Diagnostic Tests for the Diagnosis of CAD

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Objectives

1. Describe typical angina, atypical angina and non-anginal chest pain and describe how age and gender associated with these types of chest pain determine pretest probability of CAD (see table 4). Describe how pretest probability impacts the interpretation of the results of the diagnostic test for CAD.
2. Fill in the table
3. Know the contraindications to the pharmacological stress agents including dobutamine, adenosine and regadenoson.
4. Describe the Framingham risk score and how it classifies patients as low, intermediate, or high risk for ME or death from CAD over 10 years. Know how the Framingham risk score differs from the new scoring system developed in 2013 for assessment of CAD risk
5. Describe the appropriate evaluation for patients with chest pain and low, intermediate and high pretest probability for CAD

Introduction

- Chest pain is one of the most common problems evaluated in the ED
  - Each year ~5 million patients present to the ED c/o CP
  - 1.2 million of these patients are ultimately diagnosed with AMI
  - 2-4% of patients who arrive with CP and AMI are inappropriately discharged home
- Rapid evaluation and risk stratification of patients with CP are essential to identify life-threatening conditions and improve outcomes

Introduction

- Differentiating ischemic from nonischemic causes of chest pain can be difficult
- Patients present with a spectrum of signs and symptoms reflecting the many potential etiologies of chest pain
  - Diseases of the heart, aorta, lungs, esophagus, stomach, mediastinum, pleura, and abdominal viscera may all cause chest discomfort
- Patients with life-threatening etiologies for chest pain may appear deceptively well, manifesting neither vital sign nor physical examination abnormalities

Introduction

- A detailed history, physical exam, labs and diagnostic tests can help guide decisions regarding the diagnosis and subsequent testing
- With clinical history, physical exam and initial ECG, 92-98% of cases of AMI and ~90% of cases of UA can be identified
- It has been estimated that >50% of patients initially admitted with a dx of UA are later discharged with a non-cardiac diagnosis

Differential diagnosis of chest pain

- CARDIAC
  - Acute coronary syndrome (ACS) - UA, NSTEMI, STEMI
  - Coronary spasm
  - Syndrome X (microvascular disease)
  - Myopericarditis
    - Pericarditis with cardiac tamponade
  - Aortic stenosis
  - HCM

Differential diagnosis of chest pain

- AORTIC
  - Aortic dissection
  - Penetrating aortic ulcer
  - Aortic aneurysm
- PULMONARY
  - Pulmonary embolism
  - Pneumothorax
  - Pneumonia/pleuritis
- GI
  - Esophageal spasm/GERD
  - Esophagitis
  - Esophageal rupture
- MISC
  - Costochondritis
  - Cervical spondylosis and other compression neuropathies
  - Herpes zoster
  - Anxiety

Acute Coronary Syndrome

- Ischemic symptoms suggestive of ACS
  - UA: negative troponins, +/- ischemic ECG changes
  - NSTEMI: positive troponins, +/- ischemic ECG changes
  - STEMI: positive troponins, ST segment elevation
- Spectrum of severity
  - differ primarily in whether the ischemia is severe enough to cause sufficient myocardial damage to release detectable quantities of a marker of myocardial injury (troponins)
- Since an elevation in troponins may not be detectable for hours after presentation, UA and NSTEMI are frequently indistinguishable at initial evaluation
  - NSTE-ACS

ACS

- Sudden imbalance between myocardial oxygen consumption and demand
- Type 1 MI
  - Spontaneous MI related to atherosclerotic plaque rupture, ulceration, fissuring, erosion, or dissection with resulting intraluminal thrombus in one or more of the coronary arteries leading to decreased myocardial blood flow or distal platelet emboli with ensuing myocyte necrosis
- Type 2 MI (Secondary to an ischemic imbalance):
  - Instances of myocardial injury with necrosis where a condition other than coronary artery disease contributes to an imbalance between myocardial oxygen supply and/or demand
  - Coronary endothelial dysfunction, coronary artery spasm, coronary embolism, tachy-/brady arrhythmias, anemia, respiratory failure, hypotension, and hypertension with or without left ventricular hypertrophy.

Evaluation of chest pain

- History
- Physical exam
- Diagnostic testing
  - ECG
  - Biochemical markers
  - Imaging studies
  - Early exercise stress testing

Initial Evaluation of chest pain

- What is the likelihood that the symptoms and signs represent ACS?
  - History, PE, ECG
  - HEART score
- What is the likelihood of adverse clinical outcomes?
  - Risk assessment scores to identify patients with ACS who have an increased risk of adverse outcomes
    - TIMI (Thrombolysis in Myocardial Infarction) risk score
    - GRACE (Global Registry of Acute Coronary Events) risk score

History

FAVORING ISCHEMIC ORIGIN

- Character of pain
  - Squeezing, burning, heaviness
- Location
  - Substernal, across mid-thorax
  - Radiation to the arms, shoulder, neck, head, forearms, interscapular region
  - Associated with nausea, vomiting and diaphoresis
- Provoking factors
  - Exercise, excitement, stress, cold weather
- Duration
  - Minutes

History

FAVORING NON-ISCHEMIC ORIGIN

- Character of pain
  - Sharp, knifelike, stabbing, aggravated by respiration
- Location
  - Left submammary area, left hemithorax, discomfort localized by one finger
  - Back pain that suggests aortic dissection
- Provoking factors
  - Pain after completion of exercise
  - Pain relieved by exercise
  - Provoked by a specific body motion
- Duration
  - Seconds
  - Hours without evidence of myocardial damage

History

- **Atypical presentations**
  - Dyspnea is often associated with chest pain during an MI
    - Dyspnea may also be the only major presenting symptom in about 10% of patients with MI
  - Fatigue
  - Syncope
  - Altered sensorium
  - Stroke
  - Nausea/vomiting
  - Lethargy

- Atypical presentations of AMI are more common in the elderly, in patients with diabetes, and in women

History

- Risk factors
  - Age
  - History of CAD
  - Male sex
  - Diabetes
  - Family history

History

- Type of chest pain (Diamond & Forrester)
  1. Substernal
  2. Brought on by exertion or emotional distress
  3. Relieved by rest or nitroglycerin

- **Typical** – meets 3 criteria
- **Atypical** – meets 2 of 3 criteria
- **Non-anginal** – meets 0-1 of 3 criteria

Physical exam

- Evaluate for signs of LV dysfunction and valvular heart disease
- S3 gallop, rales, sinus tachycardia, hypotension, increased JVD – associated with worse outcome
- PE findings of nonischemic chest pain
  - Chest wall tenderness, skin lesions, pleural or pericardial friction rub
- Response to treatment is not reliable
  - Pain relief with nitroglycerin does not necessarily point to MI or UA, as other etiologies for CP are relieved with nitro

Physical exam

- PE findings suggestive of other life-threatening diagnoses in patients with CP
  - Aortic dissection: back pain, unequal palpated pulse volume, a difference of ≥15 mm Hg between both arms in SBP, a murmur of aortic regurgitation
  - Acute pericarditis: pericardial friction rub
  - Cardiac tamponade: pulsus paradoxus
  - Pneumothorax: acute dyspnea, pleuritic chest pain, and differential breath sounds
  - Pneumonitis or pleuritis: pleural friction rub

ECG

- Almost 50% of patients with MI have a normal or nondiagnostic ECG on presentation to the ED
  - Check serial ECGs!
- LCX distribution ischemia is notoriously silent on ECG
  - Posterolateral wall is underrepresented on ECG
  - Posterior ECG leads V7-9 may be helpful
- Inferior STEMI – RV infarction
  - Right-sided leads (V3R-V4R)

ECG

- Among patients with ischemic type CP
  - ST elevation: SP 90%, SN 50% for AMI
  - ST depression, Q waves or LBBB: SP 82%, SN 69%
- Normal ECG indicates <3% risk for MI and <6% risk for death in the following year
- However, ~1/3 of patients with UA may have a normal or equivocal ECG
- ECG cannot be used alone to exclude ACS

ECG

- Preexisting abnormalities that make the interpretation of the ECG difficult
  - LVH
  - LBBB
  - Q waves
  - Preexcitation
  - Paced rhythms
- Compare the current ECG to an old ECG!

