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NONINVASIVE CARDIAC IMAGING FOR CORONARY ARTERY DISEASE:

A PRACTICAL APPROACH

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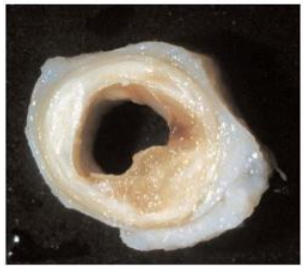
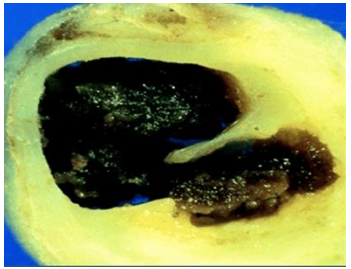
Outline

- Coronary artery disease: What exactly are we testing?
- Philosophy of noninvasive ischemia testing
- Practical aspects of:
  - Exercise stress testing
  - Exercise and pharmaceutical nuclear imaging
  - Exercise and pharmaceutical stress echocardiography
  - Cardiac CT angiography
- The impact of the ISCHEMIA trial on what we do

A TALE OF TWO CITIES

POSSIBLE PRESENTATIONS OF CAD:

	STABLE CAD	UNSTABLE CAD
PREDICTABLE?	YES	NO
MORTALITY	LOW	HIGH
		
	"LIFESTYLE LIMITING"	"LIFELINE LIMITING"

The Best Model of Atherosclerosis

Reason to do ANY diagnostic test for CAD

Symptomatic:

1. Diagnosis of undifferentiated symptoms (CP/SOB/Other):
   - Is it due to obstructive CAD?
2. Prognostication of known CAD:
   - Is it being adequately managed?

Asymptomatic:

1. Risk stratification:
   - Do you have enough subclinical atherosclerosis to justify treating risk factors?

Purpose of testing for CAD: the question are you posing will determine the answer you get

(ASYMPTOMATIC PT)

Detection of subclinical atherosclerosis

Carotid IMT ultrasonography
Coronary calcium scanning
hsCRP

STATIN YES OR NO

(SYMPTOMATIC PT)

Detection of flow-limiting atherosclerosis

FUNCTIONAL

Exercise stress testing
Stress imaging (MIBI, Echo)

ANATOMICAL

Coronary CTA
Traditional angiogram

TREAT FOR ISCHEMIA YES OR NO

In other words, for symptomatic patients..

THE QUESTION IS:

Do they have FLOW LIMITING CAD that conceivably be the cause of their symptoms (ie do they have cardiac ischemia, and the anatomical substrate in the coronary arteries severe enough to cause it)

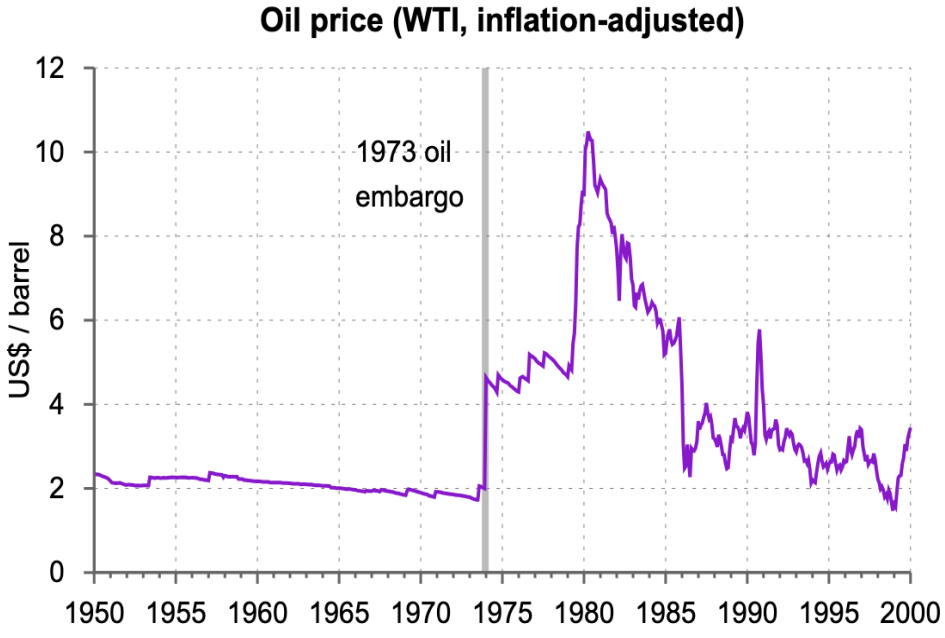
Asymptomatic CAD: How to use Coronary Calcium Scanning

- Presence of coronary calcium indicates presence of CAD
- Extent of coronary calcium linear with extent of CAD
- Extent of coronary calcium predicts risk of CAD related events
- >300 Agotson units or >75%ile for age or gender proposed as a cutoff to consider starting a statin amongst pts at otherwise low cardiovascular risk (10 year event rate <7.5%)

BACK TO OUR SYMPTOMATIC PT…

ISCHEMIA: ITS ALL ABOUT ECONOMICS

Organization of the Petroleum Exporting Countries



ECONOMIC IMBALANCE….

