess patients pre-operatively?

- 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



# 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

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

# 1986 Detsky

- Modified Goldman
- Even more complicated than Goldman

# ACC 2002

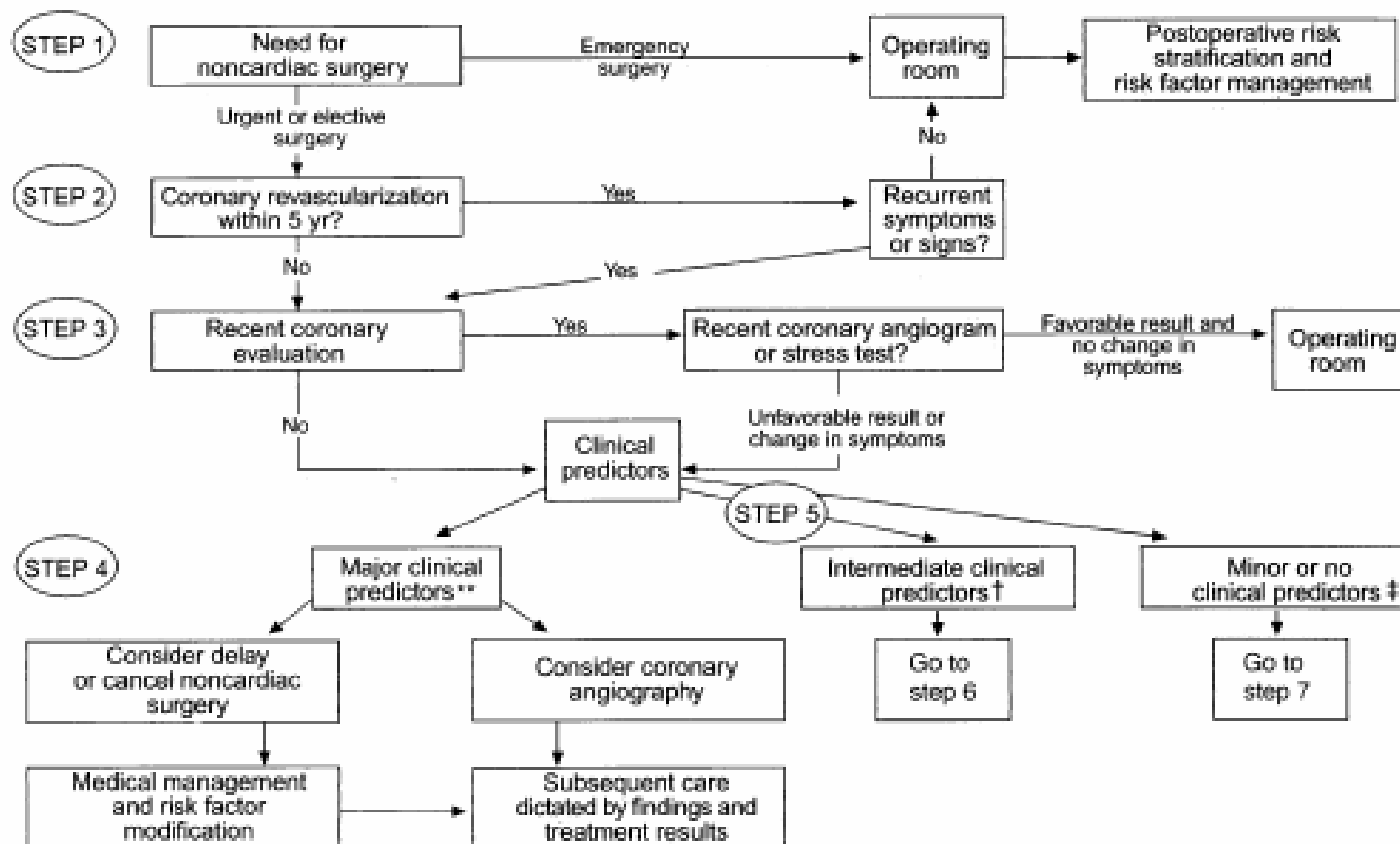
- Most recent guideline for cardiac pre-operative evaluation
- Stepwise evaluation of patient

# History & Physical

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



# ACC 2002



### Major Clinical Predictors \*\*

- Unstable coronary syndromes
- Decompensated CHF
- Significant arrhythmias
- Severe valvular disease