ECG

- LBBB
  - Whether new or old, the presence of a LBBB is an adverse prognostic finding
  - New LBBB suggests LAD ischemia/infarct
  - Preexisting LBBB alone defines a group of patients at high risk for cardiac morbidity and mortality
  - Sgarbossa criteria

Biochemical markers

- Cardiac troponins are the most sensitive and specific biomarkers for NSTE-ACS
- Troponin begins to rise 2-3 hours after onset of an acute MI and can remain elevated for several days

Imaging studies

- Echo
- Cardiac CTA and CAC score
- Stress testing
- Coronary angiography

- Which test to order?

Cardiac Imaging

- Functional vs Anatomic imaging:

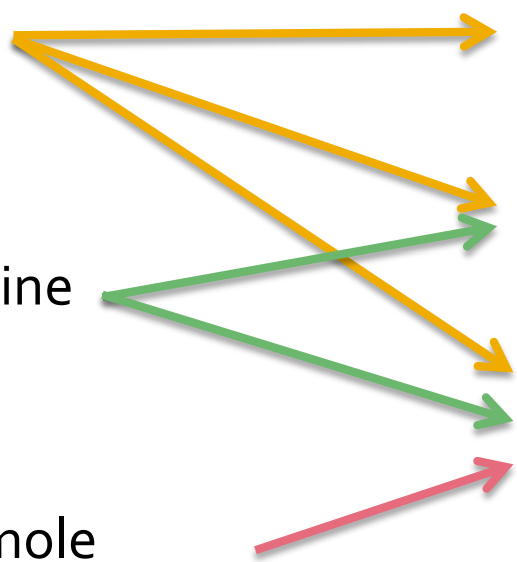
- Functional testing
  - Evaluate the effect of inducible myocardial ischemia on ECG or imaging
  - Hemodynamically significant coronary lesions must be present for functional tests to be abnormal

- Anatomic imaging
  - Assess coronary anatomy and size of the coronary lumen

Cardiac stress tests

STRESSOR

- Exercise
- Dobutamine
- Dipyridamole
- Adenosine
- Modified adenosine (Lexiscan)



IMAGING

- ECG
  - Ischemic ECG changes
- Echo
  - Wall motion abnormalities
- Nuclear (SPECT) myocardial perfusion imaging (MPI) – Tc 99m, Tl-201
  - Reversible defects in cardiac function or blood supply

Exercise

- Preferred modality of stress testing for patients who can exercise and achieve an adequate cardiac workload and HR
- Provides the most information concerning symptoms and the hemodynamic response during exercise
- Exercise variables that have been shown to predict outcome:
  - Exercise duration
  - ST segment response
  - Chronotropic incompetence
  - Heart rate recovery
  - Exercise-induced hypotension
- Inability to perform an exercise test is a marker of increased risk

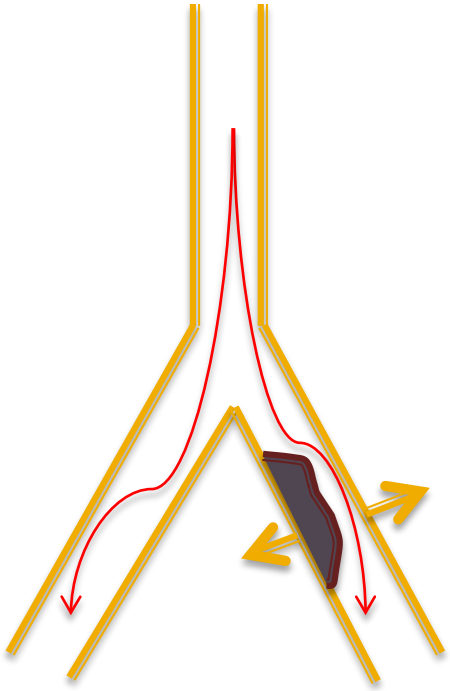
Pharmacologic: Ionotrope/Chronotrope agents

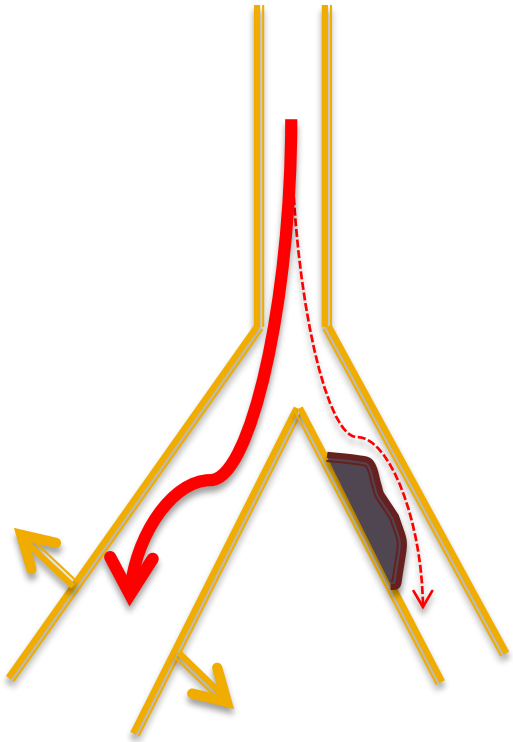
- **Dobutamine - β1 agonist**
  - Ionotropic and chronotropic effects
  - Increased HR, BP and contractility ➔ increased blood flow to myocardium supplied by normal arteries, while flow is increased to a lesser extent in areas supplied by stenotic vessels
- Hold beta blocker before test (Unless assessing for efficacy of medical management)
- Contraindications:
  - Recent MI (within 1-3 days)
  - Unstable angina
  - Uncontrolled HTN
  - Tachyarrhythmias
  - Hemodynamically significant LVOT obstruction (severe AS, HOCM)
  - Aneurysm

Pharmacologic: Vasodilator agents

- Activation of adenosine **A2A receptors** on vascular smooth muscle ➔ inhibition cellular reuptake of adenosine ➔ increased adenosine ➔ **coronary artery vasodilation**
- Stimulation of other adenosine receptors (A1, A2B, A3) contributes to many of the common side effects associated with these drugs
- Vasodilators are the preferred pharmacological stress agent for radionuclide MPI studies

