

International Heart Consortium: Cardiac Evaluation and Treatment of Chest pain

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Question

- What is the criteria for concluding an exercise treadmill stress test is positive for inducible myocardial ischemia?
 - A. 1-2 mm up sloping ST segment depression.
 - B. ≥ 1 mm horizontal or down sloping ST segment depression 0.08msec after the J-point for 3 consecutive beats.
 - C. Chest pain while on the treadmill.
 - D. Frequent premature ventricular contractions.
 - E. New T wave inversions during exercise.

Question

- A 55-year-old man with a history of hypertension presents to the cardiology clinic with progressive, intermittent exertional substernal chest discomfort over the past 3 months. The discomfort is relieved by rest. His baseline electrocardiogram (ECG) shows left ventricular hypertrophy with secondary ST-T abnormalities. He is capable of exercising for about 5 minutes on a standard Bruce protocol. Based on his age, sex, and multiple comorbidities, he has an intermediate-to-high pre-test probability of obstructive coronary artery disease (CAD).
 - According to current AHA/ACC guidelines, which of the following is the most appropriate initial non-invasive testing strategy for this patient?
- A. Exercise treadmill test without imaging (Standard Exercise ECG)
 - B. Coronary computed tomography angiography (CCTA)
 - C. Stress radionuclide myocardial perfusion imaging (SPECT)
 - D. Invasive coronary angiography immediately

Objectives

- Determine the probability of CAD in patients with chest pain by history
- Describe the complementary aspects of non-invasive imaging-functional vs. anatomic
- Recognize the contra-indications, ECG abnormalities and high risk markers on treadmill stress testing
- List the strengths and weaknesses of non-invasive cardiac testing
- Know guideline ratings for non-invasive cardiac testing

Introduction

2021 AHA/ACC/ASE/CHEST/SAEM/SCCT/SCMR Guideline for the Evaluation and Diagnosis of Chest Pain: A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines

Martha Gulati, Phillip D. Levy, Debabrata Mukherjee, Ezra Amsterdam, Deepak L. Bhatt, Kim K. Birtcher, Ron Blankstein, Jack Boyd, Renee P. Bullock-Palmer, Theresa Conejo, Deborah B. Diercks, Federico Gentile, John P. Greenwood, Erik P. Hess, Steven M. Hollenberg, Wael A. Jaber, Hani Jneid, José A. Joglar, David A. Morrow, Robert E. O'Connor, Michael A. Ross and Leslee J. Shaw

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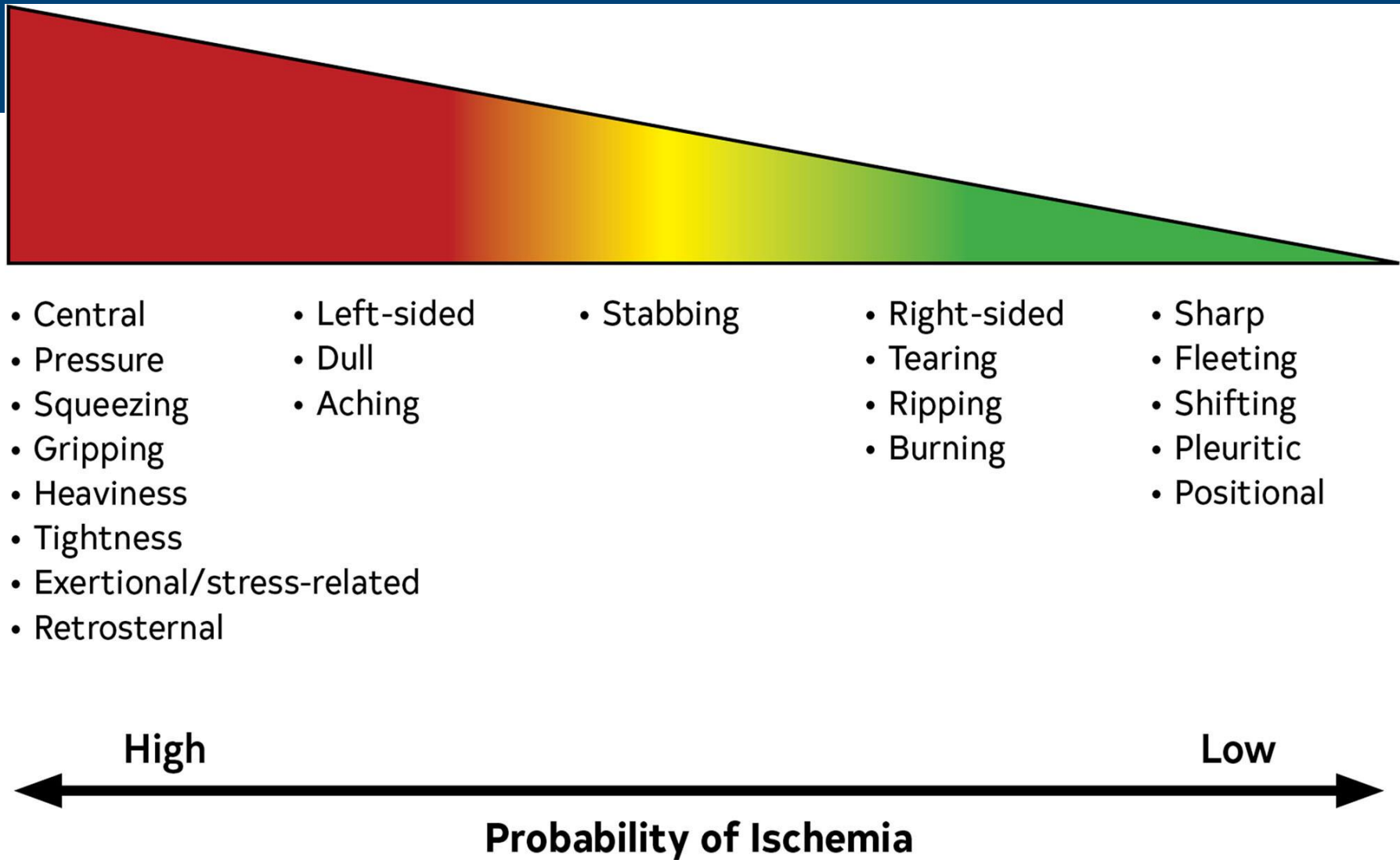
Introduction

- Angina common problem, increases with age
- In ER's in the US, CP accounts for >6.5 million visits, or 5% of all ED visits
- 4 million outpatient visits in the US annually
- New stable CP results in 4 million annual stress tests
- Non cardiac CP patients
 - 1/3 of patients who die from CV cause or have ACS event over next 5 years
- Improved diagnostic testing and risk prediction still needed

ACC/AHA Guideline Grading

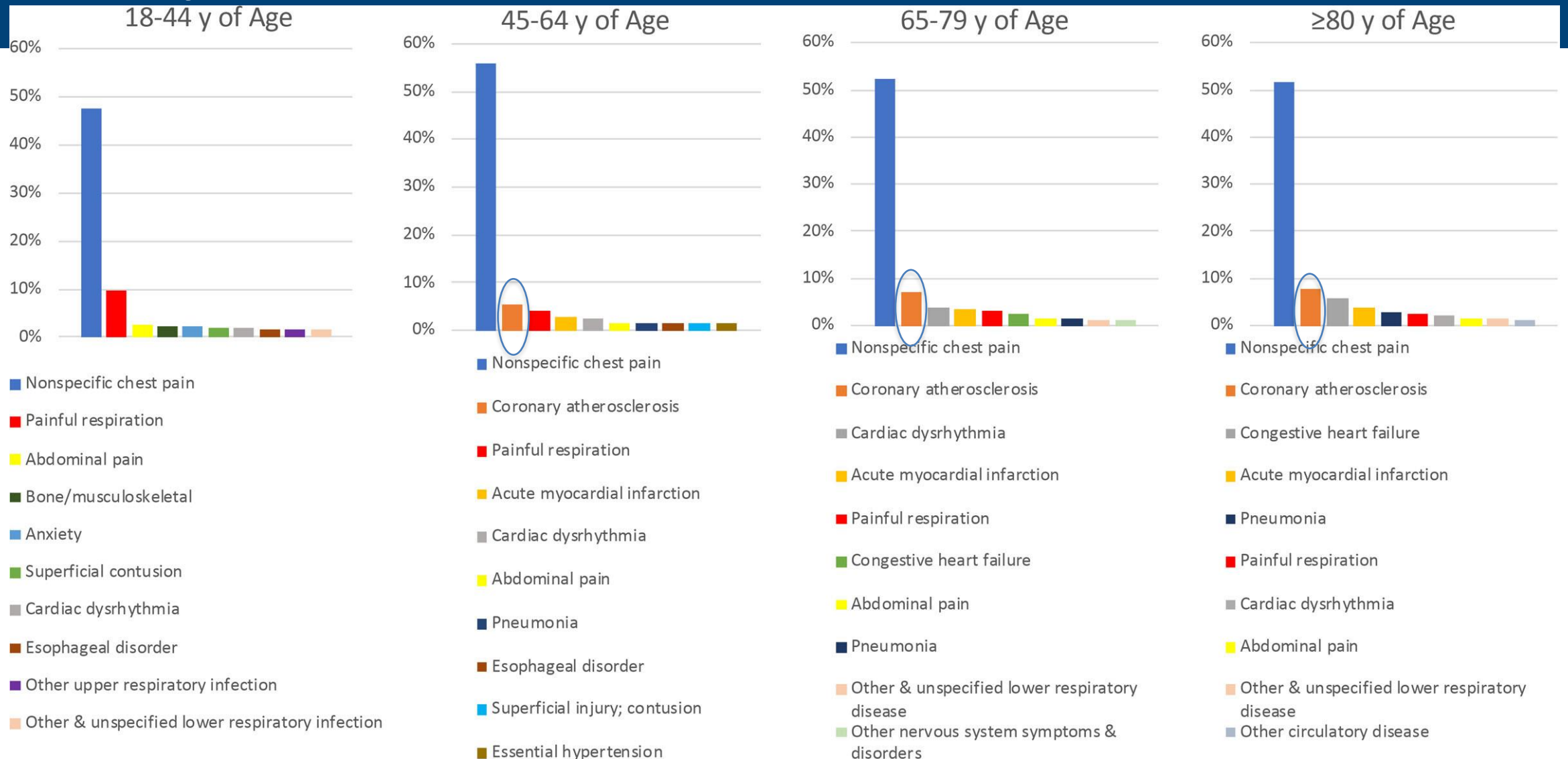
- I: Useful and effective
- II: Conflicting evidence
 - IIa: Evidence favors
 - IIb: Evidence less well established
- III: Not useful and maybe harmful

History



- Use “cardiac,” “possible cardiac,” and “noncardiac”