# 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

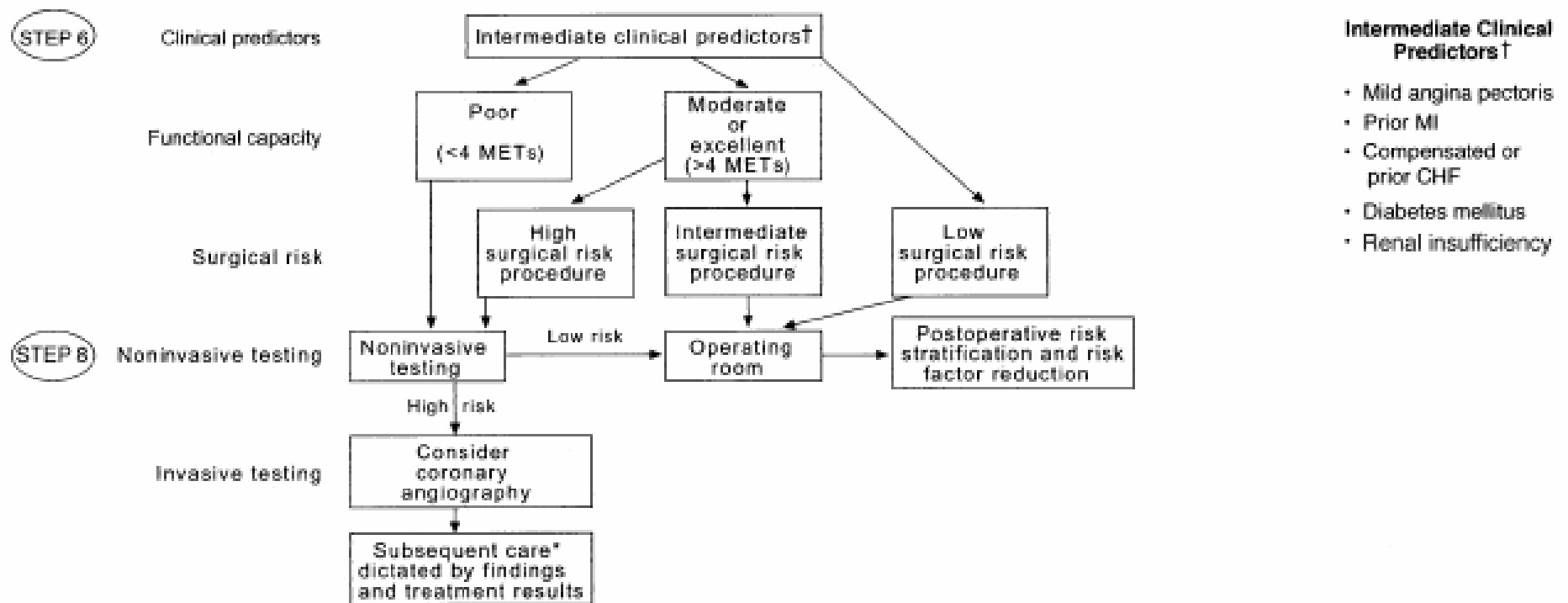
## Step 4

- 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



# Step 6

- What is the functional status
  - $\geq 4$  Mets or  $< 4$  Mets
  - If  $< 4$  Mets then stress test



# What's a MET?

**Table 2.** Estimated Energy Requirements for Various Activities\*

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1 MET	Can you take care of yourself? Eat, dress, or use the toilet? Walk indoors around the house? Walk a block or two on level ground at 2 to 3 mph or 3.2 to 4.8 km per h? Do light work around the house	4 METs	Climb a flight of stairs or walk up a hill? Walk on level ground at 4 mph or 6.4 km per h? Run a short distance? Do heavy work around the house like scrubbing floors or lifting or moving heavy furniture? 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
  - $\geq 4$  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

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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
- Intraabdominal and intrathoracic surgery
- Orthopedic surgery
- Prostate surgery

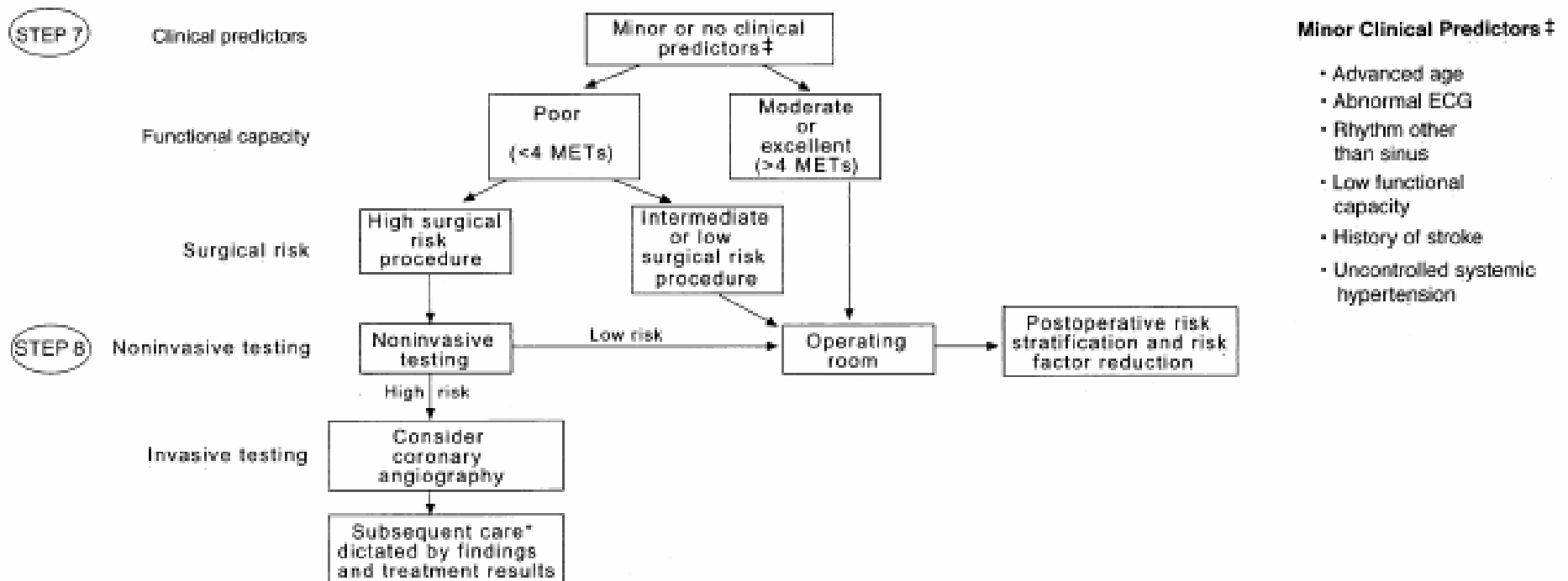
Low† (Reported cardiac risk generally less than 1%)