Pharmacologic: Vasodilators





Pharmacologic: Vasodilators

- **Dipyridamole** (antiplatelet medication)
- Adenosine
  - 140mcg/kg/min infused over 6 minutes
- **Regadenosin (Lexiscan)**
  - Modified adenosine
  - Selective A2A receptor agonist – less adverse side effects
  - Rapid onset (30 seconds), lasts about 2-5 minutes, fixed dose (0.4 mg/5ml) injected over 10 seconds
  - Less side effects compared to adenosine

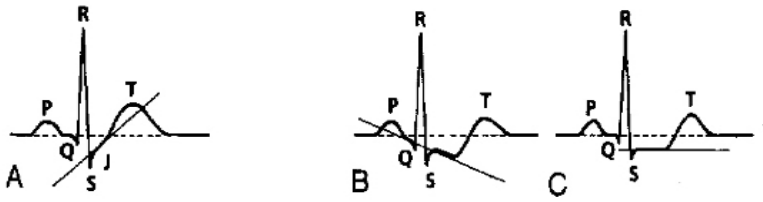
Side effects: flushing, lightheadedness, nausea, chest pain, dyspnea

Pharmacological: Vasodilators

- Contraindications
  - Active wheezing due to bronchospastic airway disease
    - Stimulates the A2B receptors which causes bronchospasm
  - Significant hypotension
  - SSS or high-degree AVB without a PPM
  - Unstable or complicated ACS
- Methylxanthines (caffeine, theophylline) should be held for at least 12 hrs before
  - Adenosine receptor antagonists
- Reversal agent: **Aminophylline**

Exercise Stress Test

- Exercise on a treadmill or bicycle
- Advantages: Low cost, easy to do, non-invasive, low risk of complications, no radiation
- Goal: achieve 85% of the maximum age-predicted HR (220-age)
- Abnormal test if:
  - Ischemic chest pain
  - Horizontal or down-sloping ST depression ≥1mm
  - A blunted BP response or hypotension may suggest multivessel or high-grade stenosis



ST depression: upsloping (A), downsloping (B), horizontal (C)

Exercise Stress Test

- Duke treadmill score
  - Duke prognostic treadmill score = Exercise time (minutes based on the Bruce protocol) - (5 x maximum ST segment deviation in mm) - (4 x exercise angina [0 = none, 1 = nonlimiting, and 2 = exercise limiting])
  - Low risk ≥ +5
  - Moderate risk +4 to – 10
  - High risk < - 10

- Annual event rate in patients with a low-risk exercise treadmill score <1%

Exercise Stress Test

- Contraindications
  - Unable to exercise or achieve a satisfactory workload
    - ➔ pharmacological stress test
  - Abnormal baseline ECG (would make the EST non-diagnostic)
    - ➔ need additional imaging (echo, MPI)
    - LBBB
    - V-paced
    - Ventricular pre-excitation (WPW)
    - >1mm ST depression at rest
    - Digoxin use with associated ST-T abnormalities
    - LVH with ST-T abnormalities

Sensitivity = 67%
Specificity = 72%

Stress Echo

- Exercise or Pharmacological (dobutamine)
- Baseline resting and stress images
- Advantages:
  - Relatively low cost, non-invasive, higher SN than ETT, localized ischemia, provides additional information on cardiac structure/function/valves
- Limitations
  - Poor windows (body habitus)
  - Probably a little more work for techs

Sensitivity = 75-93%
Specificity = 79-92%

Stress Echo

- Indications:
  - Evaluation of patients with known or suspected CAD
  - Assessment of myocardial viability
  - Evaluation of dyspnea of possible cardiac origin
  - PHTN, estimate PASP at rest and with exercise
  - MR/MS
  - AS – helpful in patients with low flow-low gradient AS
  - LVOT gradients, MR, and PHTN in patients with HCM

- Positive test if:
  - New or worsening regional wall motion abnormality
  - Decreased global LV EF and/or increased LVESV suggests the presence of severe obstructive CAD (severe LMCA or severe multivessel CAD)

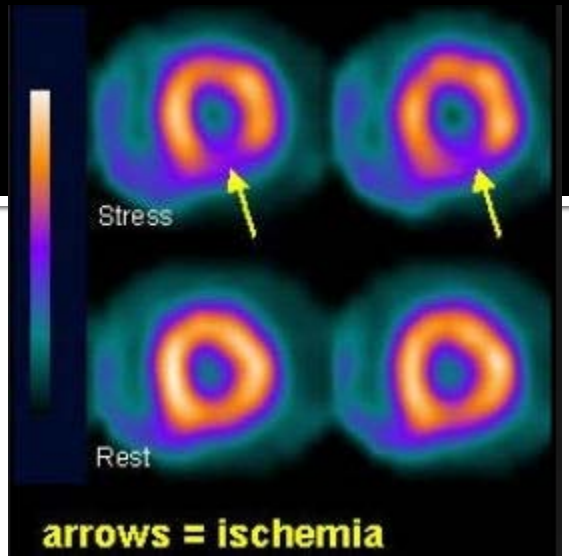
Nuclear Stress Tests

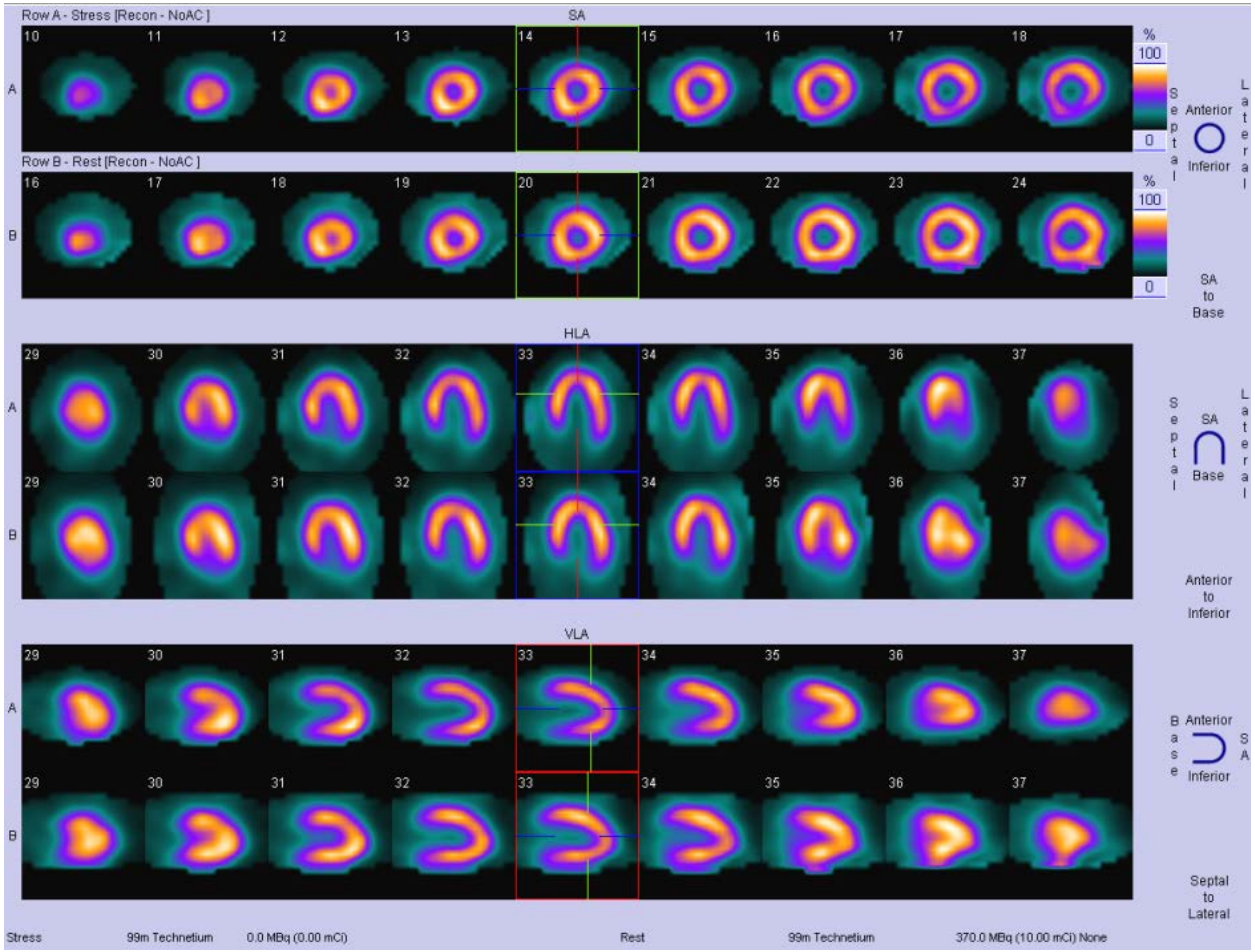
- SPECT MPI – nuclear medicine study
  - Injection of a nuclear radiotracer
    - Technetium (Tc 99m), Thallium (Tl-201)
  - Stress and rest images
  - Gating
  - Prone imaging
  - 1-day and 2-day protocols