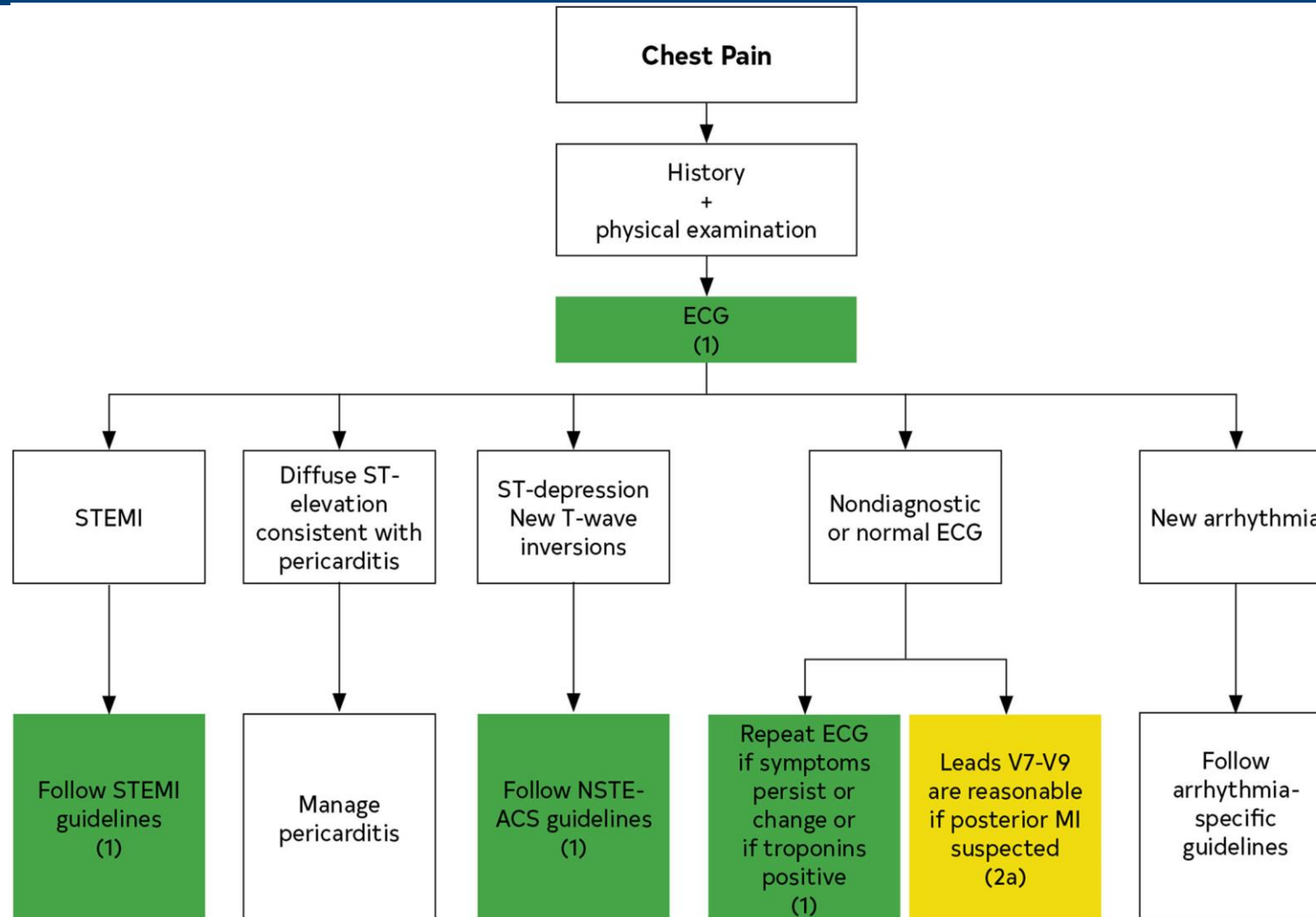
History



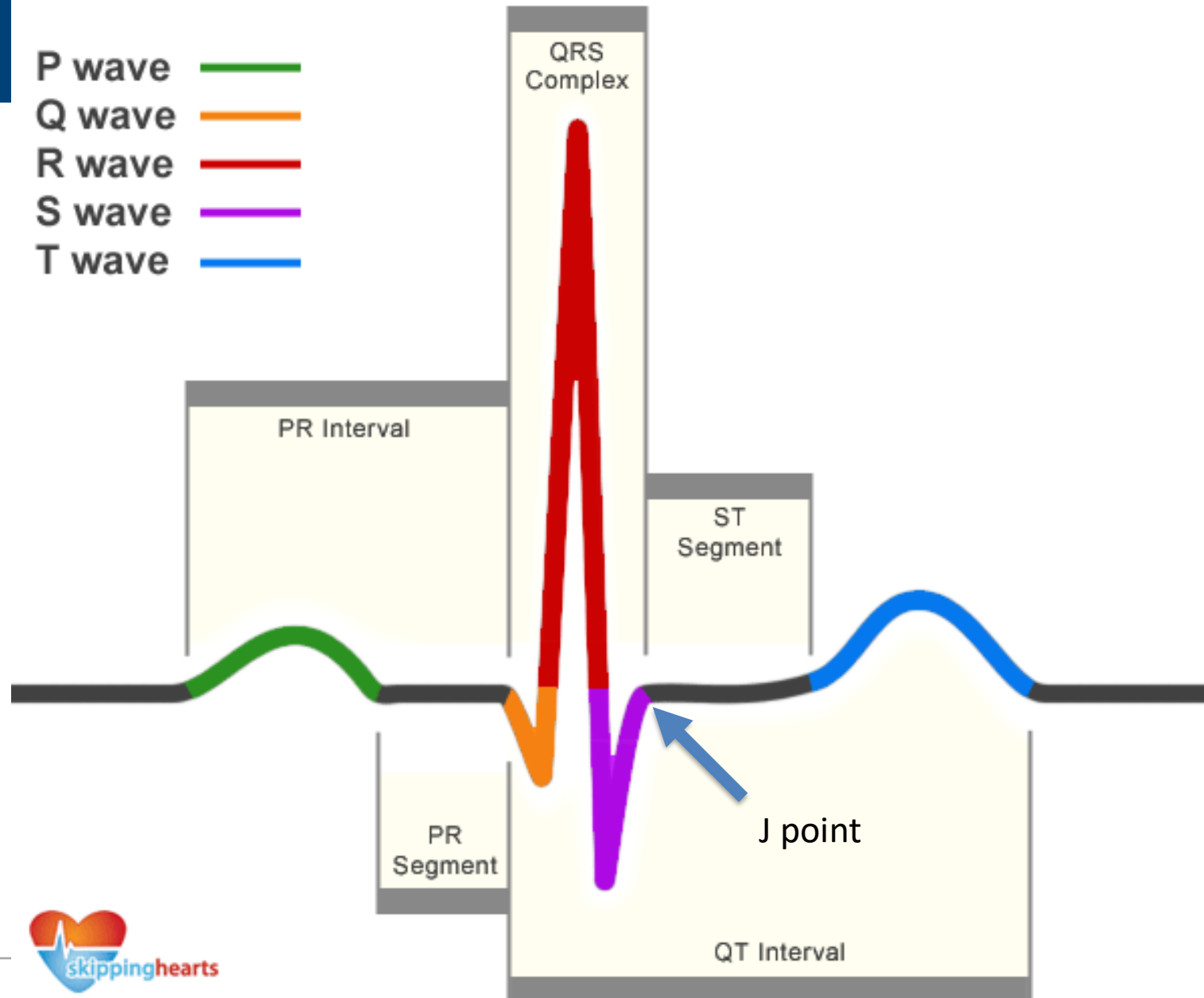
Physical Exam

- Diaphoresis, tachypnea, tachycardia, hypotension, crackles, S3, MR murmur; examination may be normal in uncomplicated cases
- Think about other causes