- 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



# 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	Revascularization	Medical Management
Postop MI	11.6%	14.3%
30-day mortality	3.1%	3.4%
2.7-year mortality	22%	23%



# 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

# 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?

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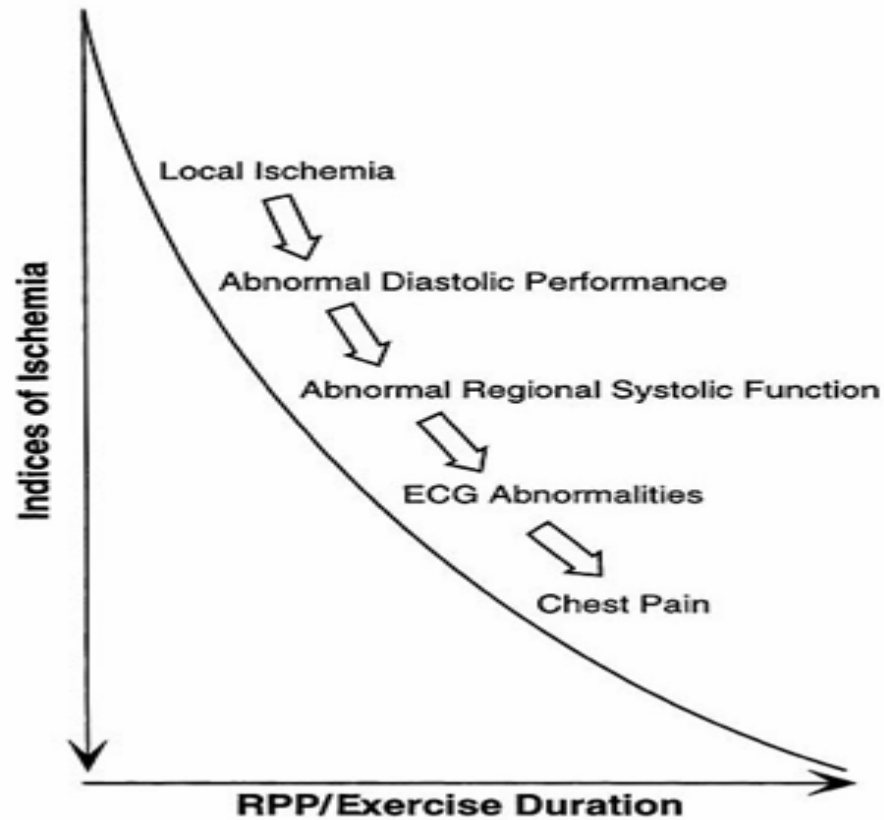
# Pearls for the Boards