DECREASED SUPPLY

INCREASED DEMAND

HOW TO FIX THE ECONOMIC PROBLEM

INCREASE SUPPLY

REVASCULARIZATION

REDUCE DEMAND

MEDICAL THERAPY

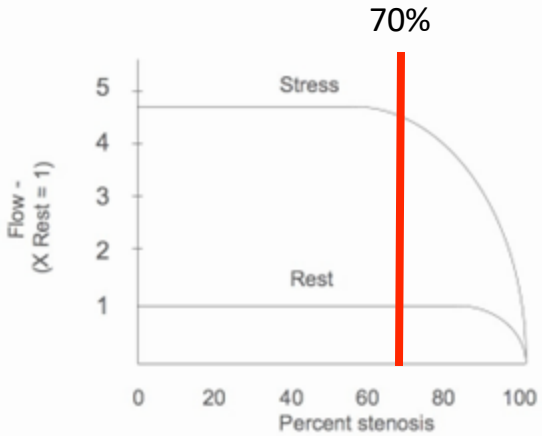
THIS IS EXACTLY THE ISSUE WITH CARDIAC ISCHEMIA

SUPPLY

Coronary blood flow
mL/min

DEMAND

Myocardial Oxygen Demand (MVO_2)

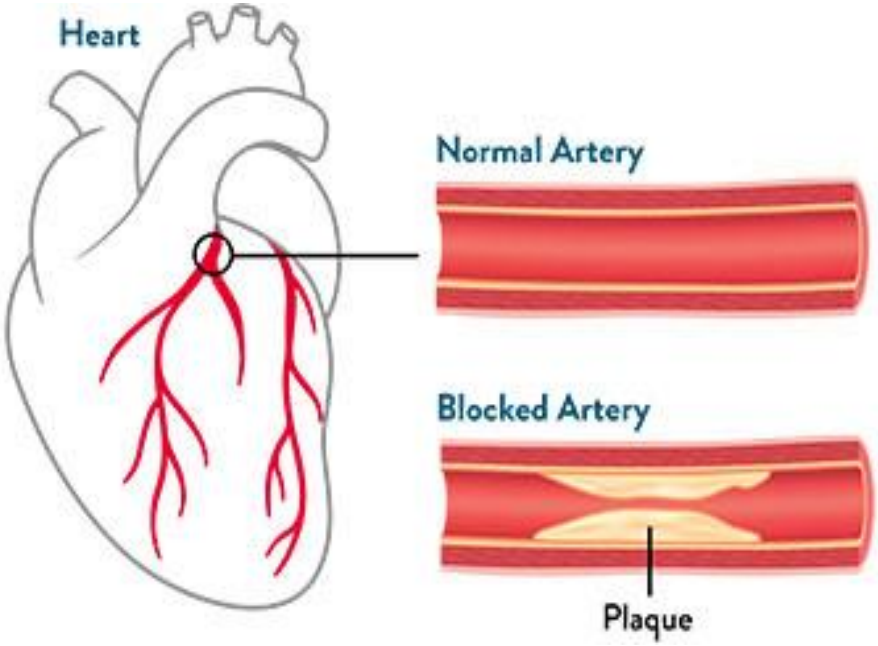


CORONARY FLOW RESERVE (CFR)

1. **Preload**
2. **Contractility**
3. **Afterload**
4. **HR**

PHILOSOPHY OF EXERCISE STRESS TESTING

BASIS OF STRESS TESTING



70% OR GREATER

- Gold standard:
  - >70% stenosis in a major epicardial artery
- Increase demand (MVO2) and see if patient's CFR can match the increased need for blood and oxygen

ANATOMICAL EXAM:

LOOKS TO SEE IF THERE IS A >70% FLOW LIMITING LESION

- **Diagnostic angiogram:**
  - Gold standard test
- **CT coronary angiogram**
  - "Virtual" angiogram
- Although angiography does not provide a physiological assessment of ischemia, there are adjunctive tests that can be done to determine if a given lesion is clinically significant (Fractional Flow Reserve, Instantaneous Free Wave Ratio, iFR)

FUNCTIONAL EXAM:

LOOKS AT THE PHYSIOLOGICAL IMPACT OF A >70% FLOW LIMITING LESION

- **Exercise stress test:**
  - Electrocardiographic changes seen with ischemic myocardium
- **Nuclear imaging (exercise or pharmacologic):**
  - Objective quantification of blood flow into the myocardium
- **Stress echocardiography (exercise or pharmacologic):**
  - Ischemia induced wall motion abnormalities (hypokinesis or akinesis)

What a Functional Test will NOT tell you…

- Will **NOT** detect a <70% stenosis
- Will **NOT** detect a vulnerable plaque that could cause an MI
- Will **NOT** be able to determine short or long term vascular risk for the purposes of a discussion on risk factor reduction

Why heart attacks happen: (in)stability vs size

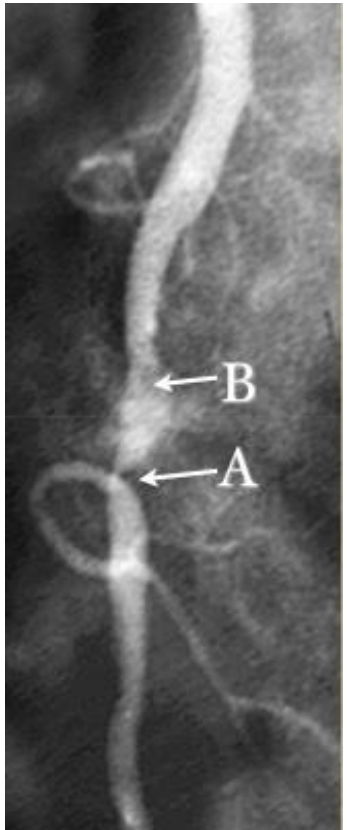
STABLE CAD (>70% LESION)