Nuclear Stress Test

- Disadvantages:
  - Radiation exposure, relatively more expensive, adverse reactions to pharmacological agents
- Sensitivity
  - Exercise MPI = 87%
  - Pharmacological (vasodilator) MPI = 89%
- Specificity
  - Exercise MPI = 73%
  - Pharmacological (vasodilator) MPI = 75%

Nuclear Stress Test





Nuclear stress tests

- **Appropriate use**
  - Chest pain syndrome with intermediate or high pretest probability of CAD with:
    - Interpretable ECG and able to exercise
    - Uninterpretable ECG
    - Unable to exercise
  - Acute chest pain with intermediate pre-test probability of CAD with:
    - Normal cardiac enzymes and no ST-segment elevation
- **Inappropriate use**
  - Low probability of CAD
  - STEMI
- **Consider use**
  - UA/NSTEMI

Coronary Artery Calcium Score

- CAC score
  - 0 – No identifiable disease
  - 1 to 99 – Mild disease
  - 100 to 399 – Moderate disease
  - ≥ 400 – Severe disease

- Radiation exposure

- High SN for the presence of ≥50% angiographic stenosis
- Moderately SP, especially in individuals over 60 yo

- Absence of CAC is highly predictive of the absence of significant (>50%) coronary artery stenosis

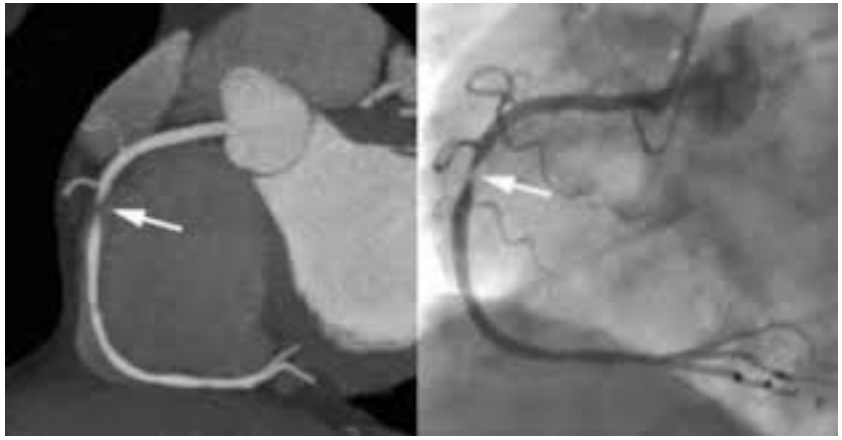
Coronary Artery Calcium Score

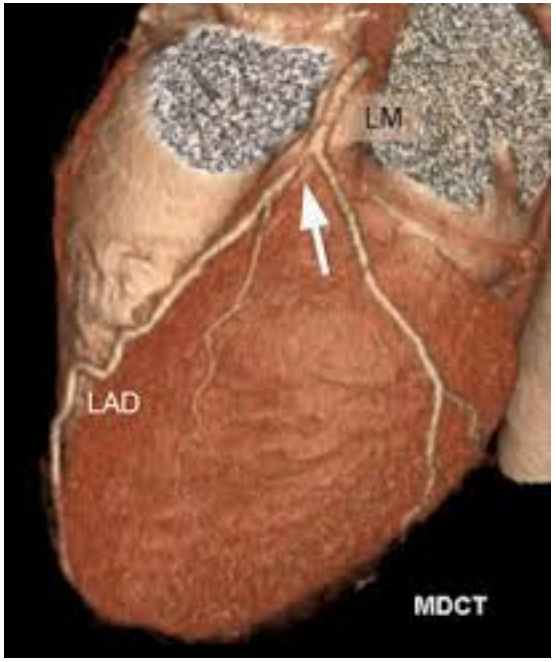
- 2010 ACCF/AHA guidelines on screening for CAD
  - Measurement of CAC is reasonable for CV risk assessment in **asymptomatic** adults at Framingham **intermediate risk** (10-20% 10 year risk)
    - Class IIa, LOE B
  - Measurement of CAC may be reasonable for patients at **low to intermediate risk** (6-10% 10 year risk)
    - Class IIb, LOE B
  - Not recommend for patients at **low risk** (<6%)
    - Class III (no benefit), LOE B

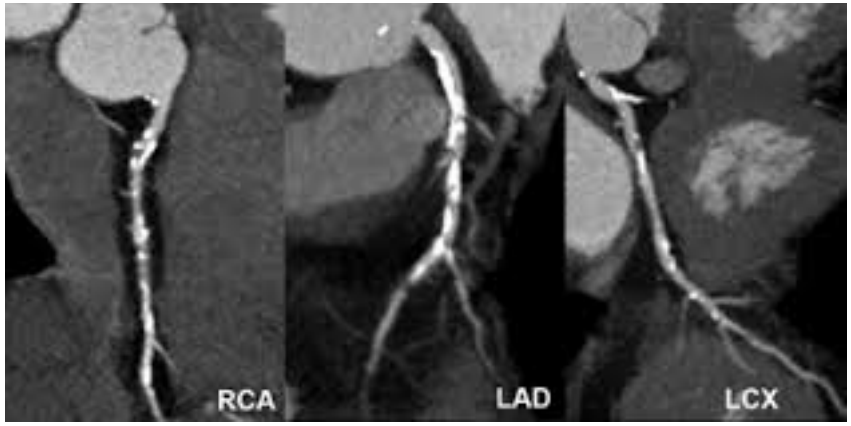
Coronary CT Angiogram

- ACCF/SCCT/ACR/AHA/ASE/ASNC/NASCI/SCAI/SCMR 2010 Appropriate Use Criteria for Cardiac Computed Tomography
- Anatomic imaging (not a function test)
- Contraindications: tachycardia, elevated Cr, allergic reaction to contrast