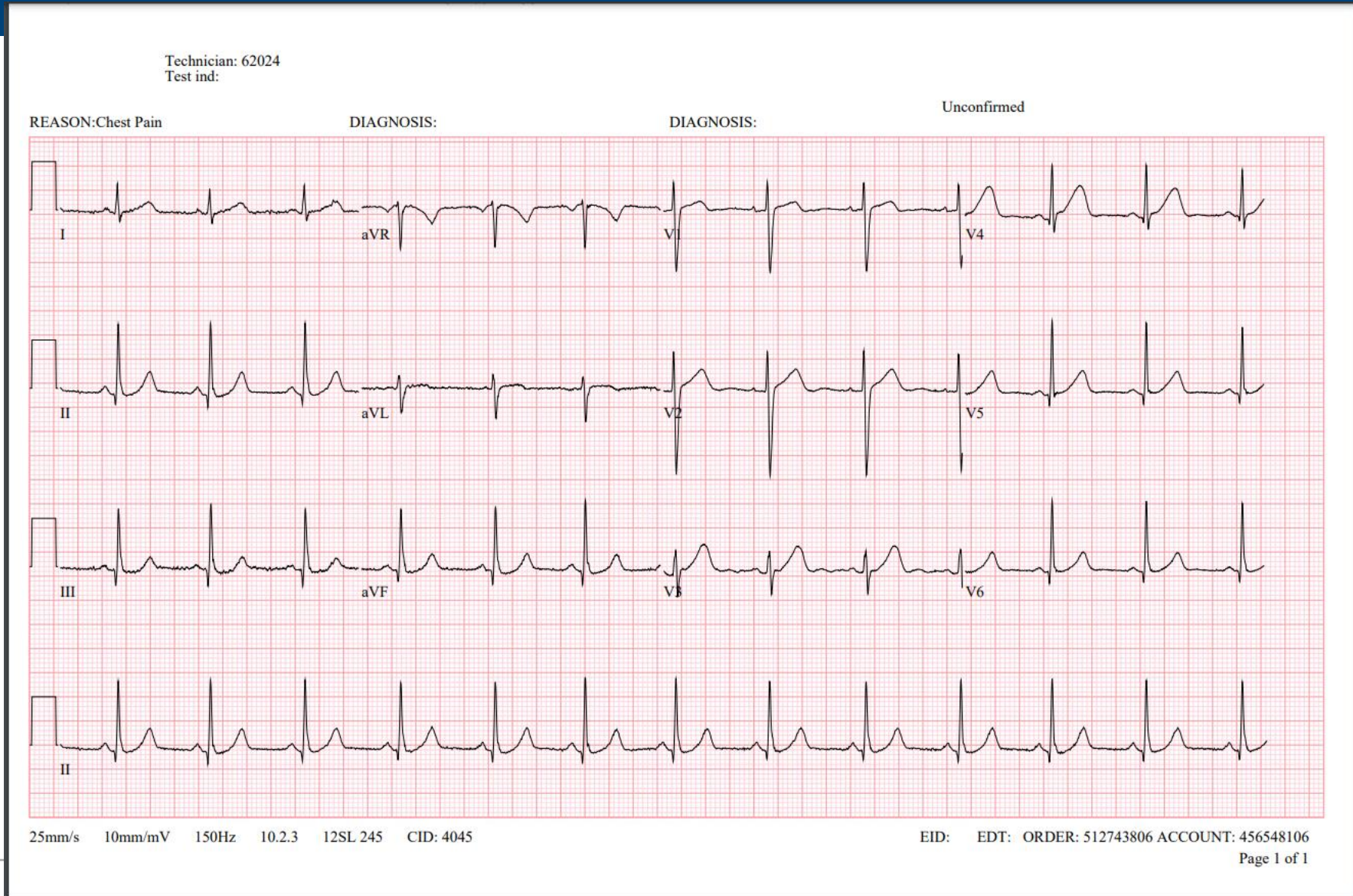
ECG initial first test



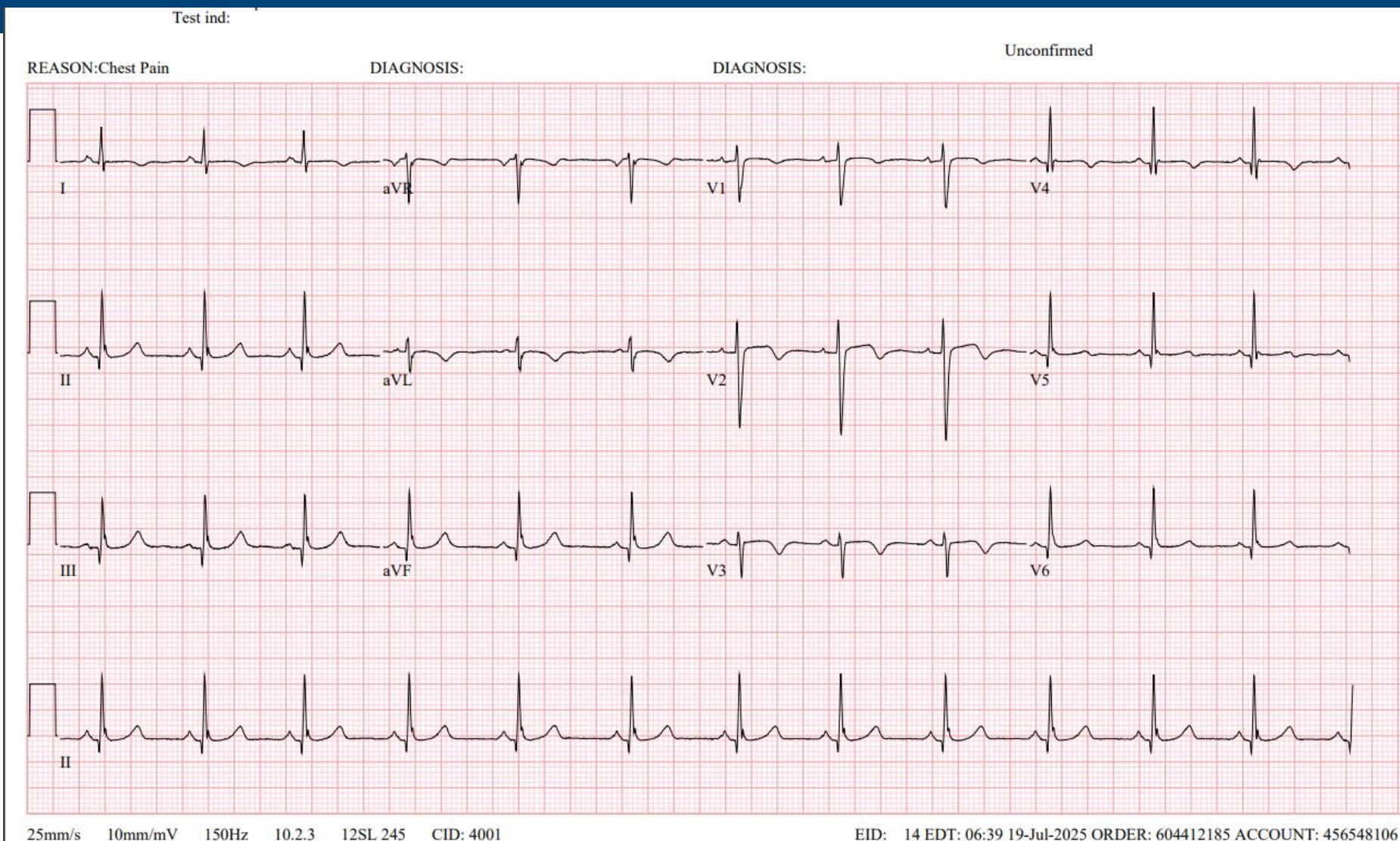
ECG of Normal Sinus Rhythm



Normal ECG



ECG with nonspecific ST-T changes



ECG in Acute Coronary Syndromes

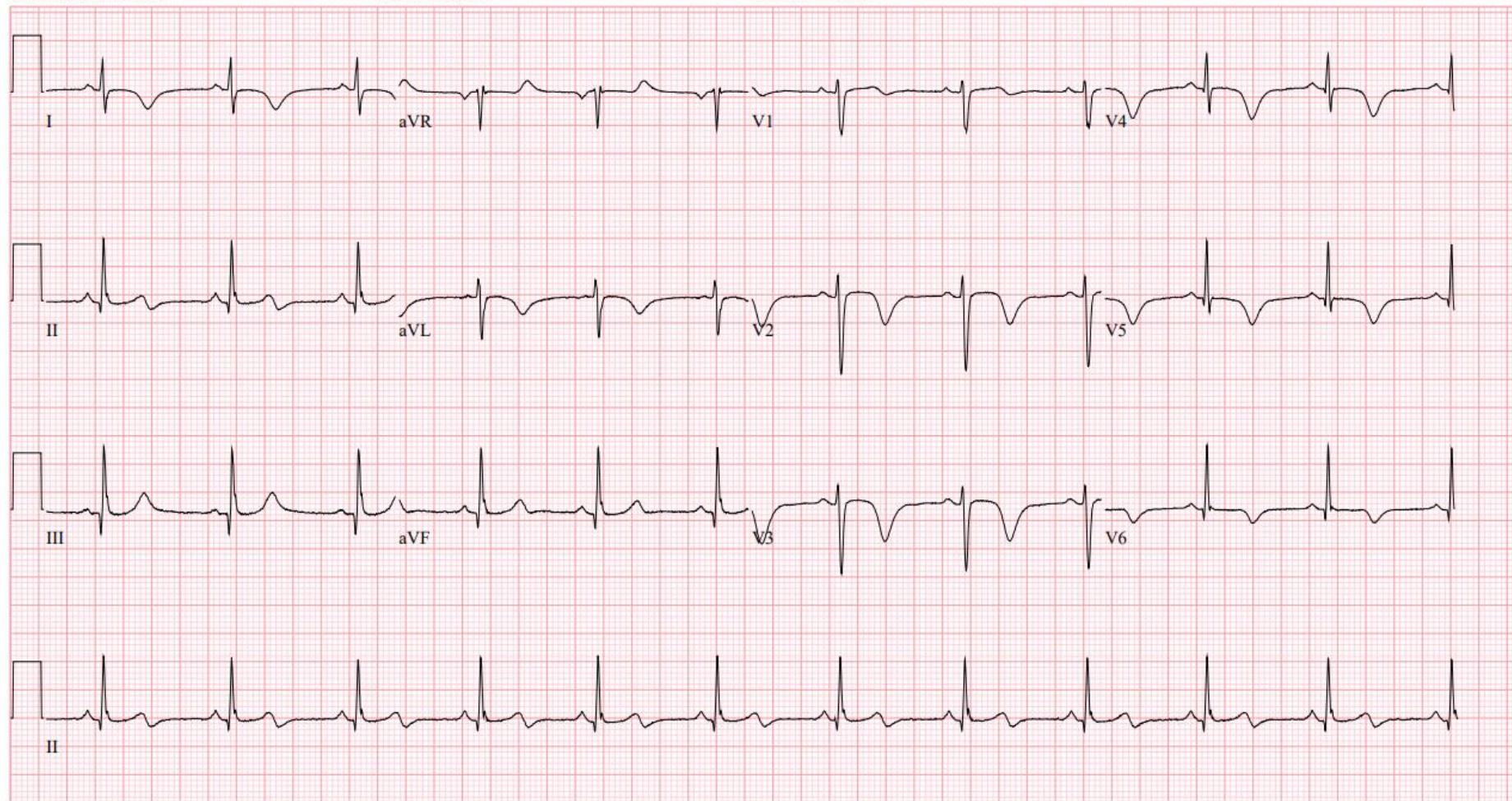
Technician: Grace Manning
Test ind:

REASON: Chest Pain

DIAGNOSIS:

DIAGNOSIS:

Unconfirmed



25mm/s 10mm/mV 150Hz 10.2.3 12SL 245 CID: 4015

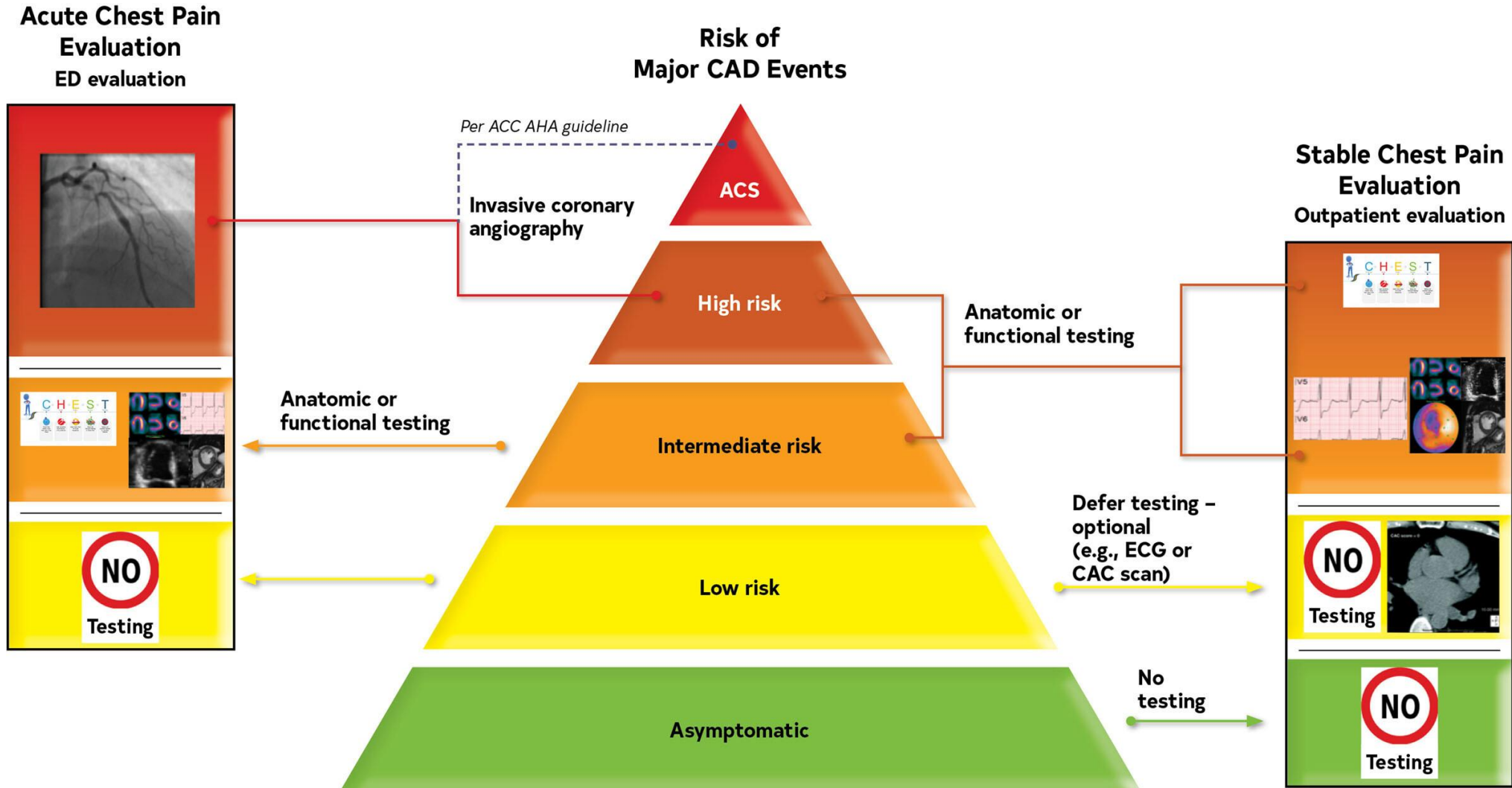
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Risk Stratifying Chest Pain

The HEART Score for Chest Pain Patients in the ED		
History	• Highly Suspicious • Moderately Suspicious • Slightly or Non-Suspicious	• 2 points • 1 point • 0 points
ECG	• Significant ST-Depression • Nonspecific Repolarization • Normal	• 2 points • 1 point • 0 points
Age	• ≥ 65 years • $> 45 - < 65$ years • ≤ 45 years	• 2 points • 1 point • 0 points
Risk Factors	• ≥ 3 Risk Factors or History of CAD • 1 or 2 Risk Factors • No Risk Factors	• 2 points • 1 point • 0 points
Troponin	• $\geq 3 \times$ Normal Limit • $> 1 - < 3 \times$ Normal Limit • $\leq$ Normal Limit	• 2 points • 1 point • 0 points
Risk Factors: DM, current or recent (<one month) smoker, HTN, HLP, family history of CAD, & obesity		
Score 0 – 3: 2.5% MACE over next 6 weeks → Discharge Home		
Score 4 – 6: 20.3% MACE over next 6 weeks → Admit for Clinical Observation		
Score 7 – 10: 72.7% MACE over next 6 weeks → Early Invasive Strategies		

Chest Pain and Cardiac Testing Considerations



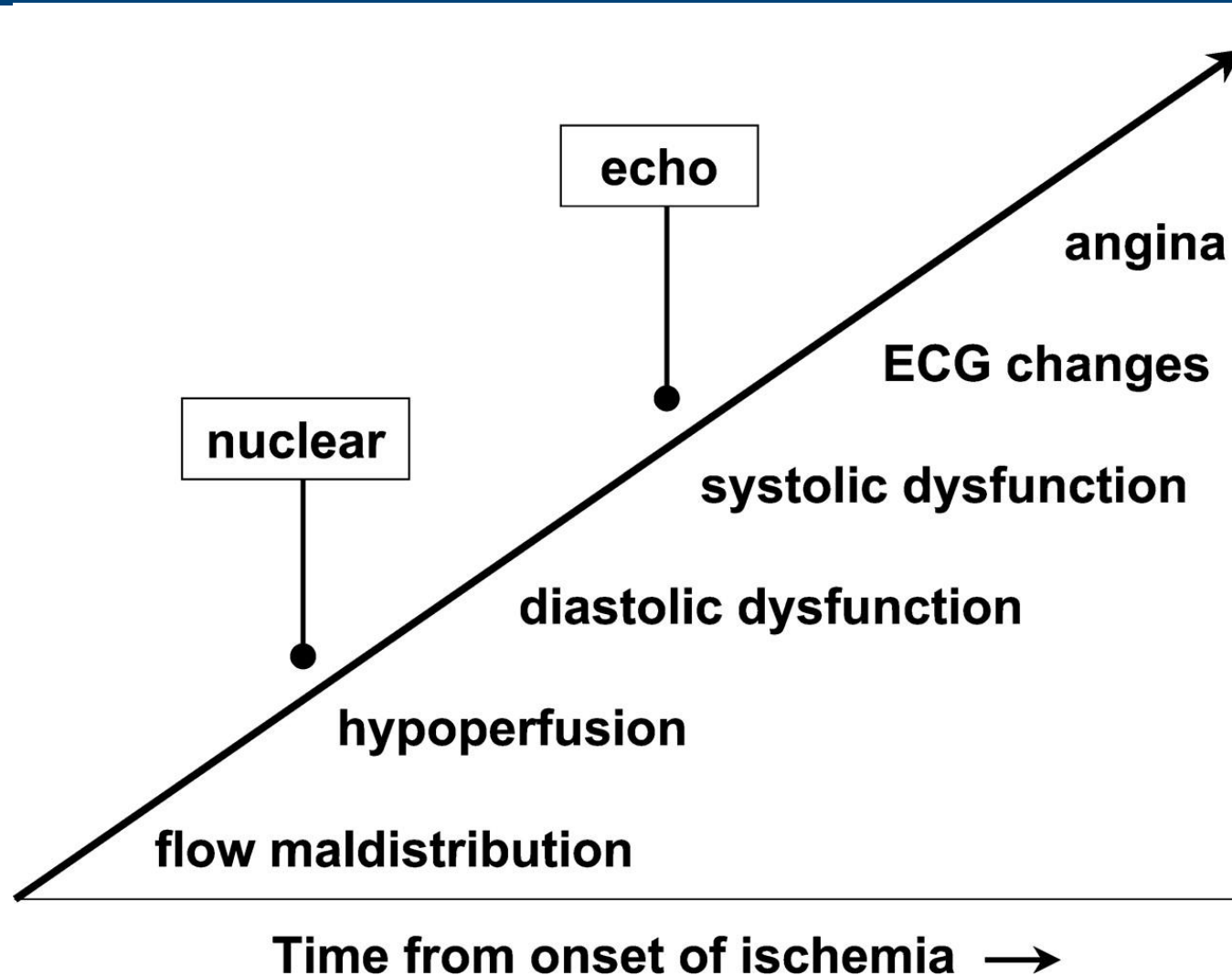
Non-invasive evaluation of suspected CAD