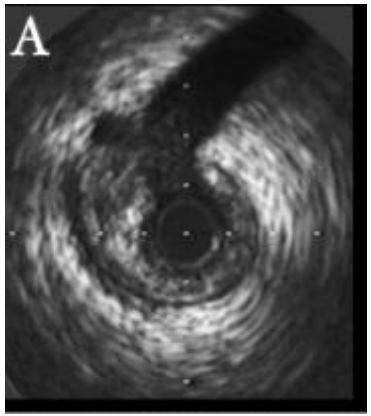
Fibrous cap

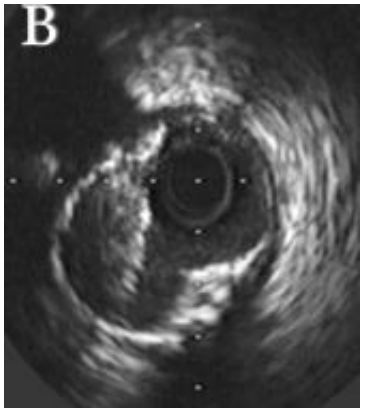
Soft gooey cholesterol center

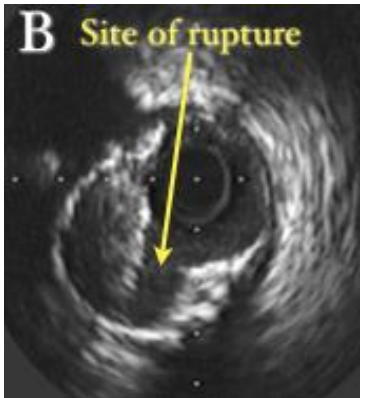
UNSTABLE CAD (ANY SIZE)

The Active Lesion is Not Always the Tight Lesion: Implications for Therapy and Diagnostics









Lesion A:
Would be detected on a functional test. Was not the cause of the MI.

Lesion B:
Would never be detected on a functional test. Was totally the cause of the MI.

What Do The Guidelines Say?

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American Heart Association.

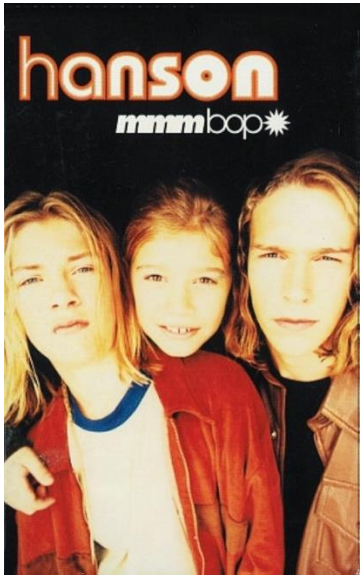
ARTICLE

ACC/AHA Guidelines for Exercise Testing: Executive Summary

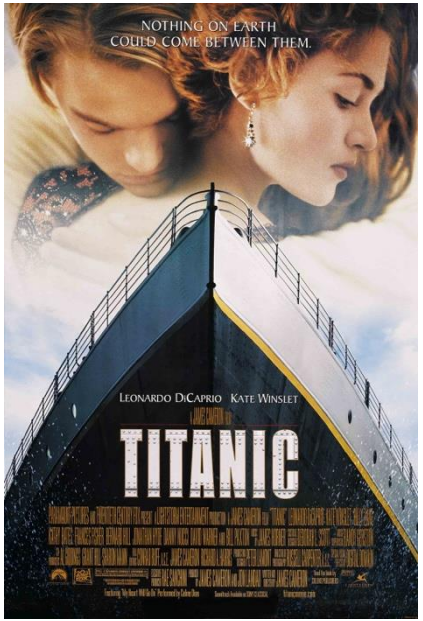
A Report of the American College of Cardiology/ American Heart Association Task Force on Practice Guidelines (Committee on Exercise Testing)

on behalf of Committee Members, Raymond J. Gibbons, Gary J. Balady, John W. Beasley, FAAFP, J. Timothy Bricker, Wolf F. C. Duvernoy, Victor F. Froelicher, Daniel B. Mark, Thomas H. Marwick, Ben D. McCallister, Paul Davis Thompson, FACSM, William L. Winters, Jr, Frank G. Yanowitz, and on behalf of Task Force Members

WHAT ELSE HAPPENED IN 1997?