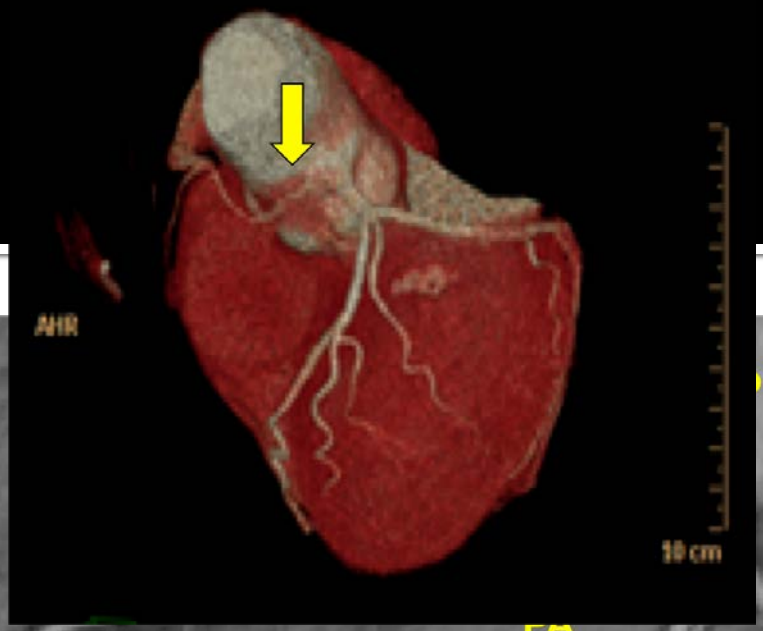
Coronary CT Angiogram

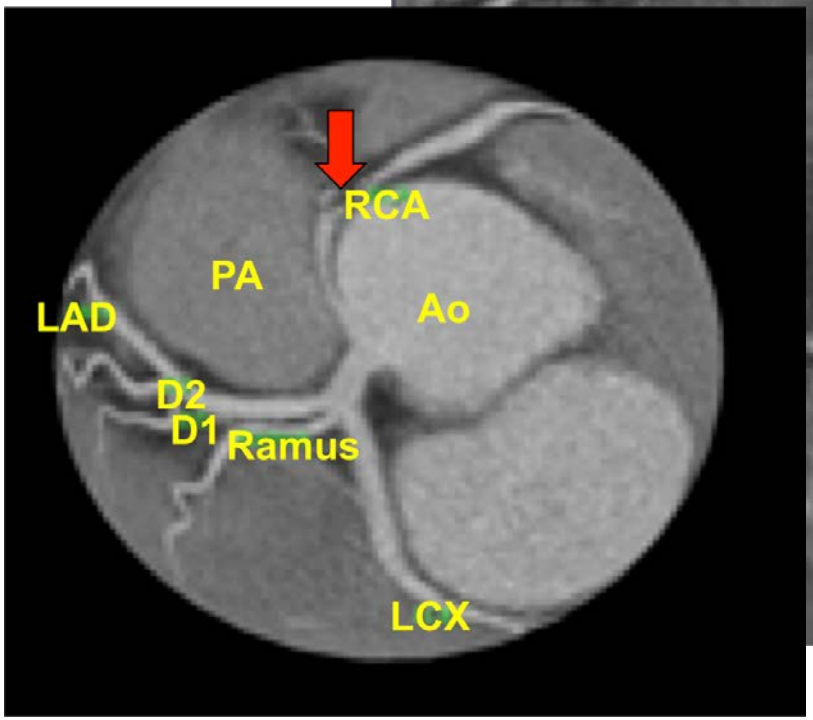






RCA

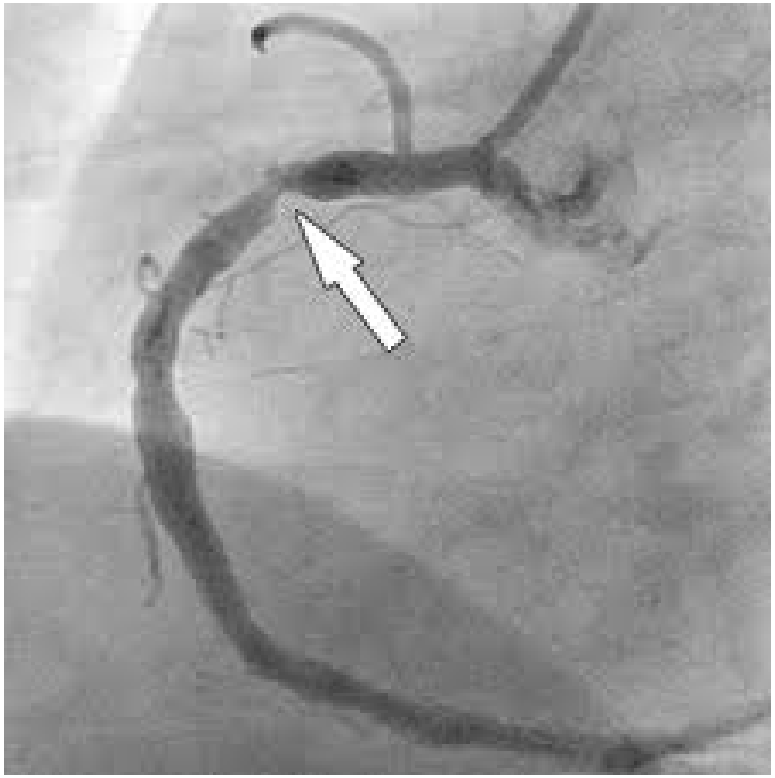


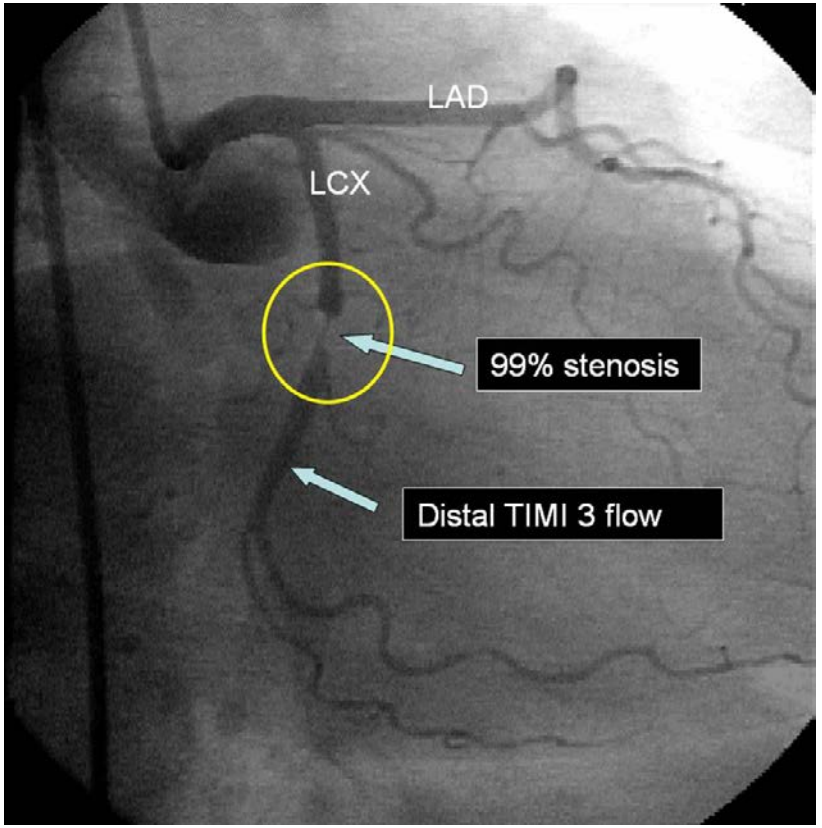


Coronary Angiography

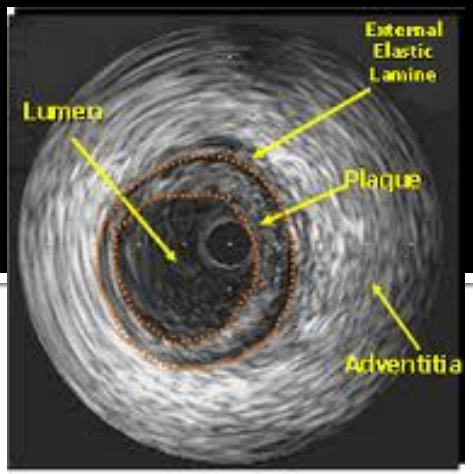
- Advantages: best test to visualize the coronary anatomy and then to treat if necessary
- Disadvantages: invasive, expensive, contrast and radiation exposure, risks of complications
- Procedural risks:
  - Death 0.2%
  - MI 0.05%
  - Stroke 0.07%
  - Serious ventricular arrhythmias 0.5%
  - Major vascular complications (thrombosis, bleeding requiring transfusion, pseudoaneurysm) 1%

Coronary angiography





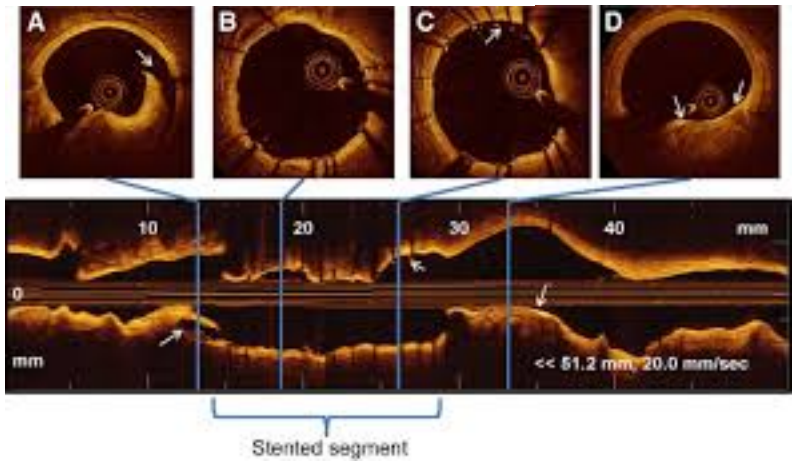
Coronary angiography



- FFR (Fractional flow reserve) - functional
- IVUS (Intravascular ultrasound) - anatomic
- OCT (Optical coherence tomography) - anatomic

$$FFR = \frac{\text{Distal Coronary Pressure (Pd)}}{\text{Proximal Coronary Pressure (Pa)}}$$

(During Maximum Hyperemia)



So which test should I order??

- What is the pre-test probability of CAD in a patient with no known h/o CAD?
- Known h/o CAD > depends on clinical scenario
- Lets look at some clinical cases…

Question 1

A 40-year old man presents to the outpatient setting for an annual physical examination. He has no symptoms of CAD. Evaluation does not reveal HTN, obesity, PVD, a history of smoking, or a family history of early CAD. His blood glucose and cholesterol levels are unknown.

Which of the following is the most appropriate approach to address his potential for CAD?

A. CT coronary artery calcium scoring or CT angiography

B. Exercise stress ECG

C. No testing but primary prevention with combination medication dipyridamole-aspirin

D. Pharmacologic cardiac stress testing with imaging

E. Risk stratification for CAD and optimal management of CAD risk factors

Risk Stratification for CAD

- No known h/o CAD ➔ Estimate pre-test probability

Table 3. Risk Stratification Systems with Testing Recommendations for Detecting Coronary Artery Disease (CAD) in Patients with Chest Pain

Author (yr)	Stratification Method	Risk Level with Basis of Classification and Testing Recommendation		
		Low	Intermediate	High