- Are patient's symptoms due to myocardial ischemia? (diagnosis)
- Is this patient going to experience an adverse Cardiac Event? (prognosis)
- Is an invasive intervention appropriate? (treatment)

Non-invasive evaluation of suspected CAD

- In the past, modalities have focused on detecting ischemia
- However, now anatomic imaging has become available
- Ischemia vs. atherosclerosis
- Changing paradigms to include anatomy

Ischemic Cascade



Patients With No Known CAD Presenting With Stable CP

Pretest Probabilities of Obstructive CAD in Symptomatic Patients

(A) according to age, sex, and symptoms;

(B) according to age, sex, symptoms, and CAC

Age, y	Chest Pain		Dyspnea	
	Men	Women	Men	Women
30–39	≤4	≤5	0	3
40–49	≤22	≤10	12	3
50–59	≤32	≤13	20	9
60–69	≤44	≤16	27	14
70+	≤52	≤27	32	12

A Pretest probability based on age, sex, and symptoms



B Pretest probability based on age, sex, symptoms, and CAC score⁺

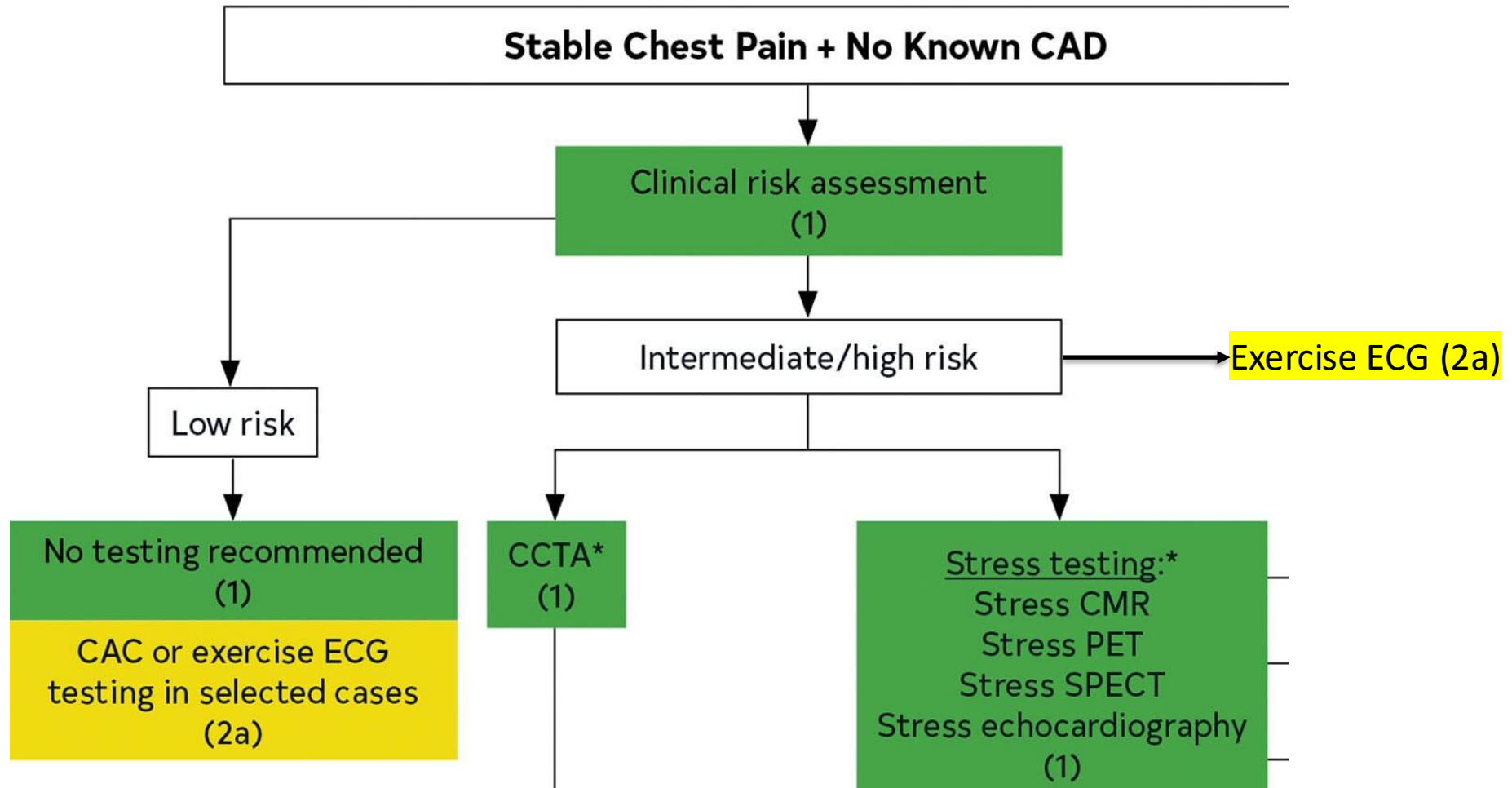


CAC
1–99

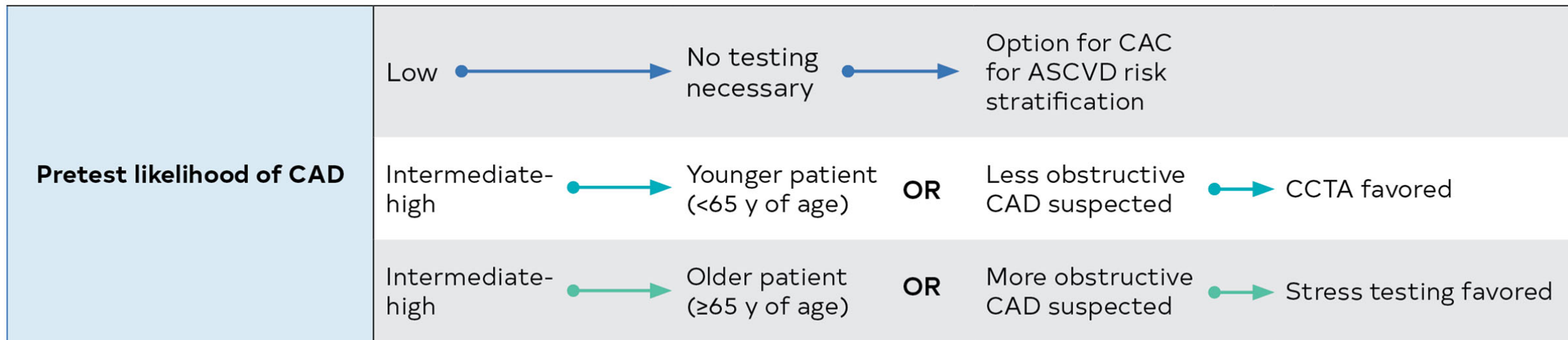
CAC
≥100–999

CAC
≥1,000

Patients With No Known CAD Presenting With Stable CP



Patients With No Known CAD Presenting With Stable CP



Absolute Contraindications to Stress Testing

Absolute contraindication

- Acute myocardial infarction or unstable angina
 - Symptomatic severe aortic stenosis
 - Cardiac arrhythmia with haemodynamic instability
 - Active endocarditis
 - Decompensated heart failure
 - Acute myocarditis or pericarditis
 - Acute pulmonary embolism, pulmonary infarction or deep vein thrombosis
 - Acute aortic dissection
-

Indications to Terminate Stress Testing

Absolute indications

- ST-segment elevation of > 1 mm in leads without pre-existing Q waves due to a prior myocardial infarction, other than aVR, aVL and V1
- Development of symptoms: moderate to severe angina, dizziness, near-syncope
- Sustained ventricular tachycardia or other arrhythmia, including second or third degree heart block that interferes with maintenance of cardiac output during exercise
- Drop in systolic blood pressure > 10 mmHg despite an increased workload, accompanied by other evidence of ischaemia
- Signs of poor perfusion (cyanosis, pallor)
- Neurological symptoms
- Individual's request to stop
- Technical difficulty in monitoring the ECG or systolic blood pressure

Exercise Treadmill Testing- Protocols

Standard Bruce Protocol

Stage	Min	MPH	Grade	METS
I	03:00	1.7	10%	5
II	03:00	2.5	12%	7
III	03:00	3.4	14%	10
IV	03:00	4.2	16%	13.5
V	03:00	5.0	18%	16+

Variations

Modified Bruce Protocol
2 warm-up stages

Naughton Protocol
mostly fixed speed

Submaximal ETT
Not to exceed 5 METS
Not to exceed 70% MPHR

Adequate stress: 85% max
predicted HR (220-age)

Diagnosis of Ischemia on Stress ECG

Positive test

- 1mm horizontal or down sloping ST segment depression 0.06-0.08msec after the j-point
(5% w/ CAD meet criteria in recovery alone)
- Lateral leads (V4-V6)