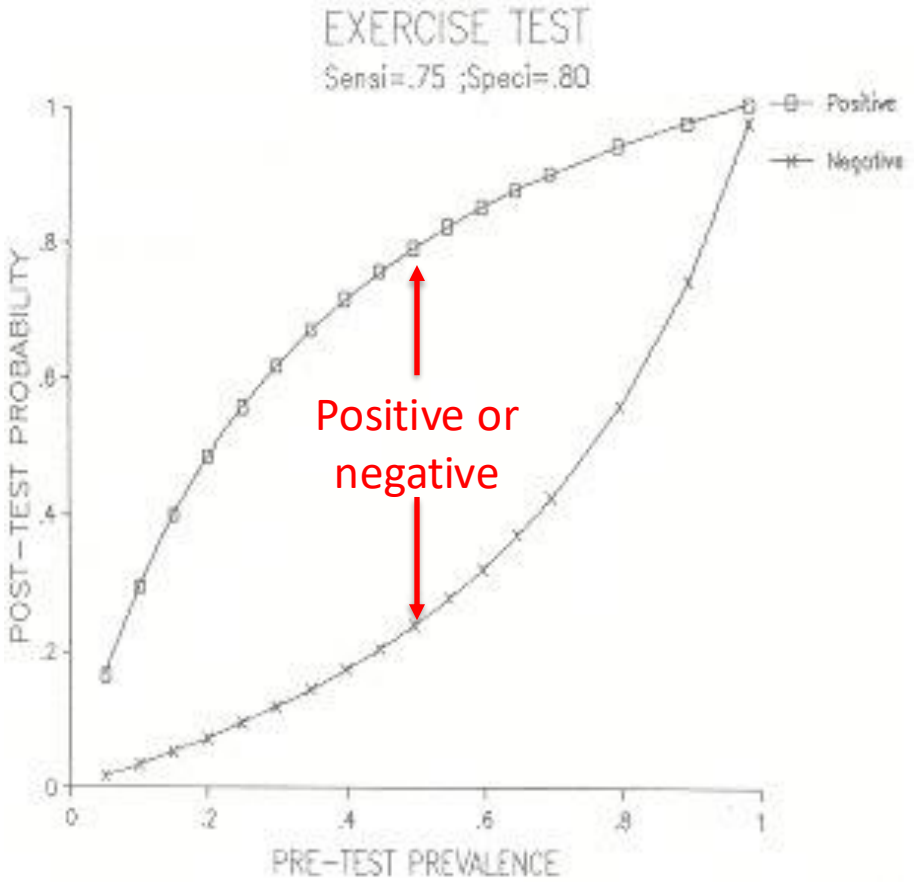
"Mmmbop" hits #1 on Billboard Hot 100



"Titanic" is released

Donald Trump separates from 2nd wife Marla Maples

THE IMPORTANCE OF PICKING THE RIGHT PATIENT



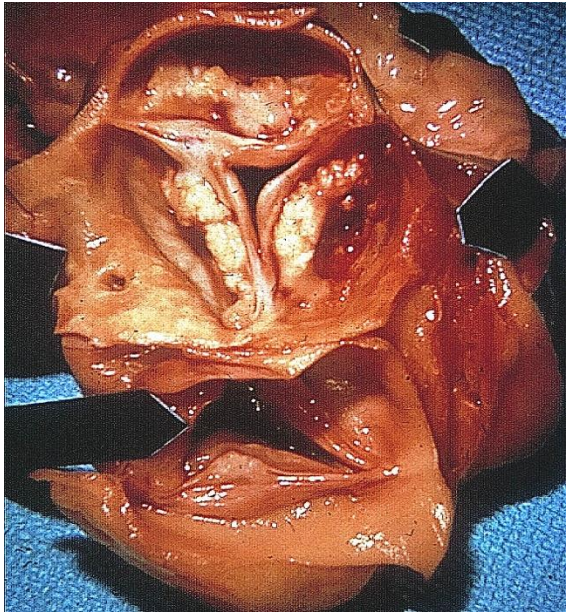
Baye's Theorem

NON CORONARY REASONS

Functional evaluation of patients with valvular heart disease

Evaluation of chronotropic competence

Evaluation of exercise induced arrhythmias



CONTRAINDICATIONS TO STRESS TESTING

- ACUTE MI WITHIN 48 HOURS
- UNSTABLE ANGINA NOT YET STABILIZED
- UNCONTROLLED ARRHYTHMIAS WITH HEMODYNAMIC COMPROMISE
- SYMPTOMATIC SEVERE AORTIC STENOSIS
- AORTIC DISSECTION
- PULMONARY EMBOLISM
- ACUTE PERICARDITIS
- UNCONTROLLED HYPERTENSION (>220/110)

EST FOR STABLE CAD: CLASS I INDICATIONS

SYMPTOMATIC

STABLE

1. Suspected/known CAD as part of initial evaluation in patients at intermediate risk of CAD
2. Suspected/known CAD with change in clinical status

PRE OR POST HOSPITAL D/C FROM HOSPITAL

1. Pre D/C to facilitate activity level or evaluate medical therapy (submaximal) (4-6 days)
2. Early (14-21 days) or late (3-6 weeks) post D/C to facilitate activity level or evaluate medical therapy (sx limited)

EST FOR STABLE CAD: CLASS I INDICATIONS

ASYMPTOMATIC

ARE THERE ANY INDICATIONS FOR STRESS TESTING IN ASYMPTOMATIC PTS?

Class IIa

1.Evaluation of asymptomatic patients with diabetes prior to initiating vigorous exercise

Class IIb

1. Evaluation of patients with multiple risk factors
2. Evaluation of men >45 or women >55 years of age who are:
    i. are at high risk for CAD
    ii. those who plan to start vigourous exercise
    iii. those who are in jobs in whom impairment may impact public safety

How sensitive and specific is exercise stress testing at detecting flow limiting (>70%) coronary artery disease?

No more than 70% sensitive nor specific!!!

PHYSIOLOGY OF EXERCISE STRESS TESTING

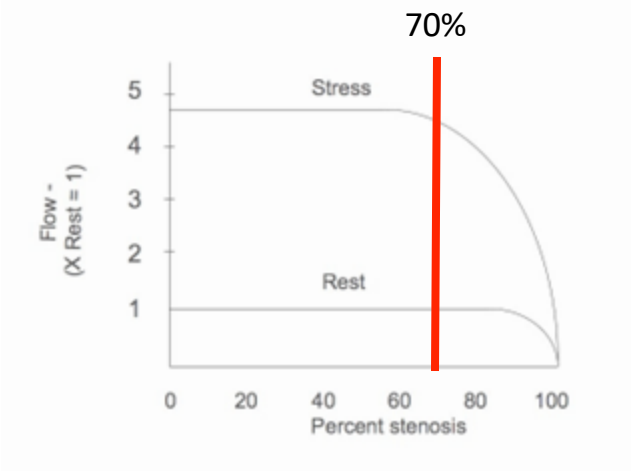
FUNCTIONAL DETECTION OF OBSTRUCTIVE CAD: STRESS TESTING

SUPPLY

Coronary blood flow
mL/min

DEMAND

Myocardial Oxygen Demand (MVO_2)



~~1. Preload~~ K
~~2. Contractility~~ K
3. Afterload
4. HR

Max SBP x MAX HR = "DOUBLE PRODUCT"