Garber and Solomon (1999)[24]	Diamond and Forrester	Pretest probability of CAD < 25% Recommendation not specified	Pretest probability of CAD 25%–75% Stress with imaging or coronary artery angiography	Pretest probability of CAD > 75% Recommendation not specified
Morise (2000)[6]	Modified Diamond and Forrester	PPV of positive EST 21% for current CAD No testing or EST without imaging	PPV of positive EST 62% EST without imaging	PPV of positive EST 92% Coronary artery angiography
Williams et al (2001)[2]	Risk of CAD mortality by Duke treadmill score	Risk < 1% Stress without imaging	Risk 1%–3% Stress with imaging	Risk > 3% Coronary artery angiography
Smith (2006)[28]	Framingham study 10-yr risk for CAD/ annual risk for CAD	10-yr risk < 10%, annual risk < 0.6% Periodic reassessment of risk	10-yr risk 6%–20%, annual risk 0.6%–2% Recommendation not specified	10-yr risk > 20%, annual risk > 2% Recommendation not specified
Mieres et al (2007)[33]	Framingham study 10-yr risk for CAD/ annual risk for MI	10-yr risk < 10%, annual risk < 0.6% EST without imaging	10-yr risk 10%–20%, annual risk 0.6%–2% EST with imaging or coronary artery calcium scoring	10-yr risk > 20%, annual risk > 2% EST with imaging

EST = exercise stress testing; MI = myocardial infarction; PPV = positive predictive value.

Risk Stratification for CAD

- Diamond and Forrester
- Framingham risk score
- ACC/AHA pooled cohort hard CVD risk calculator (2013)
- HEART score

Pre-Test Probability of CAD

- **Diamond and Forrester**
  - Age, gender, type of chest pain (typical, atypical, nonanginal)
  - Men and older age have high risk of CAD

Table 4. Pretest Probability of Coronary Artery Disease (CAD) Based on Age, Sex, and Symptoms

Age, yr	Sex	Nonanginal Chest Pain	Atypical Angina	Typical Angina
30–39	Male	Low	Intermediate	Intermediate
	Female	Very low	Very low	Intermediate
40–49	Male	Intermediate	Intermediate	High
	Female	Very low	Low	Intermediate
50–59	Male	Intermediate	Intermediate	High
	Female	Low	Intermediate	Intermediate
60–69	Male	Intermediate	Intermediate	High
	Female	Intermediate	Intermediate	High

NOTE: Probability levels are defined as follows: high, > 90% pretest probability of CAD; intermediate = 10%–90% pretest probability of CAD; low = < 10% pretest probability of CAD; very low = < 5% pretest probability of CAD.