Up sloping

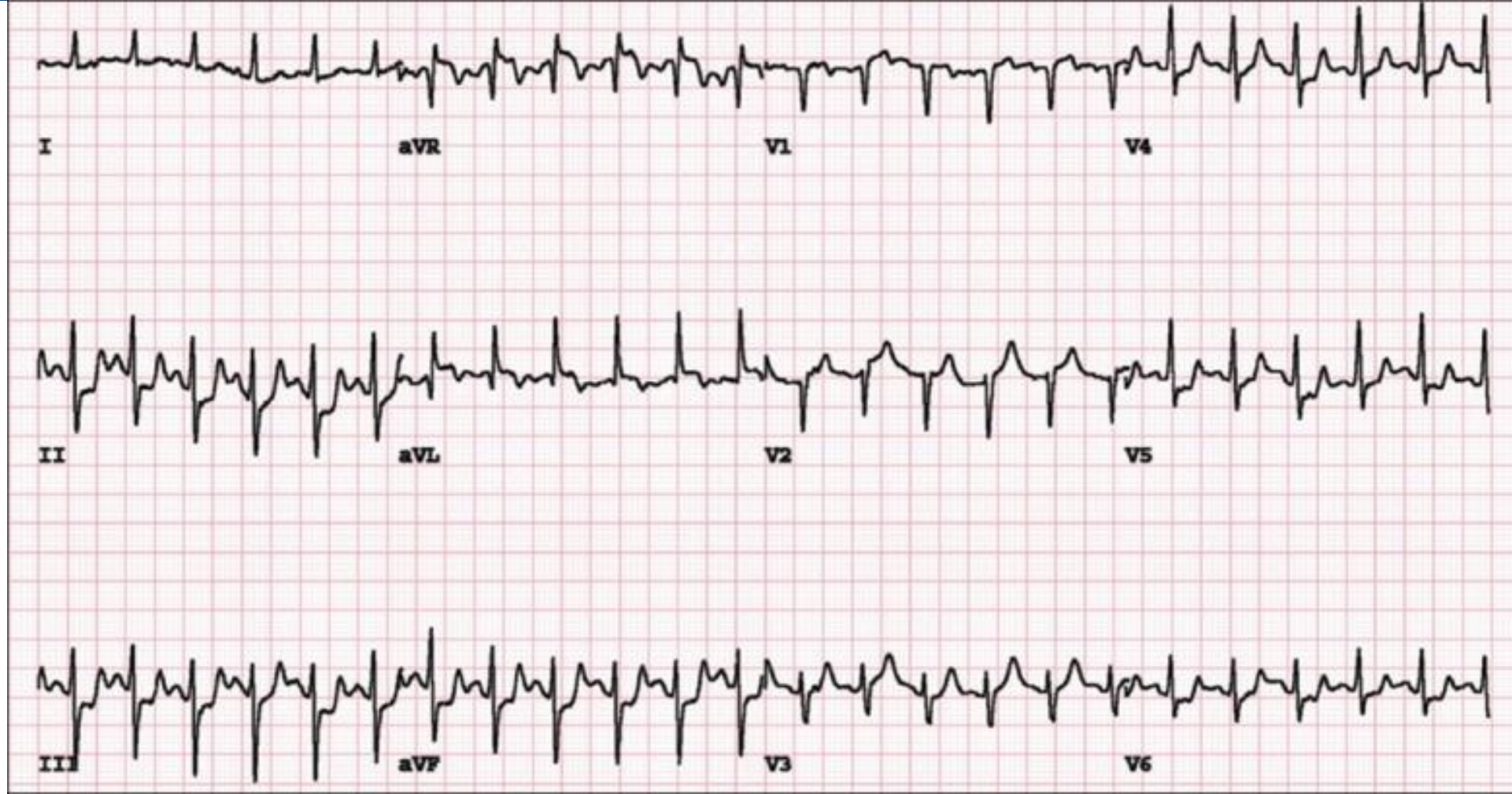


Horizontal

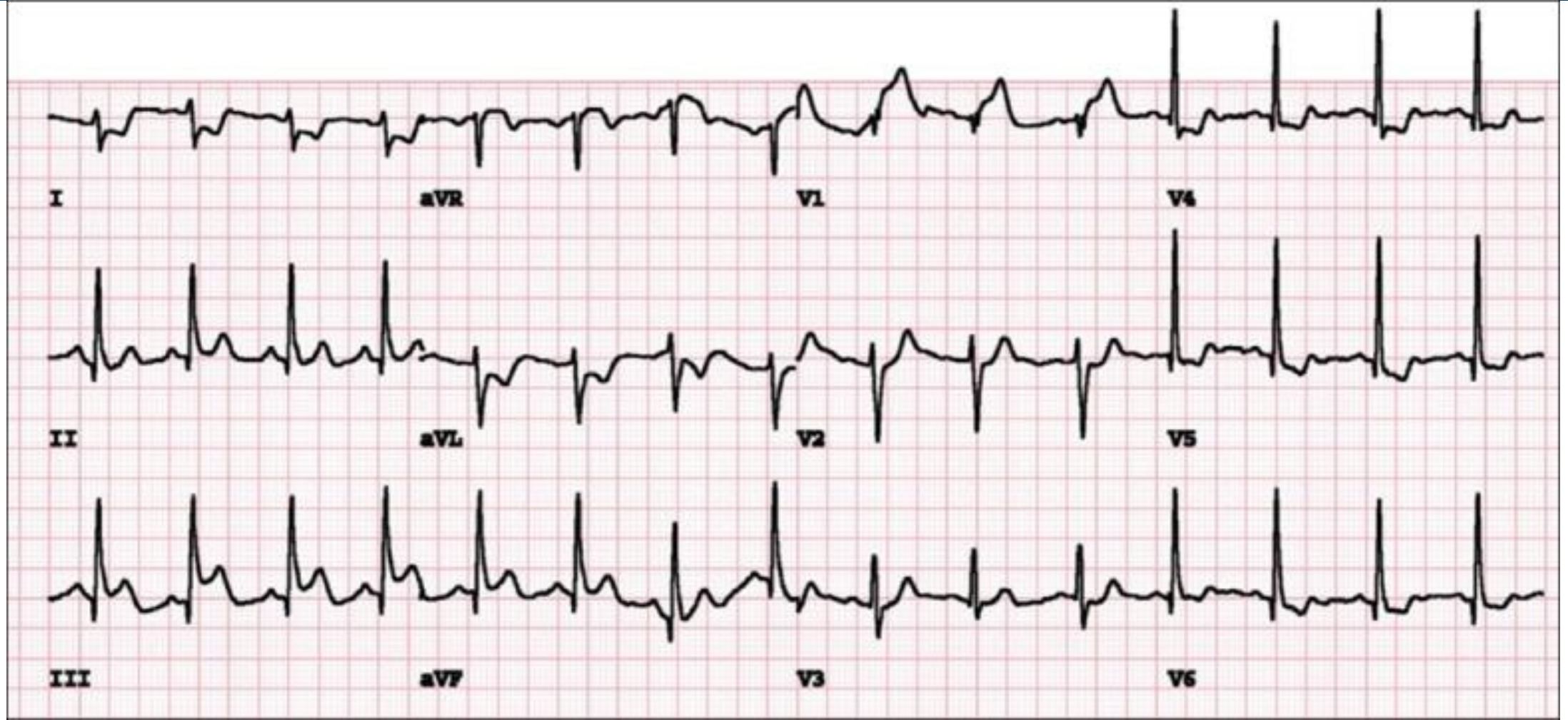


Down sloping

Abnormal stress ECG



Abnormal stress ECG



Duke Treadmill Score

DTS calculator = Exercise time in minutes-
5X ST segment depression (mm)-
4x angina index (0-no angina, 1-non limiting angina, 2-limiting angina)

Example: Patient walks 6 minutes, has 2 mm ST segment depression and has limiting angina
DTS= 6-10-8= -12, high risk

Score	4 year survival	Annual mortality
Low (>5)	99%	0.25%
Intermediate (-10 to 4)	95%	1.25%
High (<-10)	79%	5%

High risk Stress ECG

- ST ↓ >2.0 mm
- ST ↓ appearing at low workload
- ST ↓ lasting >5 min in recovery
- Low change in heart rate from rest to exercise
- Abnormal BP response
- Achieve <6 METs workload
- Exercise-induced VT
- Abnormal heart rate decline post-exercise

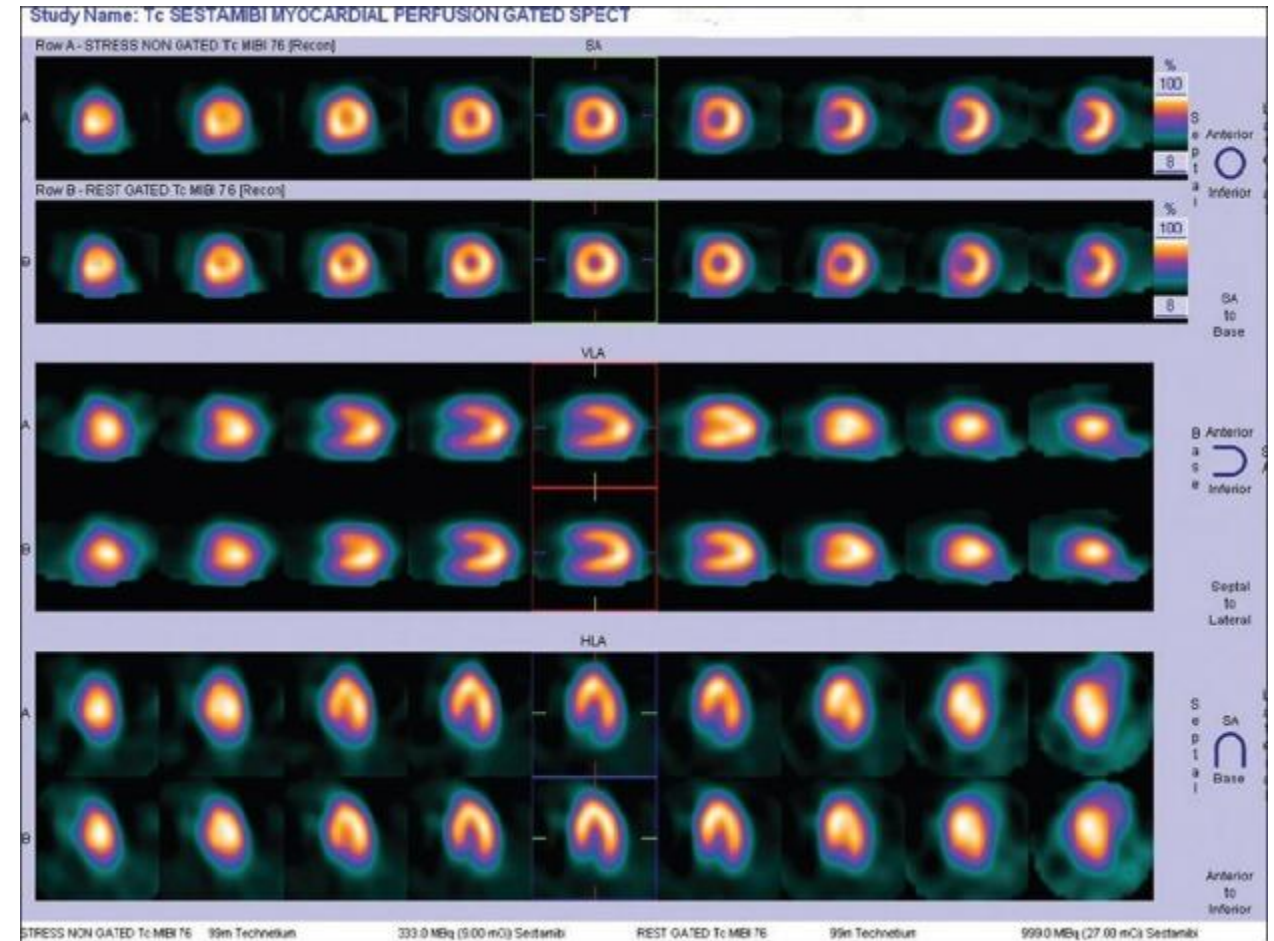
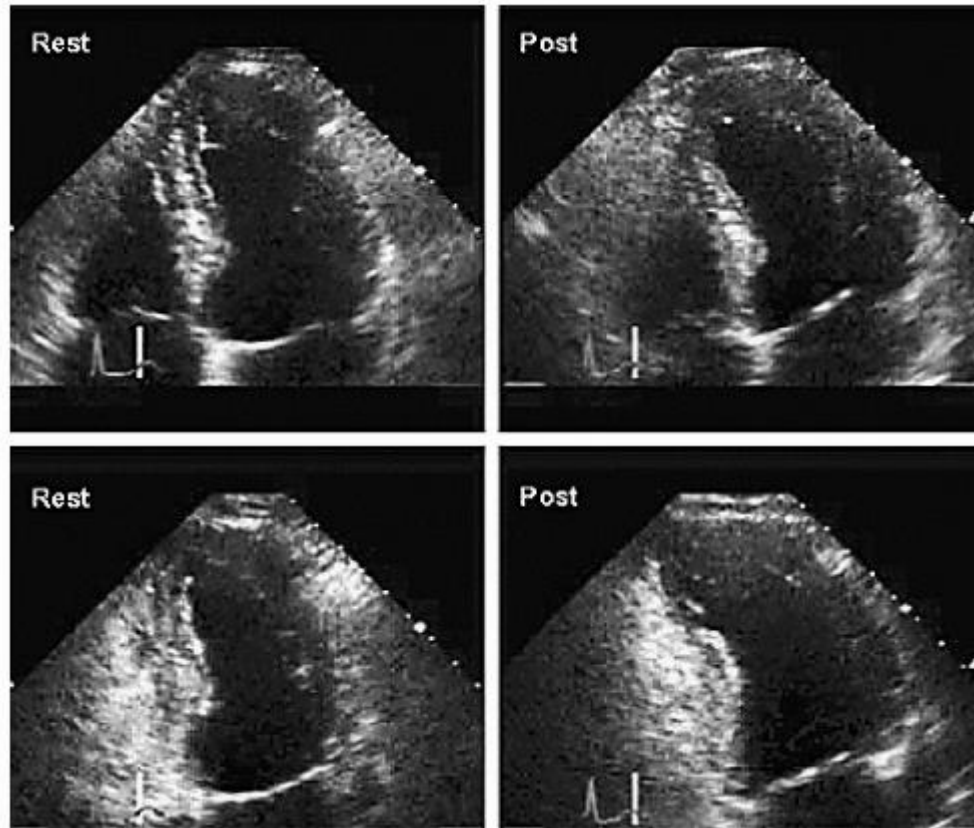
When NOT to use Stress ECG alone

- Preexcitation (Wolff-Parkinson-White) syndrome.
- LVH with ST depression.
- Digoxin and associated ST segment changes.
- Electronically paced ventricular rhythm.
- More than 1 mm of rest ST depression.
- Complete left bundle-branch block.