ALTERNATE REPRESENTATION OF MAXIMAL WORK

Metabolic
Equivalent
Threshold

1 MET = 3.5 02 /kg/min of activity

LIGHT	METS
Walking (2 mph)	2.5
Golfing with a cart	2.5
Ballroom dancing	2.9
MODERATE	
Walking (3 mph)	3.3
Golfing without a cart	4.4
Slow swimming	4.5
HEAVY	
Doubles tennis	5
Downhill skiing	6.8
Jogging (10 minute mile)	10.2

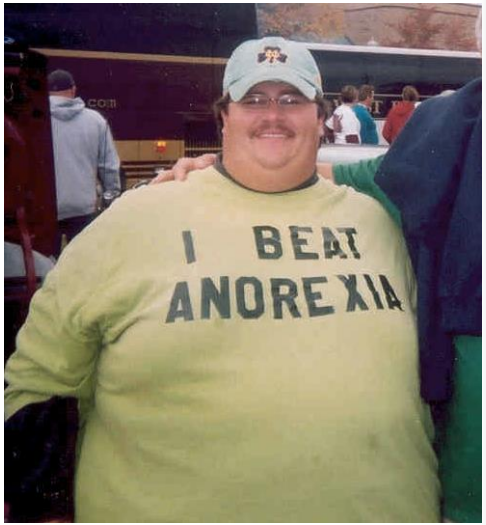
of METS AT PEAK EXERCISE ~ $V0_{2\ MAX}$

CONTRIBUTING FACTORS TO $VO_{2\ MAX}$

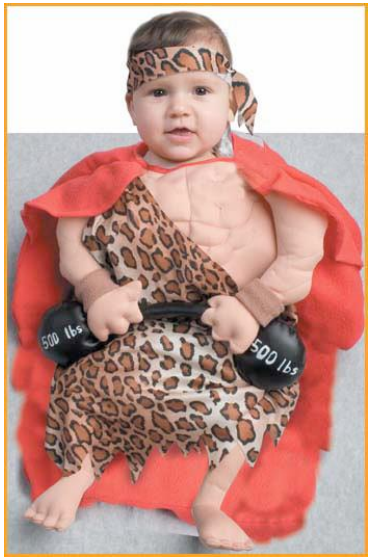
$VO_{2\ MAX}$= >80 mL/kg/min

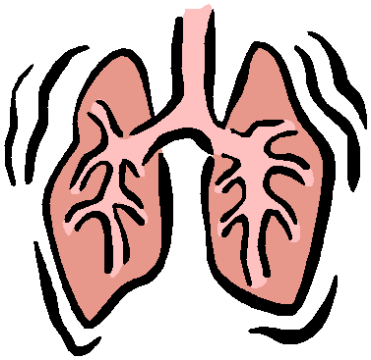
Reigning UCI Road race champion
Reigning Tour de France and Giro d'Italia winner

$VO_{2\ MAX}$= something less

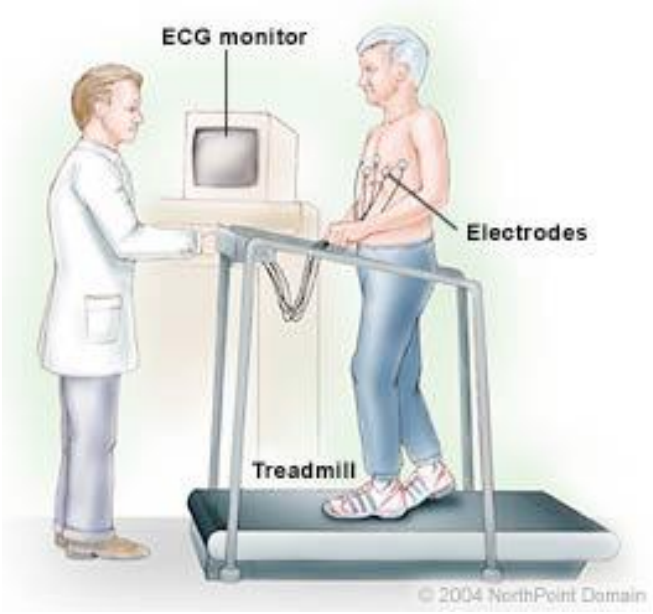


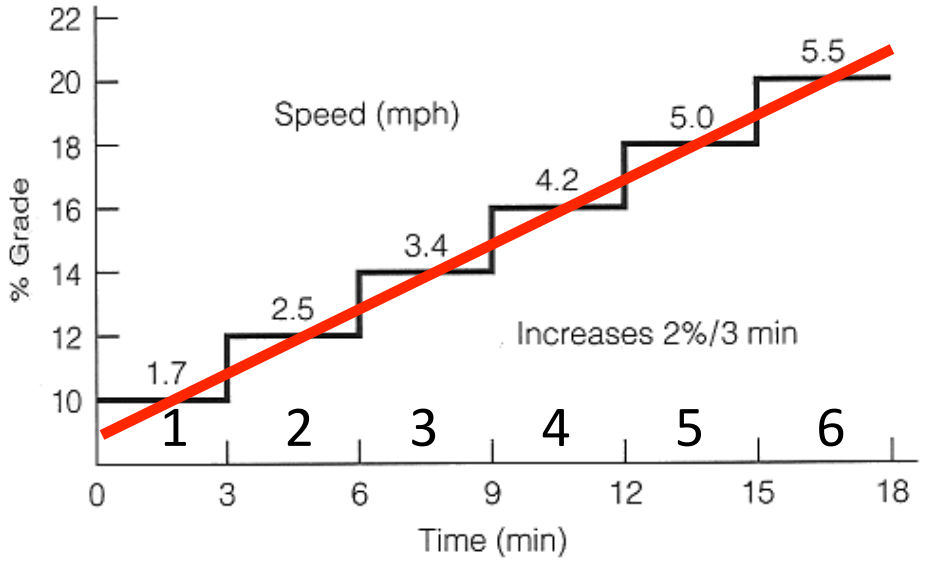
Likes his bacon extra crispy





HOW CAN WE QUANTIFY MVO_2 ON A TREADMILL?