- 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





# 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 =  $220 - \text{Age}$

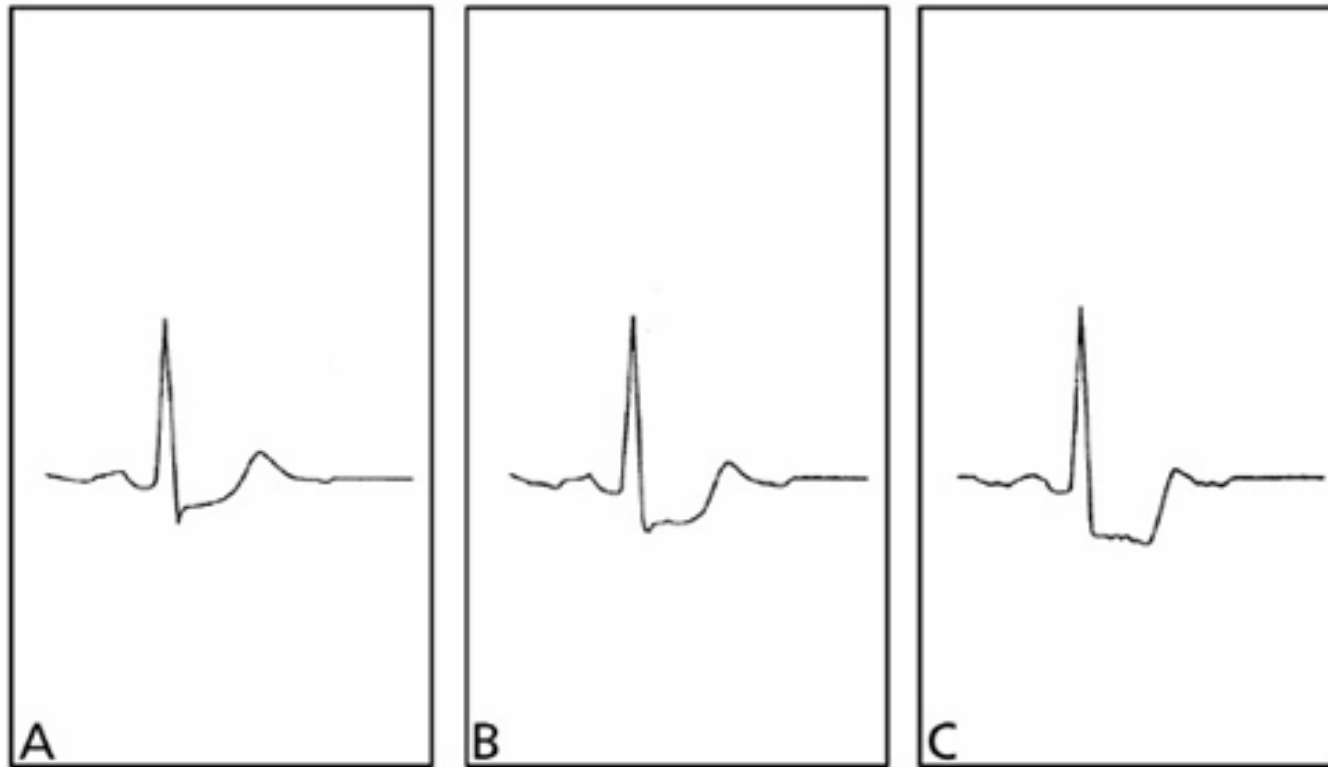
# Patients who should not have EKG only

- 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

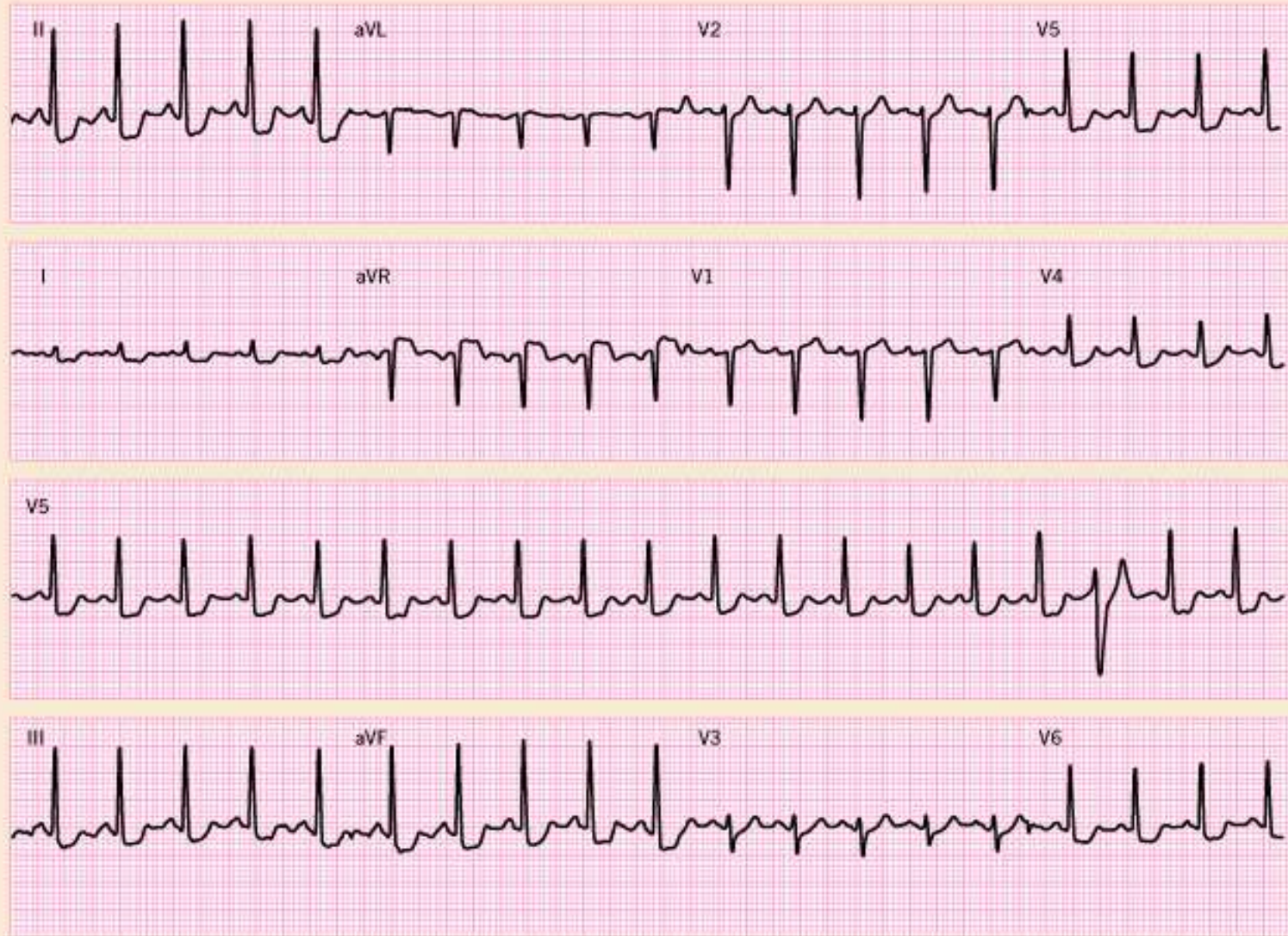
- PQ segment used as reference baseline
- Identify J point as junction of QRS complex and ST segment
- Measure ST changes 60-80 ms after J point
- $\geq 1$ mm of ST depression that is horizontal or downsloping
- 1mm ST depression with upsloping may be equivocal

# 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



# Exercise EKG

- 1 in 2500 risk of death or MI<sup>1</sup>
- Sensitivity about 68%, Specificity about 77%<sup>2</sup>  
(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<sup>1</sup>
  - 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<sup>2</sup>