Why add imaging to stress ECG?

- In the cases of previous slide
- Intermediate to high risk pre-test
- Higher sensitivity and specificity than exercise ECG alone for detecting CAD
- Functional information
 - Area of myocardium at risk

Options-Echo and myocardial perfusion (nuclear)

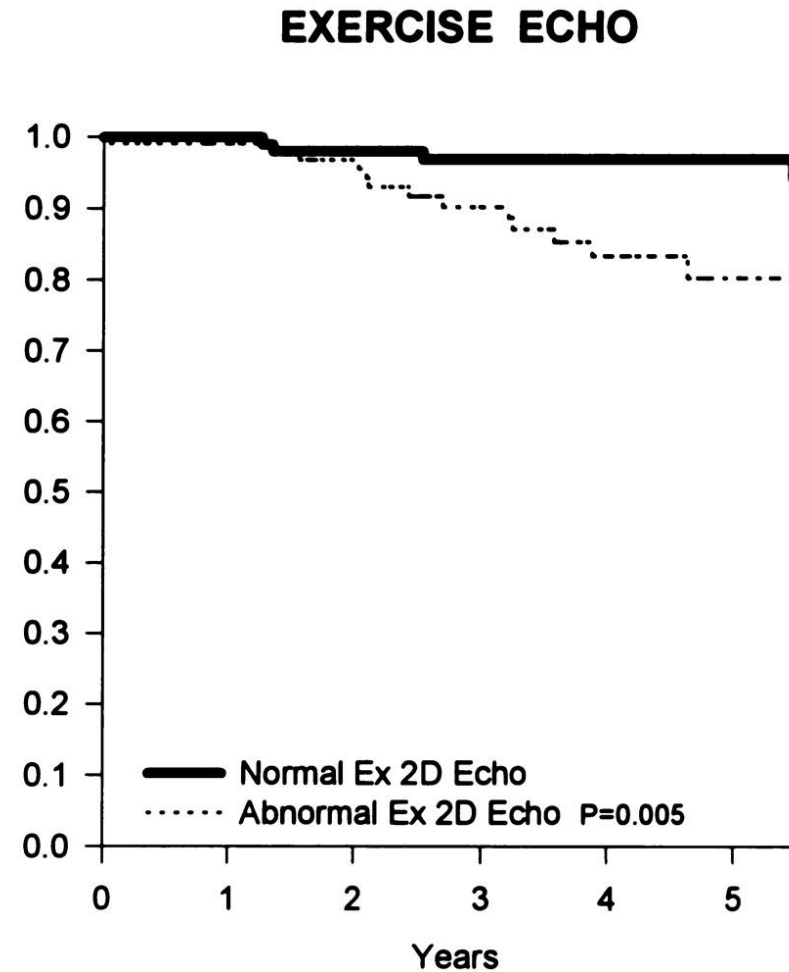
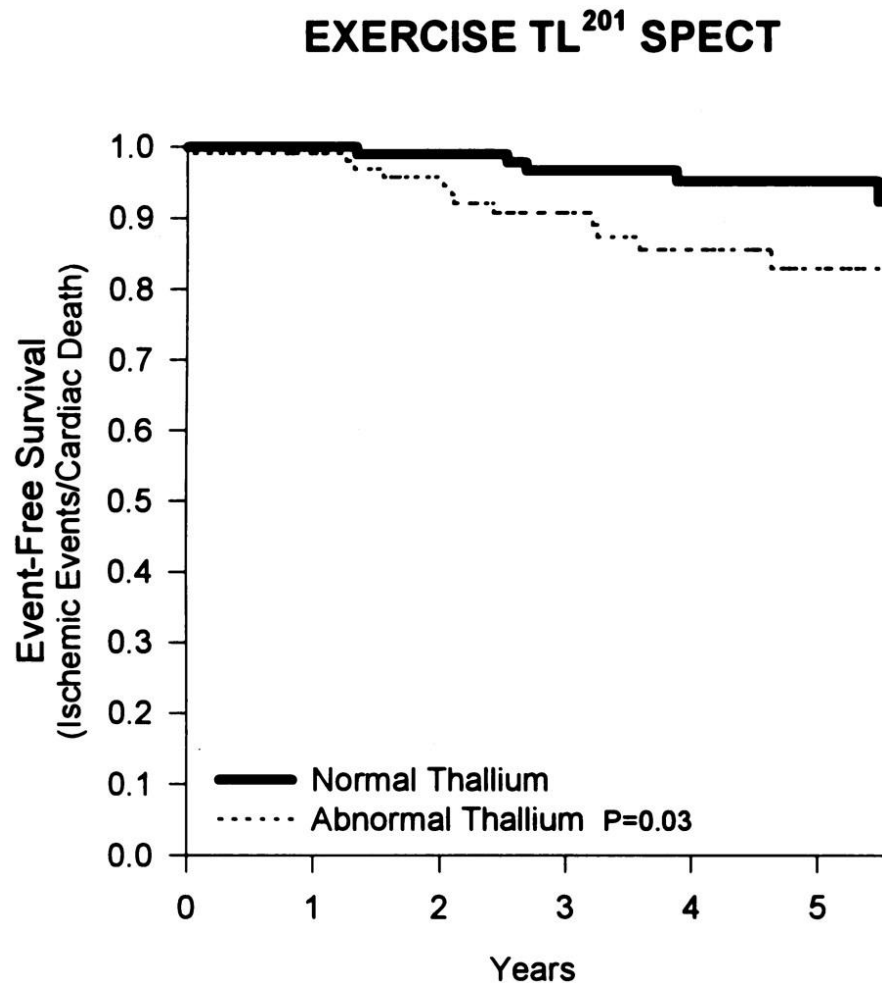


Diagnosis of flow limiting CAD

Study	MPI Sens (%)	Echo Sens (%)	MPI Spec (%)	Echo Spec (%)
O'Keefe JH, et al. 1995	83	78	77	86
Fleischmann KE, et al. 1998	87	85	64	77
Schinkel AF, et al. 2003	84	80	77	86

- Mean sensitivity 67%; mean specificity 72% for stress ECG alone
- Prognosis more important

Event-free survival curves for exercise SPECT and echo



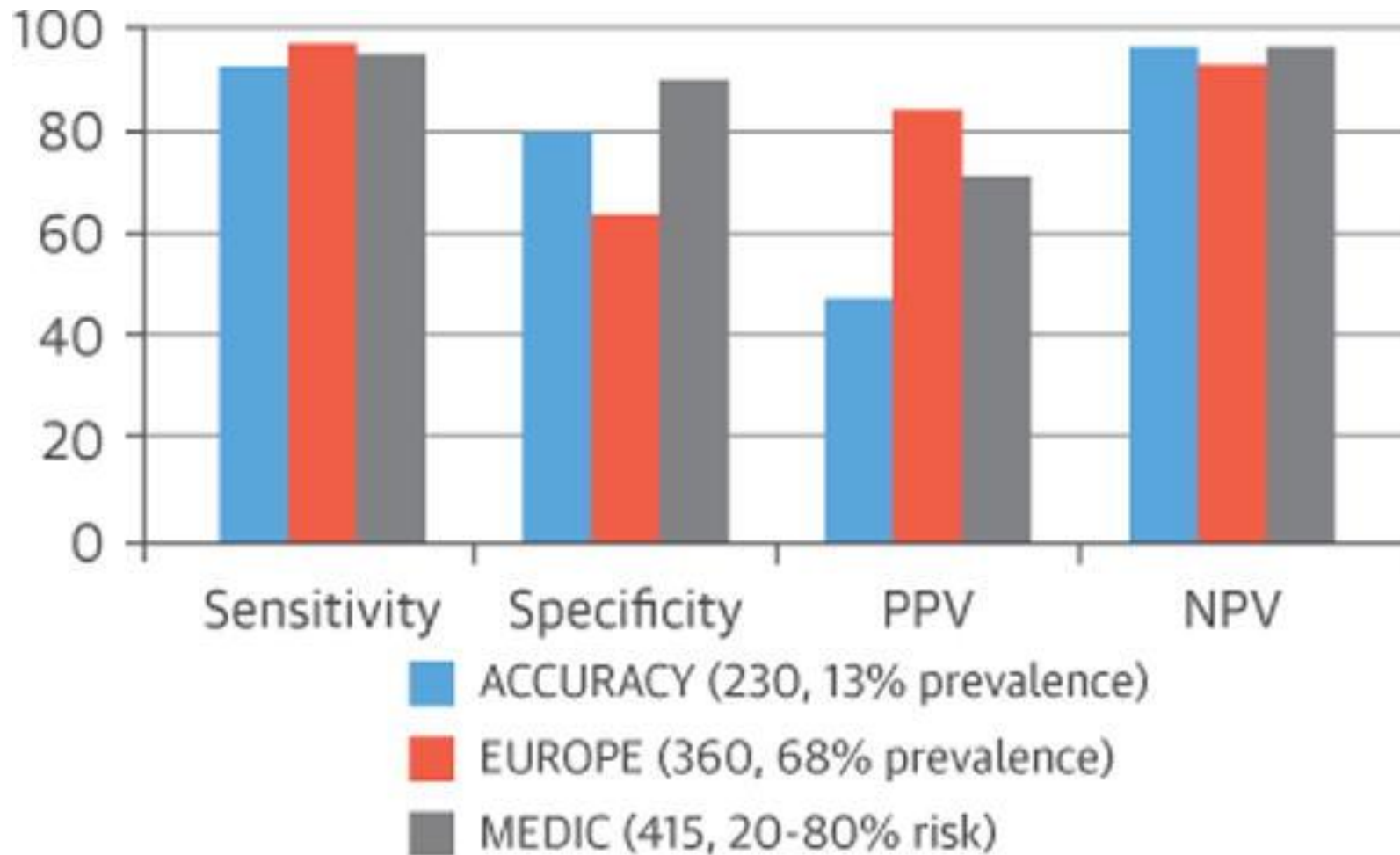
Comparing Stress echo vs MPI

	Advantages	Disadvantages
MPI (Nuclear)	Detects abnl flow reserve Peak-exercise images acquired Most studies complete Quantified LVEF and volumes Higher sensitivity	Longer time vs stress echo Radiation Lower spatial resolution Balanced ischemia missed
Stress ECHO	Safe No radiation Portable, faster Structural information Cheaper Higher specificity	Peak-exercise images difficult to acquire False-neg w/ rapid recovery 15% cannot assess entire myocardium Afib, LBBB