Pre-Test Probability of CAD

- **Framingham CVD risk score (2008)**
  - Risk of MI or death from CAD over 10 years
  - Age, gender, total cholesterol, HDL, smoking status, SBP
  - Low risk (<10%), Intermediate risk (10-20%), High risk (>20%)
- Framingham risk score: 1998 > 2002 > 2008

Framingham Risk Score

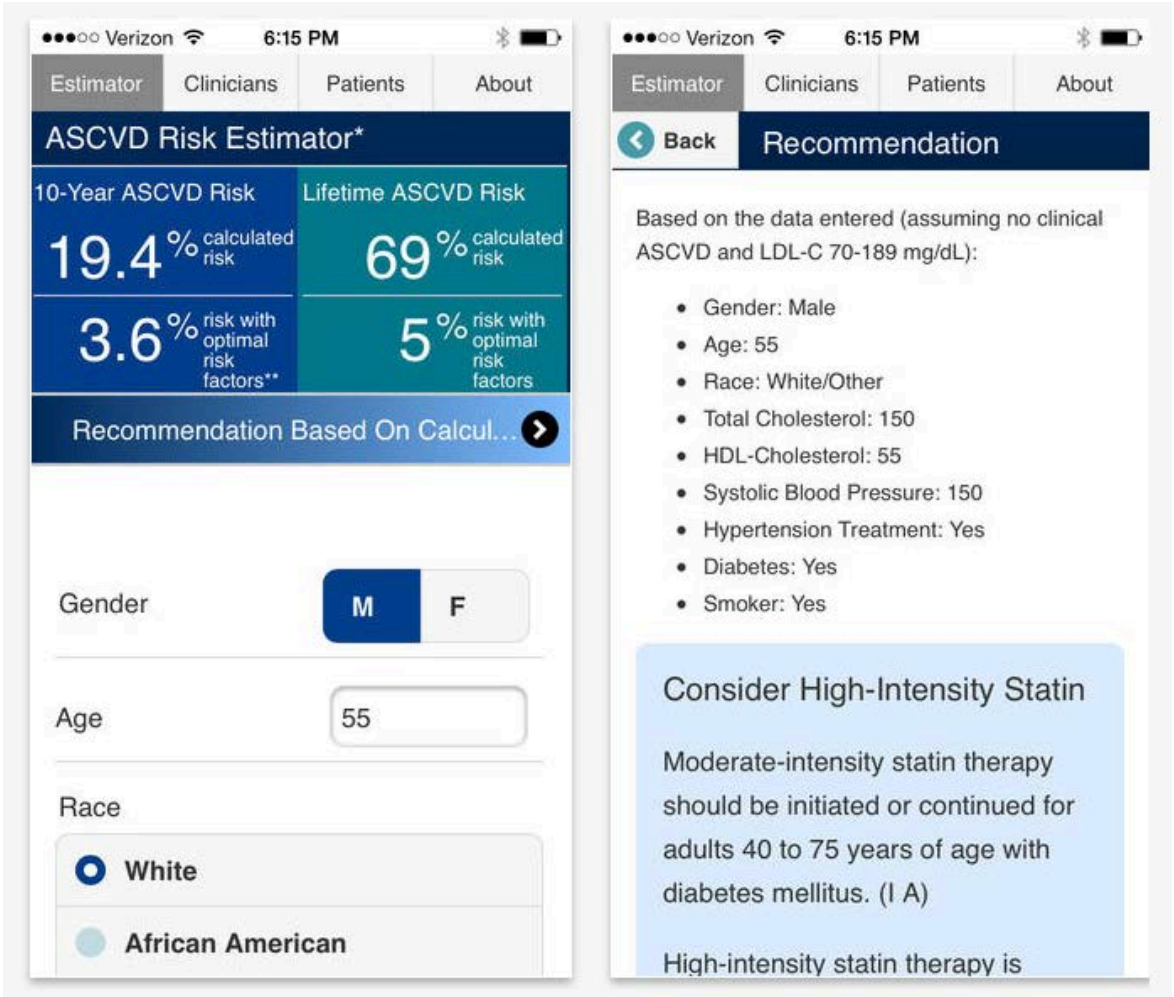
- **Prediction variables:**
  - Age
  - Gender
  - Total cholesterol (mg/dL)
  - HDL cholesterol (mg/dL)
  - Systolic blood pressure (mmHg)
  - Blood pressure treatment (yes or no)
  - Diabetes mellitus (yes or no)
  - Current smoking (yes or no)
- **Prediction variables not used:**
  - Family history of CVD (yes or no)
- **Endpoints:**
  - CHD death
  - Nonfatal MI
  - Coronary insufficiency or angina
  - Fatal or nonfatal ischemic or hemorrhagic stroke
  - Transient ischemic attack
  - Intermittent claudication
  - HF

ACC/AHA pooled cohort hard CVD risk calculator (2013)

- **Prediction variables:**
  - Gender
  - Total cholesterol (mg/dL)
  - HDL cholesterol (mg/dL)
  - Systolic blood pressure (mmHg)
  - Blood pressure treatment (yes or no)
  - Diabetes mellitus (yes or no)
  - Current smoking (yes or no)
- **Prediction variables not used:**
  - Family history of CVD (yes or no)
- **Endpoints:**
  - CHD death
  - Nonfatal MI
  - Fatal stroke
  - Nonfatal stroke

ACC/AHA pooled cohort hard CVD risk calculator (2013)

- First risk model to include data from large populations of both Caucasian and African-American patients
- The model includes the same parameters as the 2008 Framingham General CVD model, but in contrast to the 2008 Framingham model includes only hard endpoints (fatal and nonfatal MI and stroke).



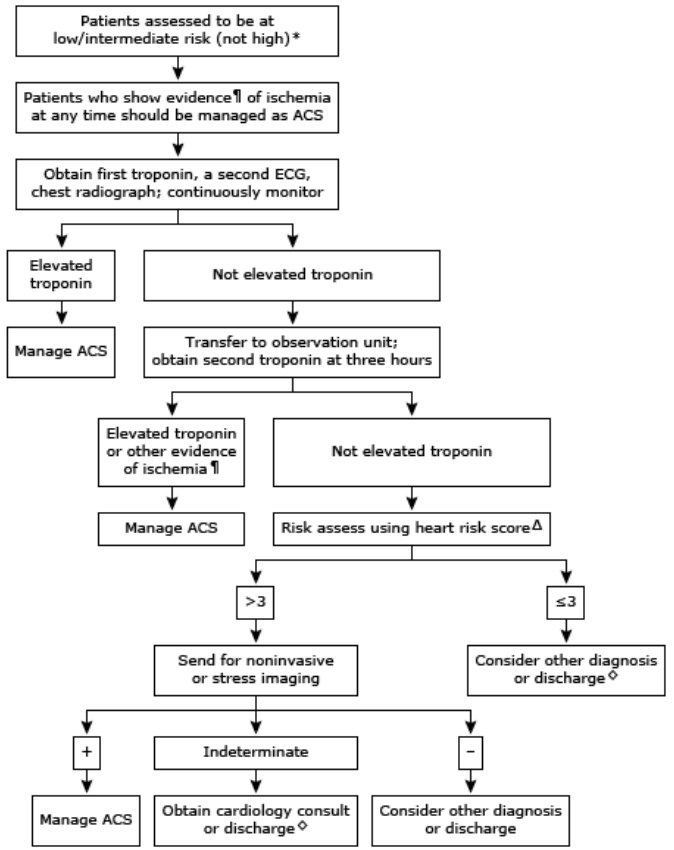
HEART score

Composition of the HEART score for chest pain patients in the emergency room

HEART score for chest pain patients		Score
History	Highly suspicious	2
	Moderately suspicious	1
	Slightly suspicious	0
ECG	Significant ST depression	2
	Nonspecific repolarisation disturbance	1
	Normal	0
Age	≥65 year	2
	45-65 year	1
	<45 year	0
Risk factors	≥3 risk factors or history of atherosclerotic disease	2
	1 or 2 risk factors	1
	No risk factors known	0
Troponin	>2x normal limit	2
	1-2x normal limit	1
	≤normal limit	0
		Total _____

Reproduced with permission from: Six AJ, Backus BE, Kelder JC. Chest pain in the emergency room: value of the HEART score. Neth Heart J 2008; 16:191.