<sup>1</sup> Wiener

<sup>2</sup> 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



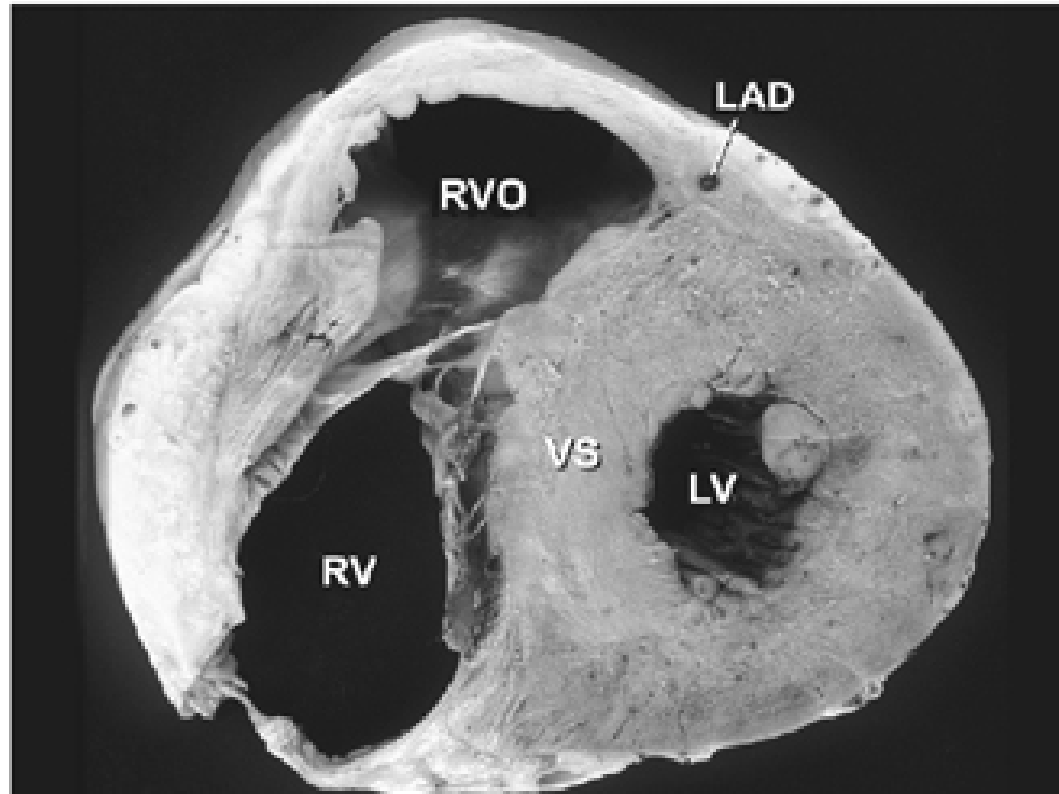
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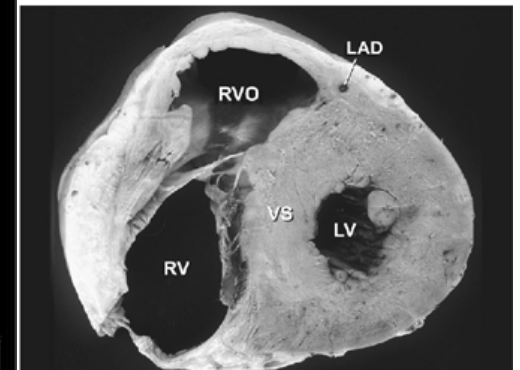
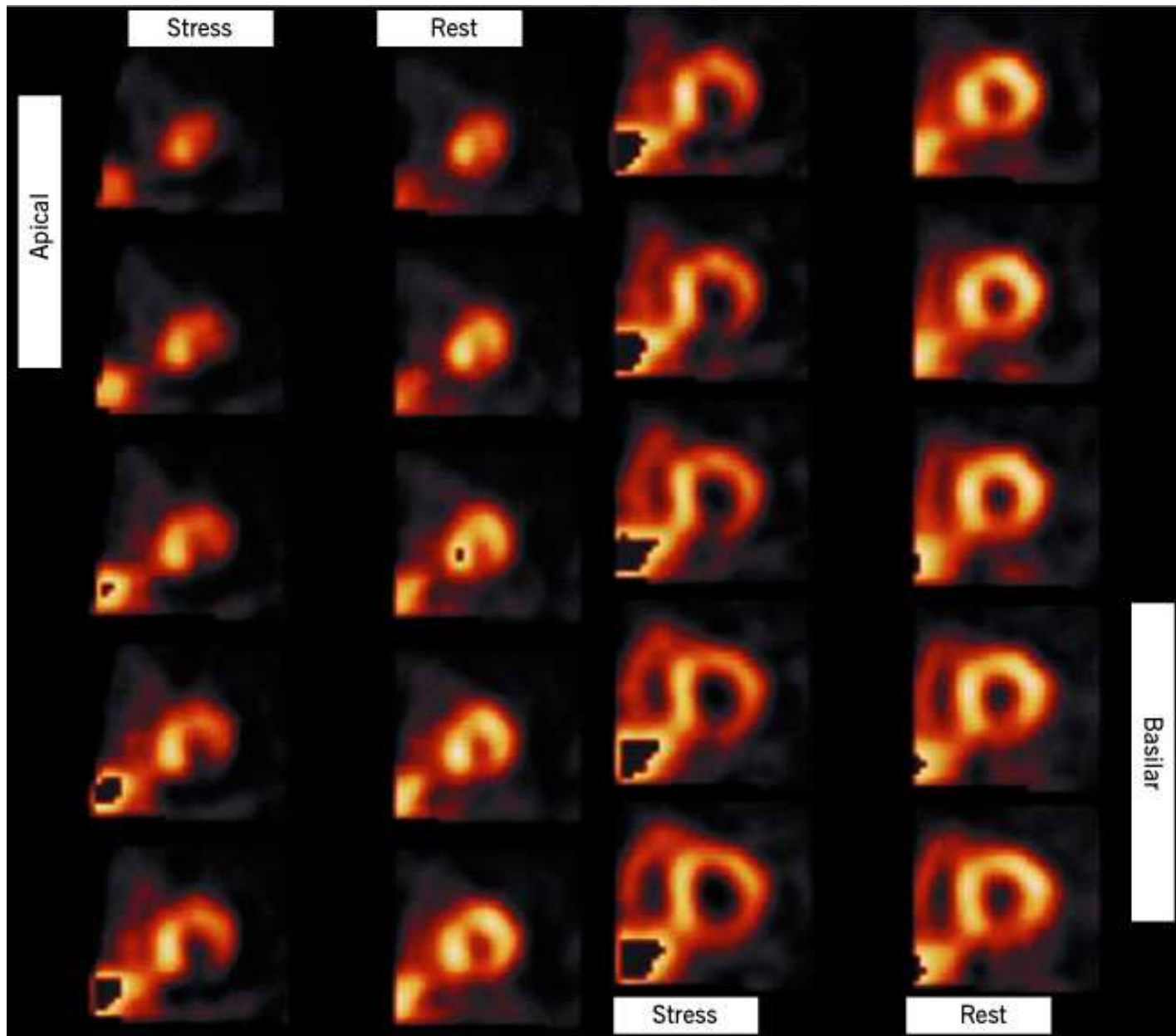
- Choice of stress agents
  - Exercise
  - Pharmacological
    - Dobutamine
      - $\beta$ -1 agonist which increases contractility, cardiac index, and oxygen consumption
    - Vasodilators
      - Adenosine
        - » Direct vasodilator
      - Dipyridamole (Persantine)
        - » Indirect vasodilator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