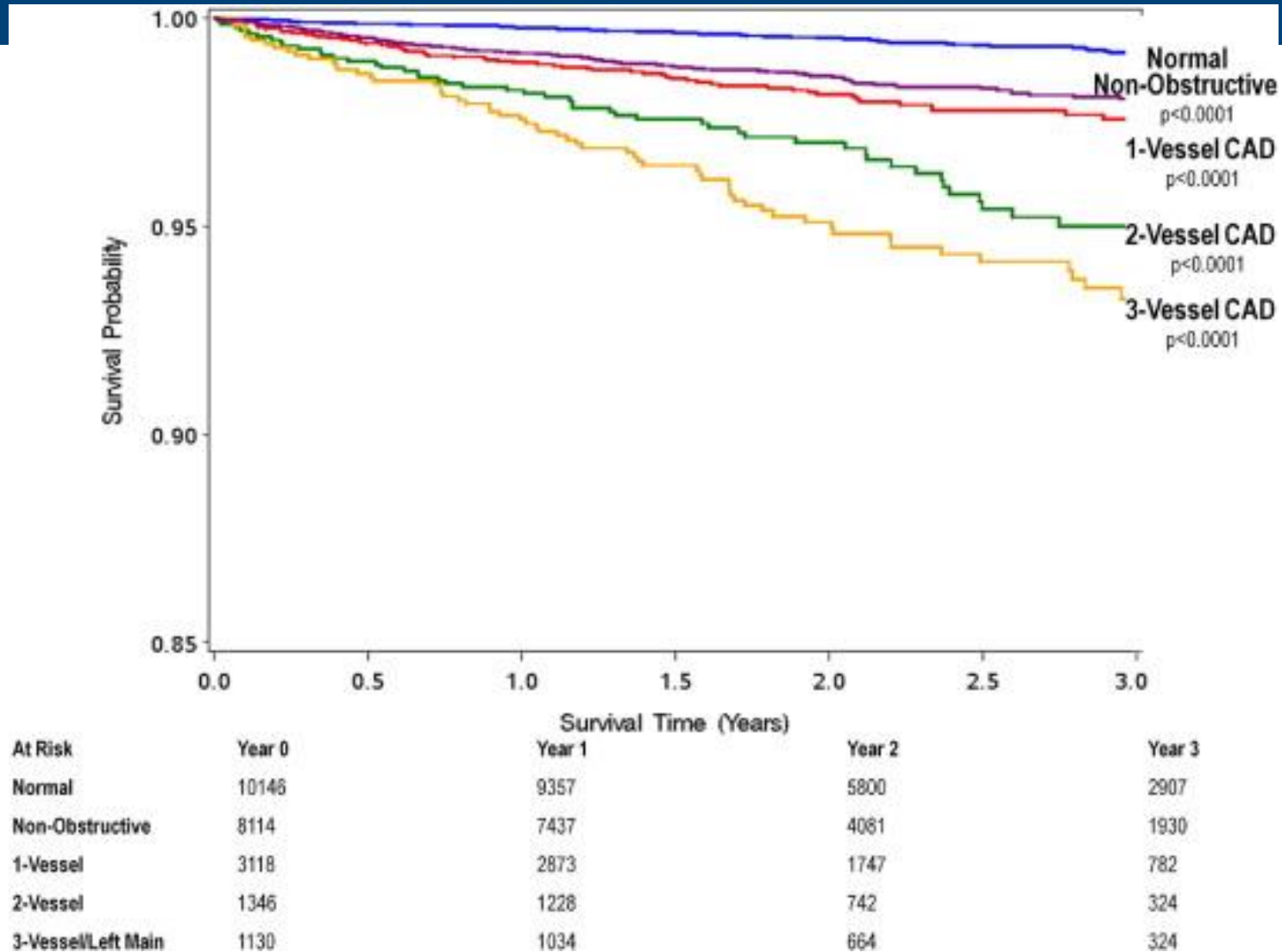
Coronary CT Angiography



Coronary CT Angiography Diagnosis



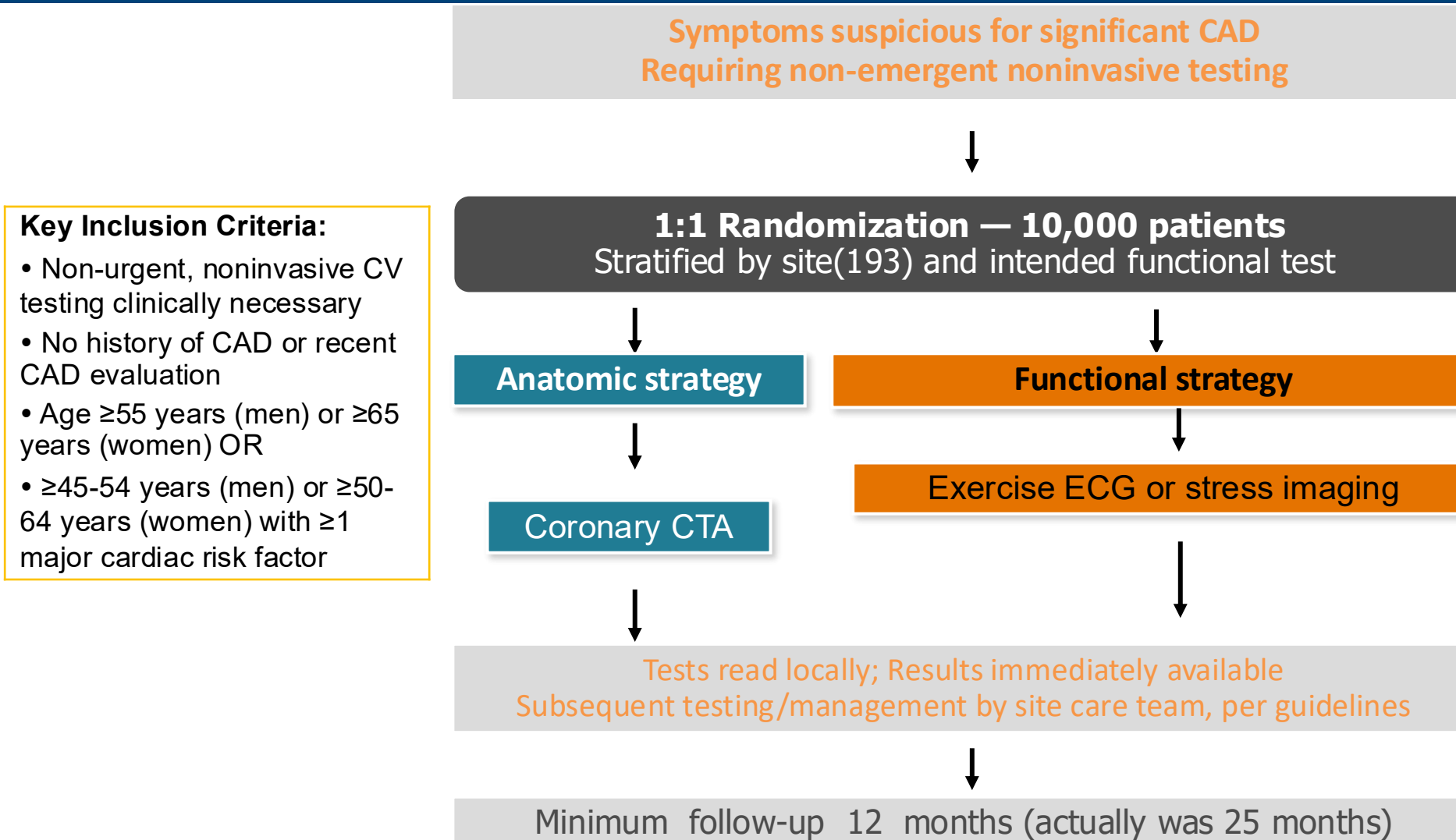
Coronary CT Angiography Prognosis



Coronary CT Angiography Limitations

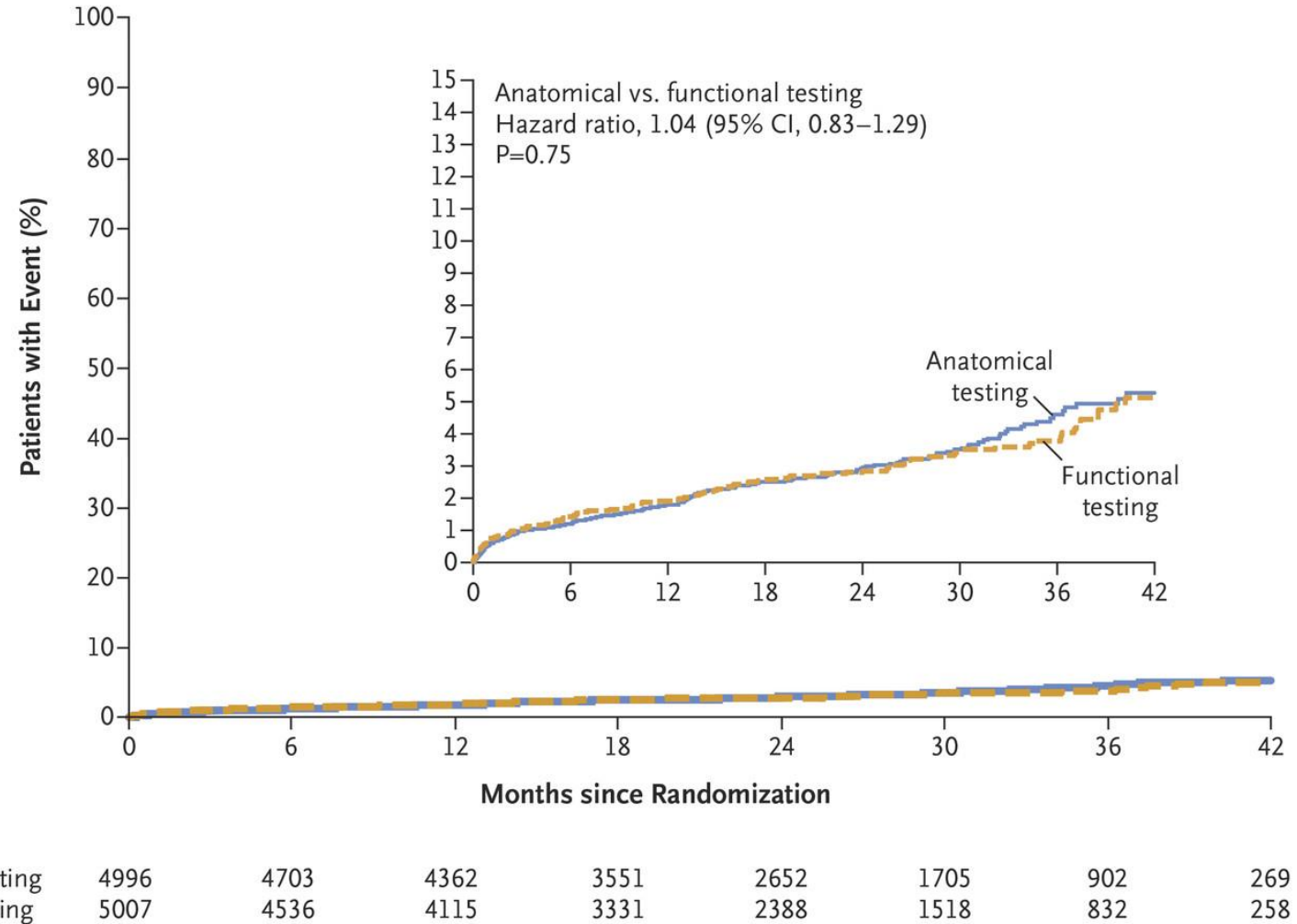
- Not a test for every patient
- Possible contra-indications: Atrial fibrillation, chronic kidney disease
- Large amount of coronary calcium
- High coronary artery calcium scores
 - Blooming artifact
- Obesity
- Contrast and radiation exposure

PROMISE trial Prospective Multicenter Imaging Study for Evaluation of Chest Pain



PROMISE trial

Primary composite end point (death from any cause, nonfatal myocardial infarction, hospitalization for unstable angina, or major procedural complication).

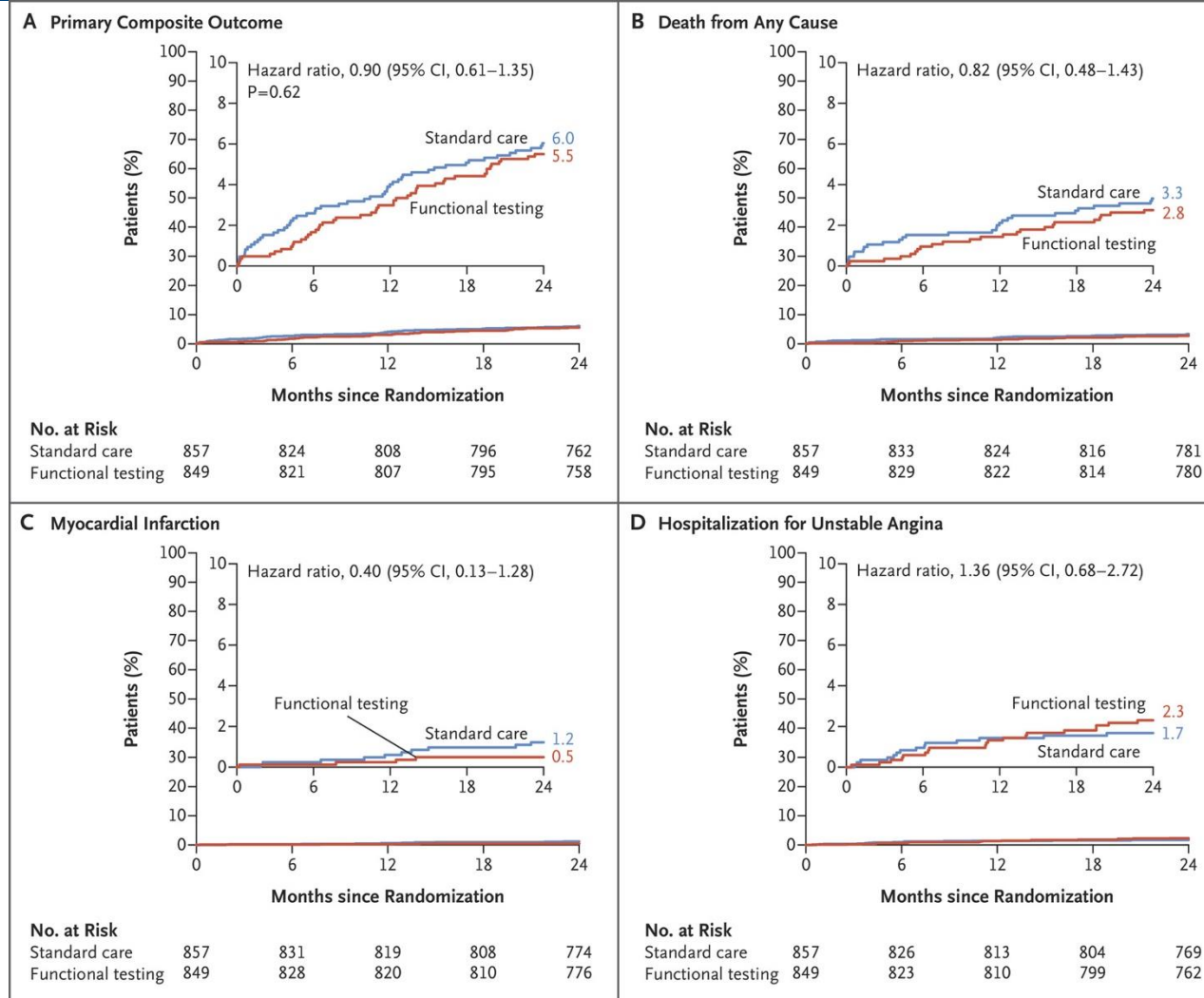


Diagnostic Testing Selection in CP with known CAD

- In patients with known CAD, and change in symptoms and/or functional capacity that persists despite GDMT
 - Class I indications:
 - stress imaging (nuclear or echo)
 - Invasive coronary angiography (ICA)
- Other testing to consider (Class 2a):
 - Exercise treadmill testing
 - Coronary CTA for larger stents (>3mm) or assess bypass patency