Assessment of low/intermediate-risk acute coronary syndrome in the emergency department



Overview of approach to the management of patients in the emergency department who are felt to be at low or moderate (not high) risk of ACS. This algorithm should be used in conjunction with other content. It does not apply to patients at very low risk of an ACS, such as those with atypical chest pain, stable vital signs, and a normal electrocardiogram.

ACS: acute coronary syndrome.
* After initial history, physical examination, and electrocardiogram.
¶ Recurrent or ongoing angina (chest pain), unstable vital signs, ischemia on repeat electrocardiogram or monitoring.
Δ Refer to topic for details.
◇ We generally instruct patients to confer with their primary care physician within 48 hours of discharge.

Question 2

A 47-year old woman complains of a 2-month history of burning-like substernal chest pain that occurs when lying flat after eating fatty meals or smoking. She and her and husband are concerned about her heart health. She smokes cigarettes, has a BMI of 28 kg/m^2, and has a brother who had a MI at age 55. She does not have HTN, HLP, DM or PVD.

Which of the following best determines this patient's pre-test probability of CAD prior to consideration of cardiac stress testing?

A. Active use of hormone replacement therapy

B. Age, gender, and location of pain

C. Brachial artery reactivity

D. Coronary artery calcium score <100

E. CRP level

Pre-Test Probability of CAD

- **Low risk** → No stress test indicated
  - Risk of false positive stress test
- **Intermediate risk** → Stress test with imaging
  - CAC or CCTA – can re-stratify patient as low or high risk
- **High risk** → Skip the stress test and proceed with cath
  - Risk of false negative stress test

Low Pre-Test Probability

- No stress testing indicated
  - Greater likelihood of false-positive tests leading to invasive testing with additional risk
- If you do choose to order a diagnostic test > exercise stress test
  - Additional imaging (echo, MPI) is **not** needed, unless they have
    - Intermediate Duke treadmill score
    - Abnormal EST
    - Baseline ECG abn: LBBB, ST depression, paced rhythm, pre-excitation
- Medical management with risk factor modification and focus on diagnosing and treating non-cardiac causes of CP

Intermediate & High Pre-Test Probability

- Intermediate pre-test probability > Stress test with imaging (echo or MPI)
  - Imaging modality helps to localize ischemia and determine extent of ischemia
- High pre-test probability > LHC
  - Men ≥ 40 yo with typical angina
  - Women ≥ 60 yo with typical angina

Question 3

For which of the following patients would **coronary artery calcium scoring** hypothetically be of benefit in risk stratification of CAD?

A. A 40-year-old man with no symptoms of angina and a Framingham risk estimate for CAD less than 2% in the next 10 years

B. A 45-year-old man with atypical angina at intermediate risk for CAD who has an indeterminate stress test imaging result and is fearful of interventions

C. A 47-year-old woman with chest pain at low risk for CAD by age, gender, and description of symptoms.

D. A 55-year-old man with a high Duke treadmill posttest probability for CAD

E. An 85-year-old woman with unstable angina

Question 4

A 64-year-old woman with severely advanced COPD and recent intubation for respiratory failure complains of a 72-hour history of intermittent chest pain not associated with exertion. In the ED, her pretest probability for CAD is intermediate by multiple stratification methods.

Which of the following is true regarding her intermediate risk status?

A. Compared with those at high and low risk for CAD, she will benefit less from stress testing

B. Coronary artery angiography is warranted if stress testing is normal

C. Further testing is warranted regardless of her interest in PCI or CABG

D. Stress echo is deemed cost-effective by usual medical economic analysis

Question 5

Which of the following is a contraindication to the use of adenosine myocardial perfusion imaging?

A. Aortic valve stenosis

B. EKG findings consistent with WPW syndrome

C. Pacemaker-dependent cardiac rhythm

D. Severe COPD

Chronic stable angina, UA/NSTEMI

- **Known history of CAD**
  - Based on history, previous LHC, PCI/CABG, CCTA, calcium score, Q waves on ECG
- Not currently having chest pain → **Stress test with imaging**
- Actively having chest pain → **Cath**

Other example cases

- 55 yo male with no known h/o CAD p/w new onset atypical chest pain
  - Dx: Unstable angina – trops neg x3, ECG with no acute ST/T changes
  - Intermediate risk for CAD, low TIMI risk score, currently asymptomatic
  - Can order an exercise or Lexiscan MPI
- 45 yo female with no h/o CAD presents with recurrent non-cardiac chest pain
  - Dx: Non-cardiac chest pain - trops neg x3, ECG with no acute ST/T changes, low pre-test probability risk for CAD
  - Can order an exercise treadmill stress test outpatient
- 68 yo male with PMH of CAD s/p PCI/CABG, current smoker, vasculopath….
  - Dx: NSTEMI – trops +, ECG with TWI, currently having angina (now 2/10 after NTG SL, improved from 9/10)
  - > Cath lab

Addition Considerations

- Would the patient be agreeable to LHC and possible intervention?
- Can they be on DAPT? (current bleeding, need for urgent surgery)
- Comorbid conditions (unstable and critically ill in the ICU)
- Pre-op cardiac risk evaluation – asymptomatic, but positive MPI, would PCI even be indicated for that patient?

Questions?

References:

- Manual of Cardiovascular Medicine, 4th edition
- Carliste, Robert, Fitzpatrick, K.M., Oreskovich, J.M., Fredrick, G.T. "Cardiac stress testing for diagnosis of coronary artery disease in adults with acute chest pain". *Hospital Physician*. November 2008.
- Amsterdam, E.A et. al. "2014 AHA/ACC Guideline for the Management of Patients With Non–ST-Elevation Acute Coronary Syndromes: A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines". 2014. http://circ.ahajournals.org
- ACCF/SCCT/ACR/AHA/ASE/ASNC/NASCI/SCAI/SCMR 2010 Appropriate Use Criteria for Cardiac Computed Tomography Kern, M.J. "The Cardiac Catheterization Book 6th Edition".
- Up-to-date:
  - Diagnostic approach to chest pain in adults
  - Selecting the optimal cardiac stress test
  - Overview of stress radionuclide myocardial perfusion imaging
  - Estimation of cardiovascular risk in an individual patient without known cardiovascular disease
  - Diagnostic and prognostic implications of coronary artery calcification detected by computed tomography
  - Troponins as biomarkers of cardiac injury
  - Clinical use of coronary artery pressure flow measurements