# Nuclear Stress Testing

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

# Short axis View of the Heart



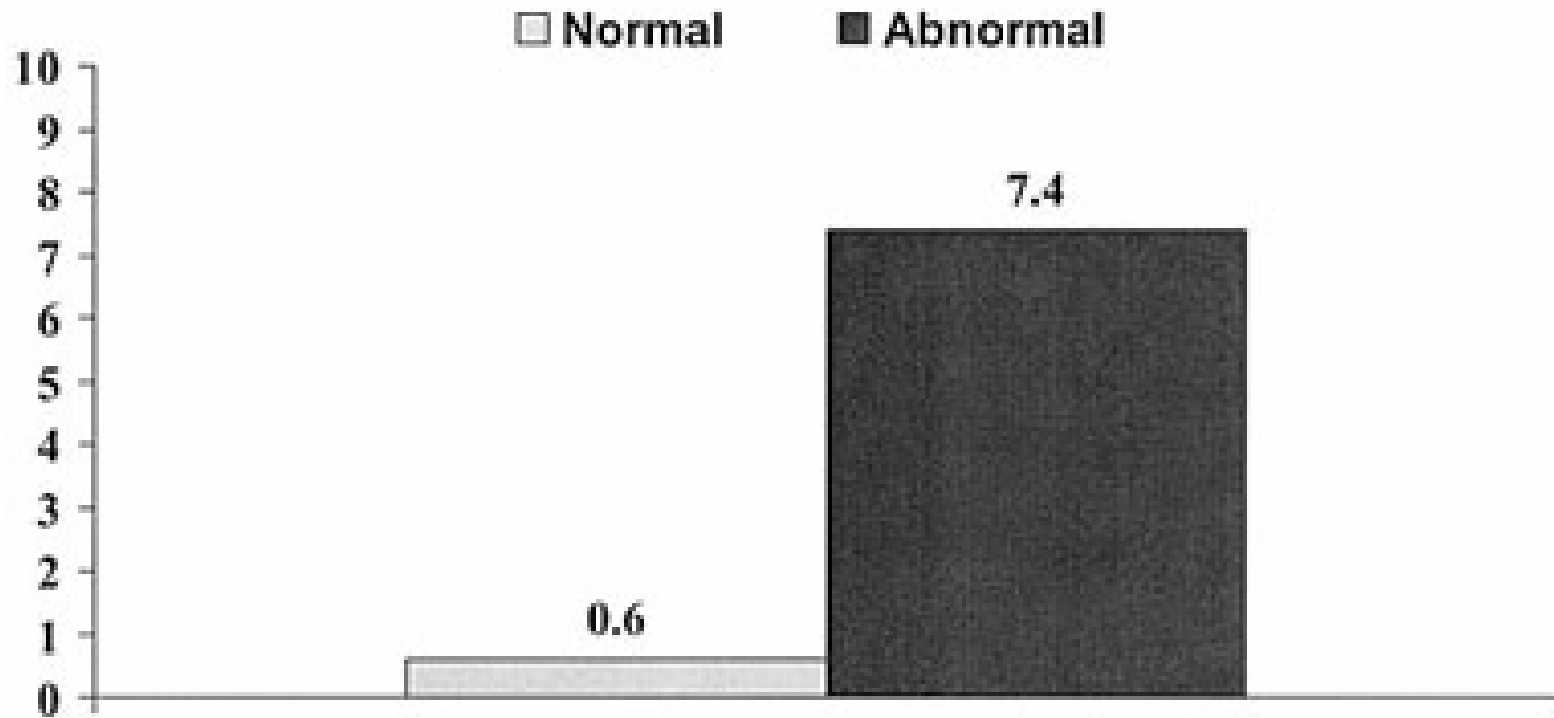


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DiMarco  
Hurst