POST PCI trial

Routine Functional Testing or Standard Care in High-Risk Patients after PCI

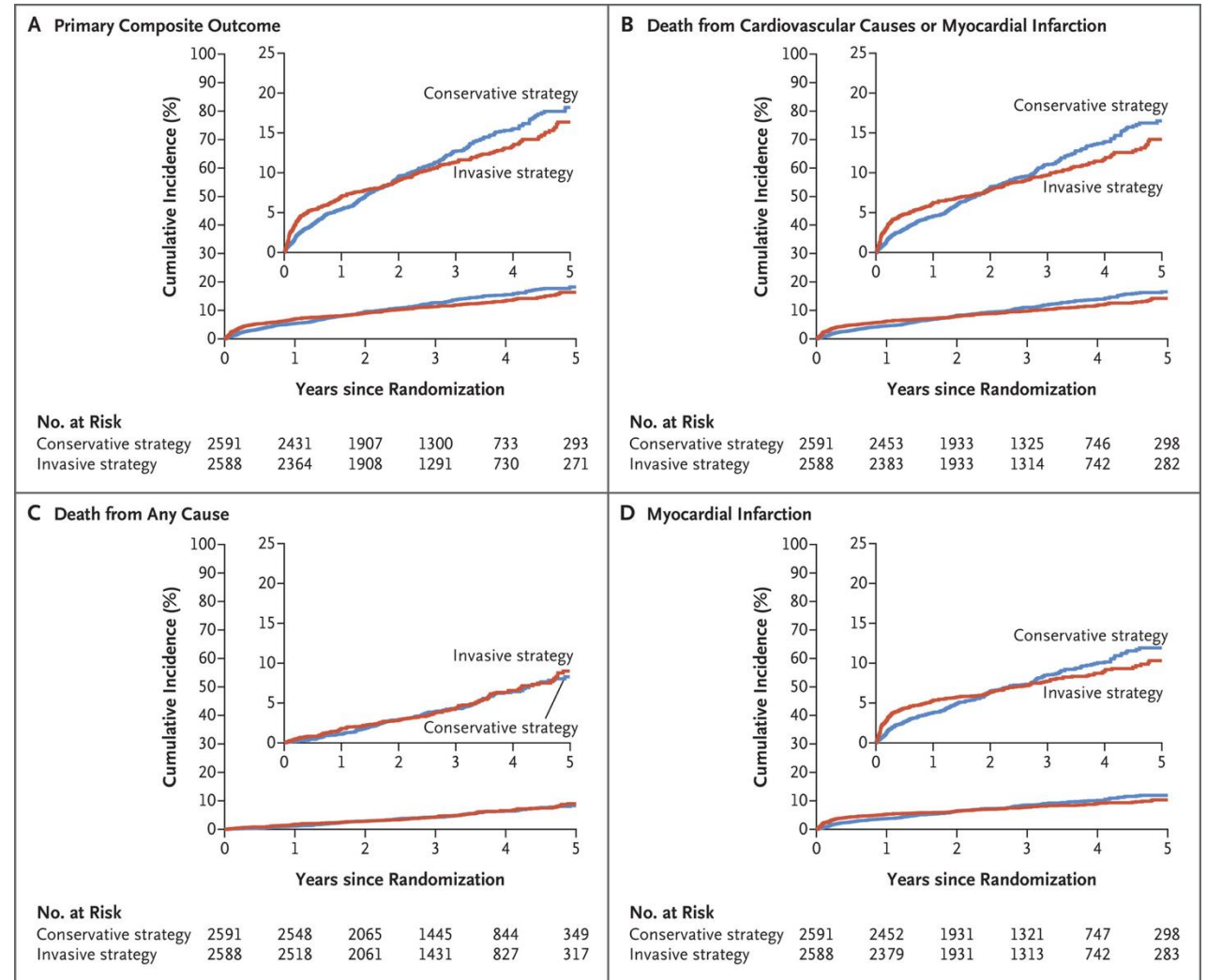


Diagnostic Testing Selection in known CAD

- *"In patients with CCD, if there is an opportunity to do so, clinicians should first intensify GDMT and defer testing."*
- Why make this recommendation?
- Three major RCTs including COURAGE, ISCHEMIA, and BARI-2D have shown no reduction in MACE with routine PCI/CABG.

ISCHEMIA Trial

- Initial Invasive or Conservative Strategy for Stable Coronary Disease
- Among patients with stable CCD and moderate or severe ischemia, an initial invasive strategy vs initial conservative strategy did not reduce the risk of ischemic CV events or death from any cause



Treatment of stable angina

- Aspirin
- Beta blockers
- Calcium channel blockers
 - Dihydropyridines-amlodipine
 - Non-DHP-verapamil and diltiazem
- Oral nitrates
- Ranolazine
- Secondary prevention of events: HIGH INTENSITY STATIN
 - Atorvastatin 40/80 mg and rosuvastatin 20/40 mg
 - Other lipid lowering therapies also now available
 - Goal LDL < 70 mg/dL , and in some cases < 55 mg/dL

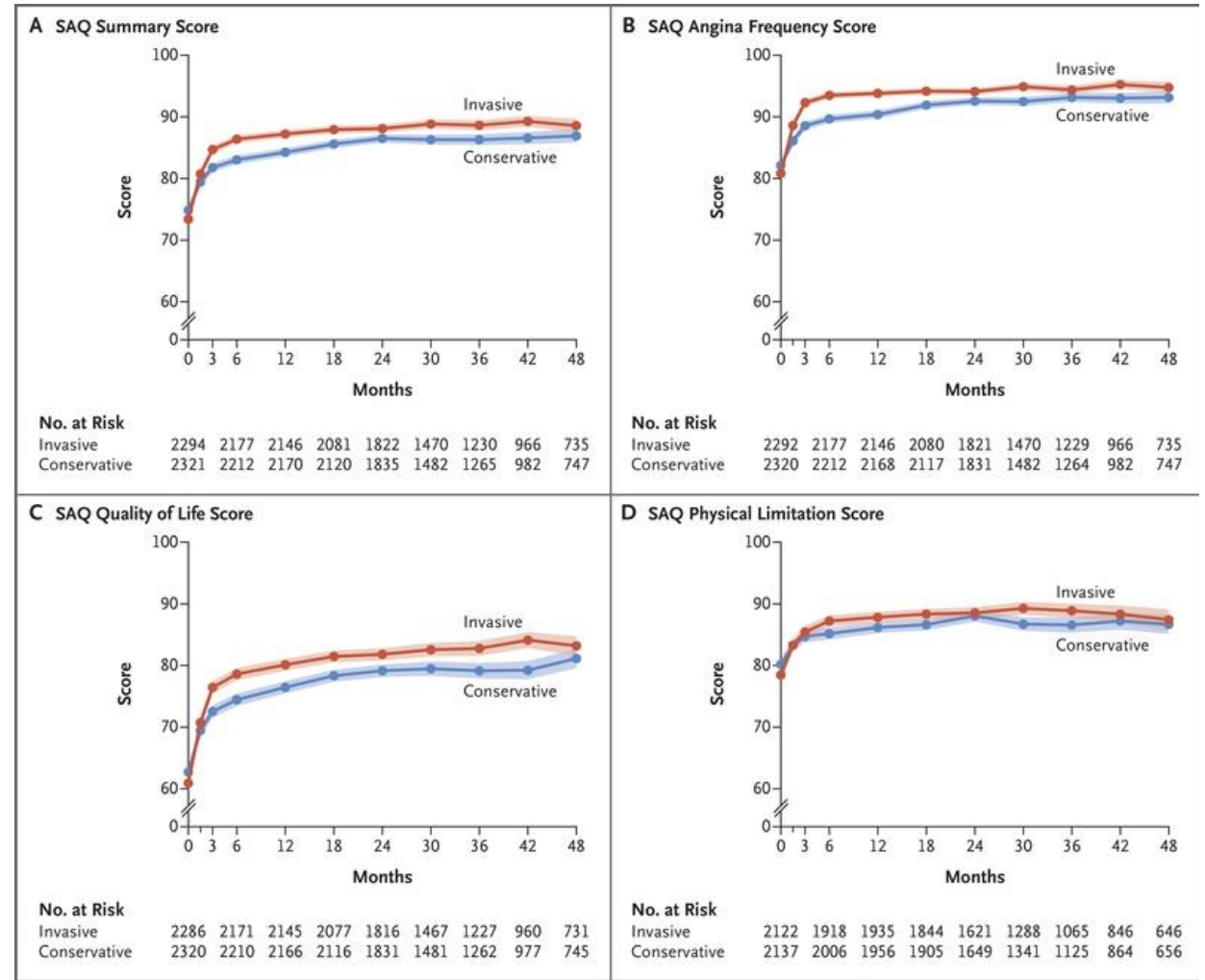
Drug	Mechanism of Action	Adverse effects	Common doses
Beta blocker	Slow HR Decrease myocardial contractility Lower afterload with lower BP	Bronchospasm Bradycardia Hypotension Fatigue Erectile dysfunction	Metoprolol 25-50 mg bid Atenolol 25-50 mg daily Carvedilol 3.125-6.25 mg bid
Calcium channel blockers-DHP	Arterial vasodilator Lower BP	Hypotension Peripheral edema	Amlodipine 5-10 mg daily
CCB-non DHP	As for DHPs Decrease myocardial contractility Slow HR	Avoid in depressed LVEF Bradycardia	Diltiazem 30 mg tid Verapamil 40 mg tid
Nitrates	Coronary vasodilator Reduce preload Lower BP	Headaches Nitrate tolerance Hypotension	Isosorbide mononitrate 60-120 mg daily Isosorbide dinitrate 10-20 mg tid
Ranolazine	Inhibits late Na channel Anti-anginal No effect on HR or BP	Prolong QT Dizziness Headache	500mg-1000mg bid

Revascularization in CCD

- For lifestyle limiting angina despite GDMT, coronary revascularization procedures are recommended (class 1)

ISCHEMIA trial and angina

- To assess angina-related health status among ISCHEMIA patients
- Patients randomly assigned to the invasive strategy had greater improvement in angina-related health status than those assigned to the conservative strategy.
- *Larger differences seen among patients who had more angina at baseline.*



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- A. Exercise treadmill test without imaging (Standard Exercise ECG)
 - B. Coronary computed tomography angiography (CCTA)
 - C. Stress radionuclide myocardial perfusion imaging (SPECT)
 - D. Invasive coronary angiography immediately

Take Home Points

- Initial evaluation of chest pain patients by history important
- Non invasive evaluation of chest pain is important for purposes of diagnosis and prognosis
- In stable chest pain patients, non invasive evaluation favored followed by medical therapy in patients with CAD
- Revascularization recommended for patients who have refractory symptoms despite medical therapy