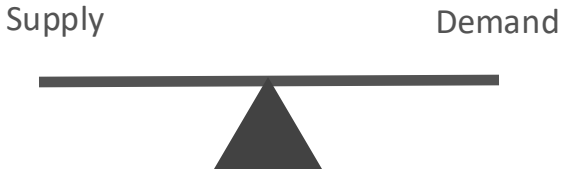




1 minute on the Bruce Protocol ~ 1.3 METs

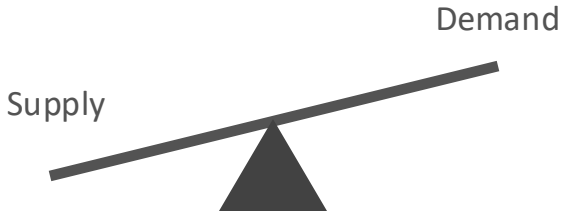
AT ANY POINT IN TIME DURING EXERCISE UNTIL $VO_{2\ MAX}$

No Ischemia



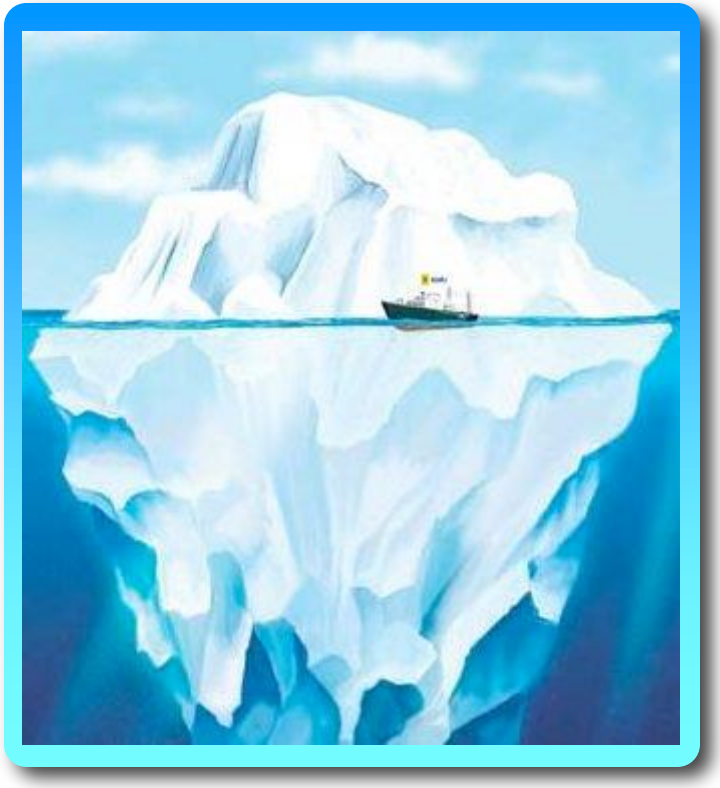
Cardiac ischemia is not limiting $VO_{2\ MAX}$

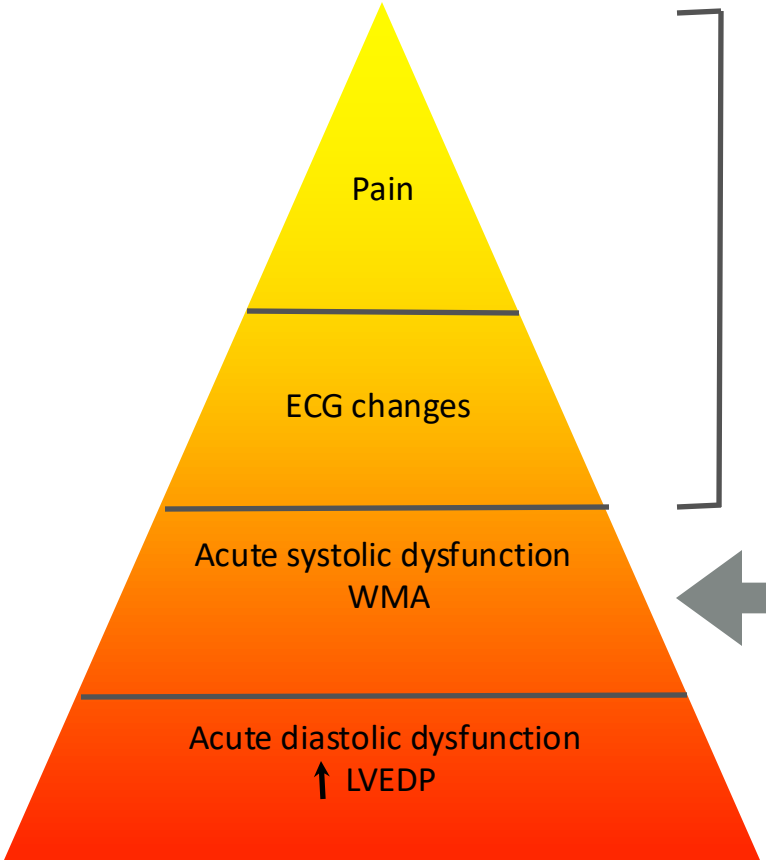
Ischemia



Cardiac ischemia is demonstrated and may be limiting $VO_{2\ MAX}$

IF PRESENT, HOW CAN WE SEE ISCHEMIA?