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

# 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

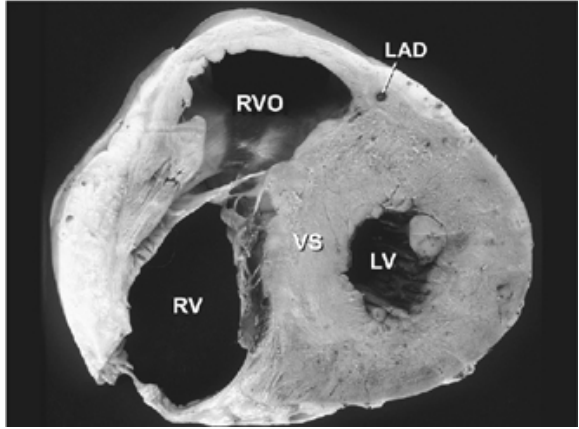
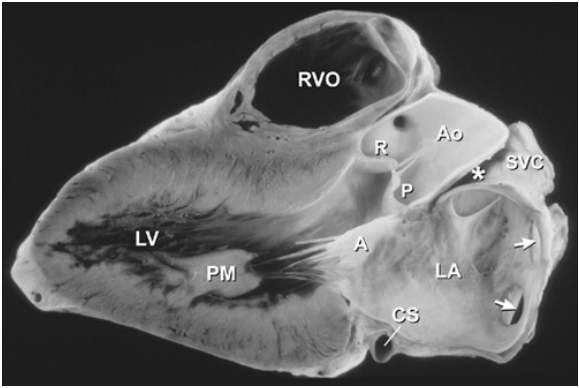
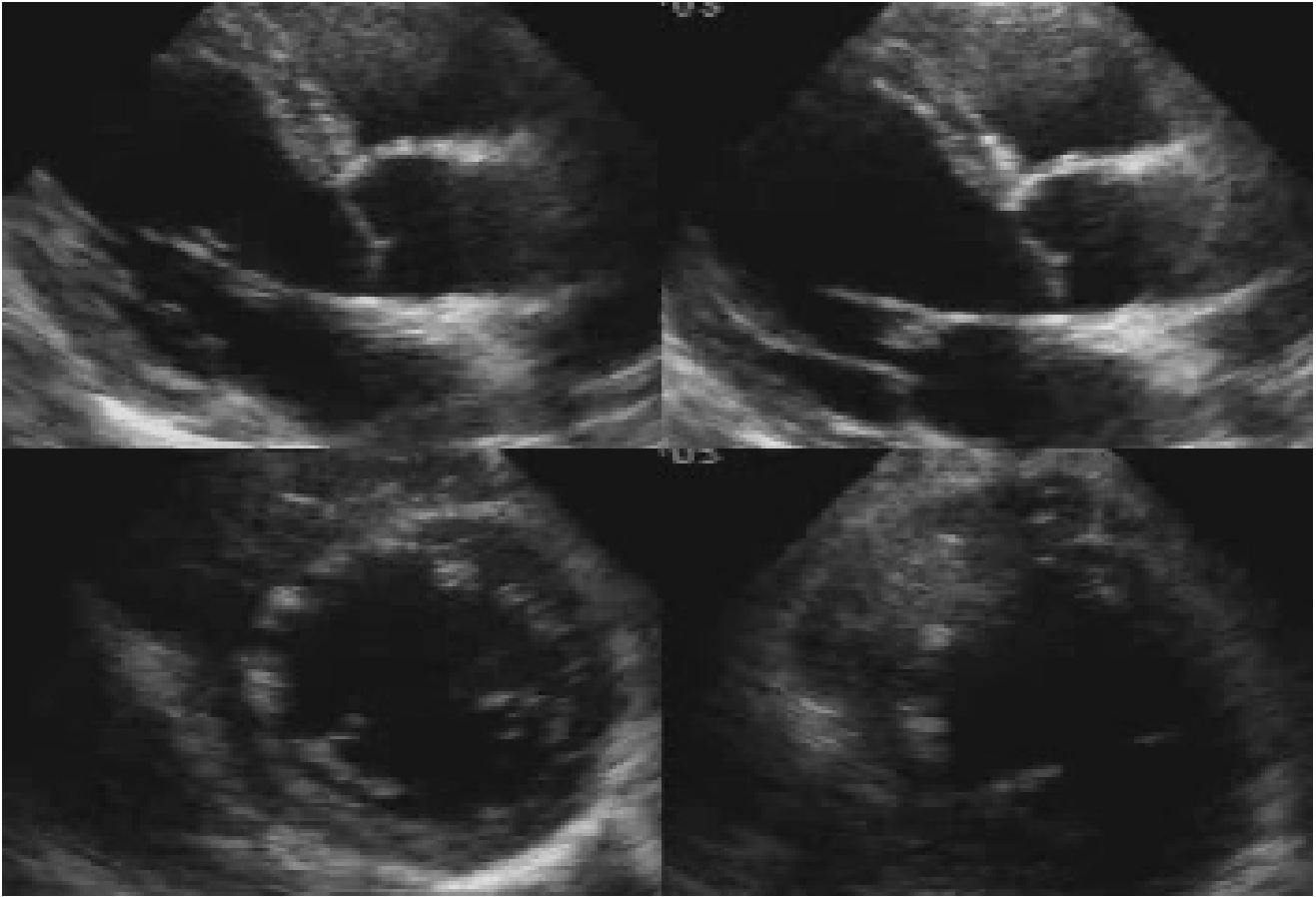
# Stress Echocardiography