Reporting a stress test: Practical aspects

Two things you can comment on

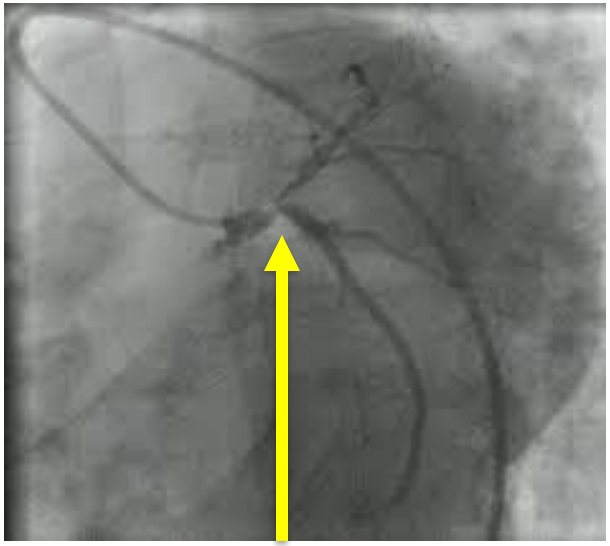
PRESENCE OF CHEST PAIN

CLINICALLY POSITIVE

PRESENCE OF ECG CHANGES

ELECTRICALLY POSITIVE

Mr. and Mrs. Smith….



99% LEFT MAIN

Exercises 30 seconds
HR goes from 50 to 55 BPM
BP goes from 100 to 110mmHg

NO CHEST PAIN
NO ST SHIFT

Exercises 30 seconds
HR goes from 50 to 55 BPM
BP goes from 100 to 110mmHg

10/10 CHEST PAIN
10mm ST DEPRESSION

BOTH DID THE SAME AMOUNT OF EXCEPTION

POS OR NEG STRESS TEST?

POS OR NEG STRESS TEST?

REPORTING A STRESS TEST

POSITIVE	NEGATIVE	INDETERMINATE
Chest pain ***OR*** ECG changes *at any heart rate*	**No** chest pain ***AND*** **No** ECG changes *at an adequate heart rate*	Everything else (non evaluable ECG or inadequate peak HR)

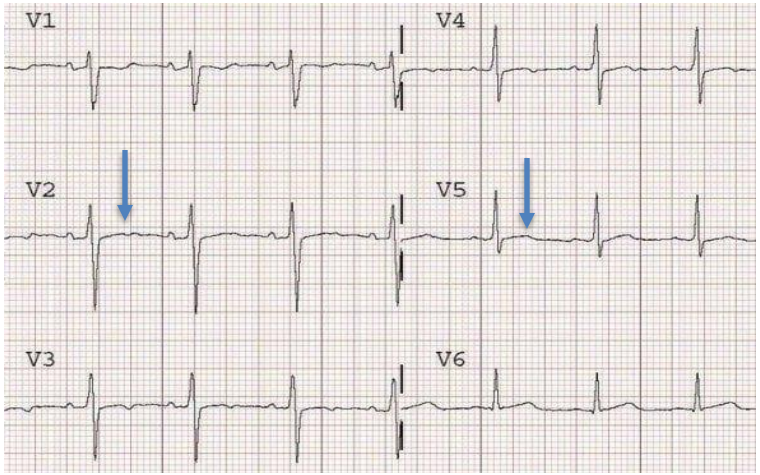
“Adequate" HR

(220 - age) x 0.85

(Defines the sympathetic state needed to bring out a flow limiting lesion if one is in fact present)

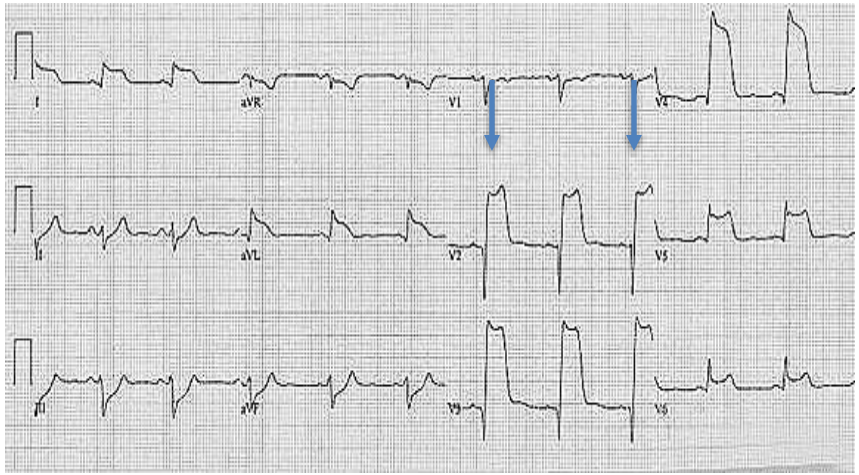
What is meant by ”ECG changes”