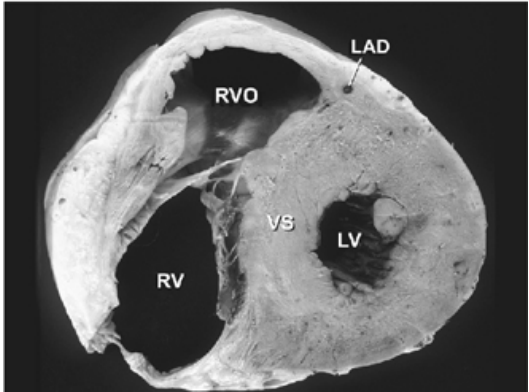
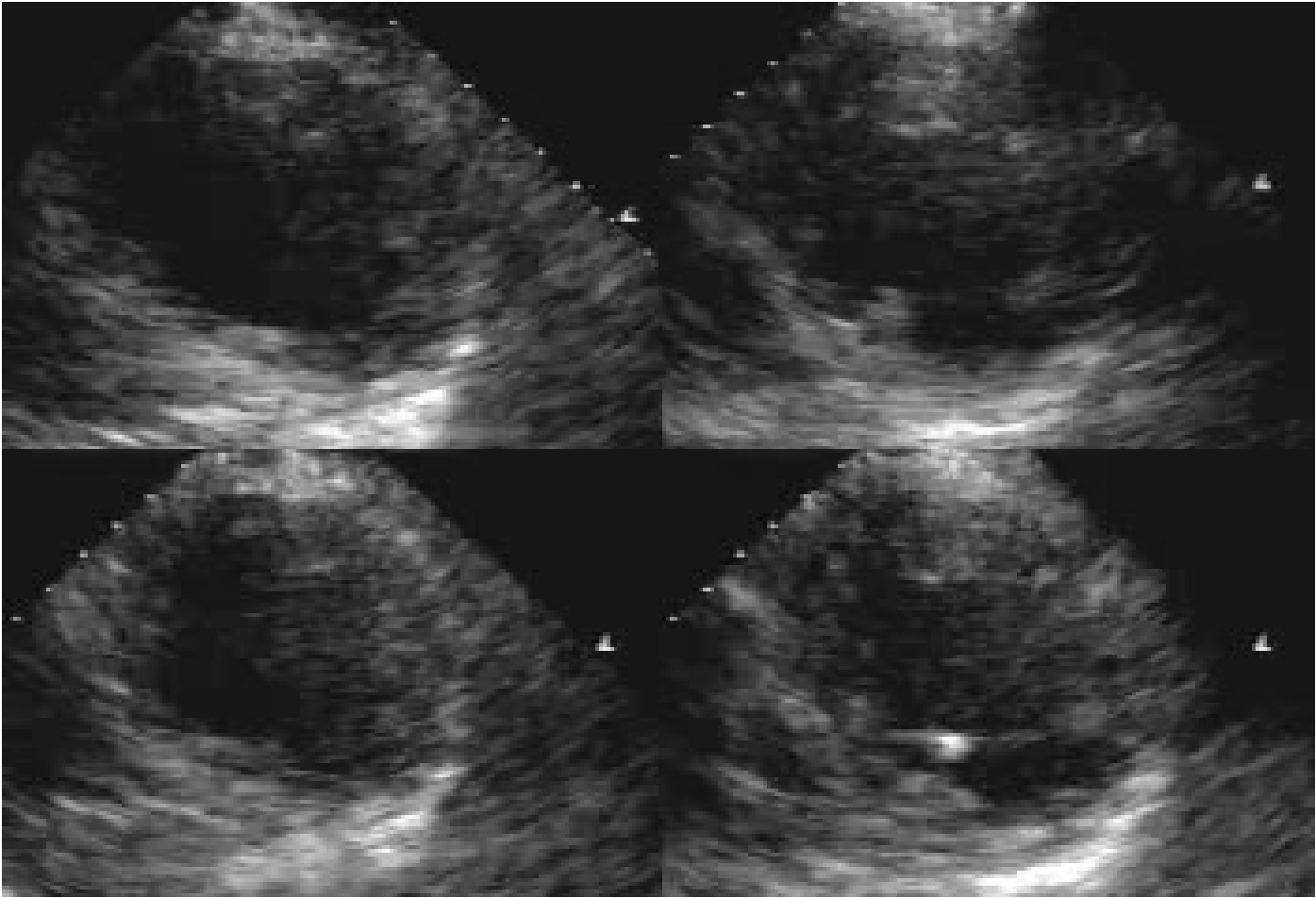
- Basic Principles
  - Imaging the heart at stress and rest
  - Evaluate for wall motion abnormalities at stress
  - Can identify akinetic scar areas
  - Dependent on adequate acoustic windows

# Stress Echocardiography

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







Topol  
Hurst

# 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

# 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

# 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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