DEFINITION 1



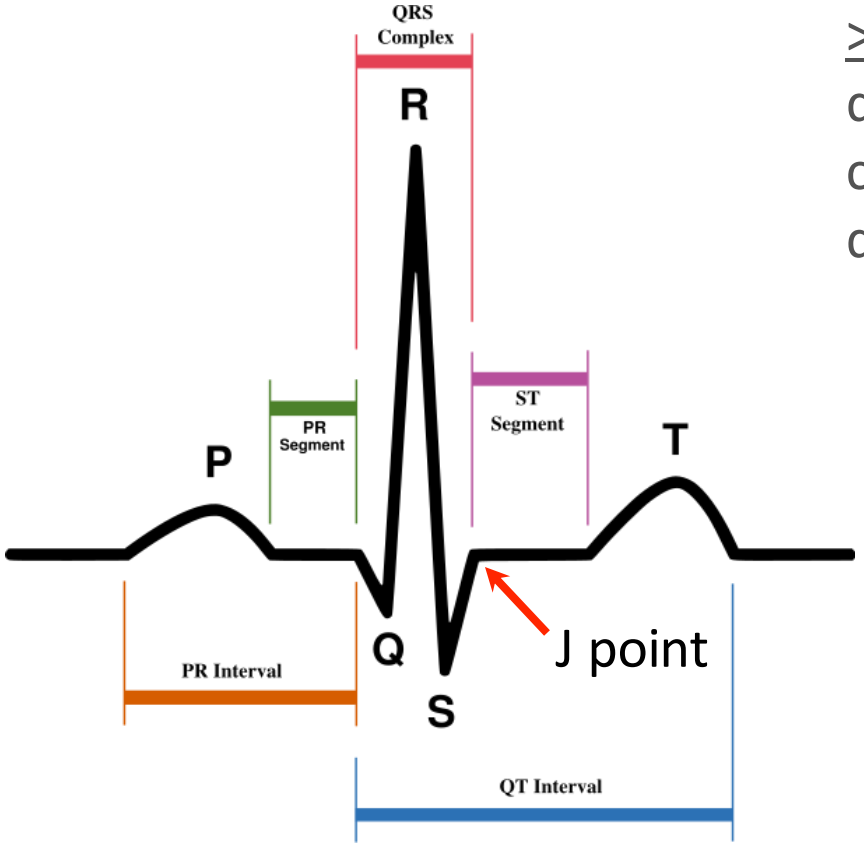
SENSITIVITY?
SPECIFICITY?

DEFINITION 2

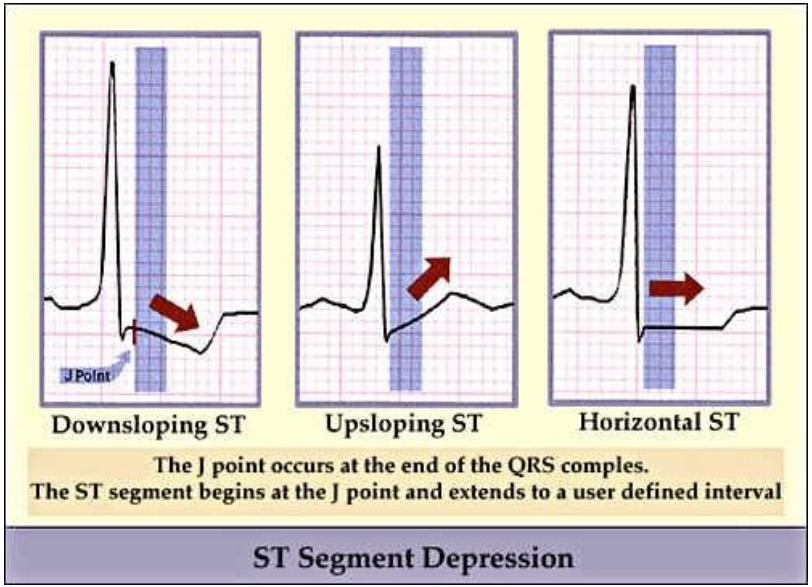


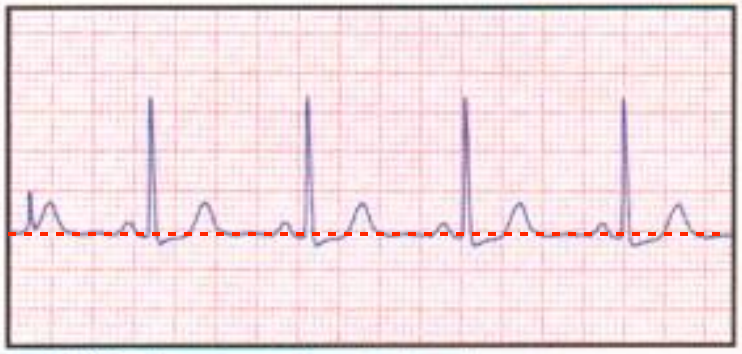
SENSITIVITY?
SPECIFICITY?

HOW TO REPORT THE ELECTRICAL PORTION OF THE STRESS TEST

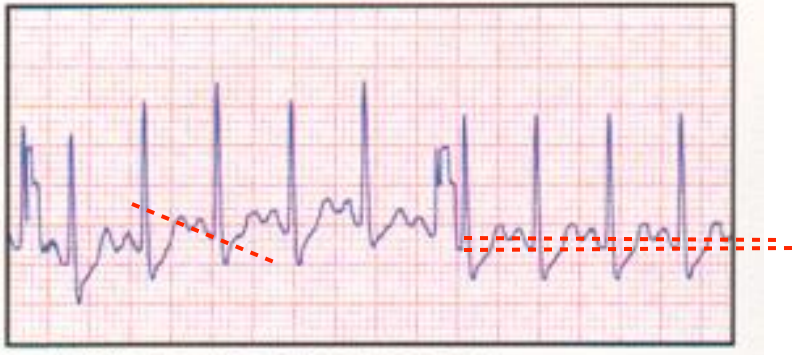


≥ 1mm horizontal or downsloping ST depression 80msec after the J point in ≥ 2 contiguous leads relative to a baseline defined as the PR-PR or TP-TP segment





An ECG showing a heart at rest.



An ECG showing a heart beating faster during exercise.

Is this a positive stress test?

PR - PR

THIS SHOULD BE INTERPRETED AS A NEGATIVE STRESS TEST

3mm
ST depression

1mm
ST depression

No
ST depression

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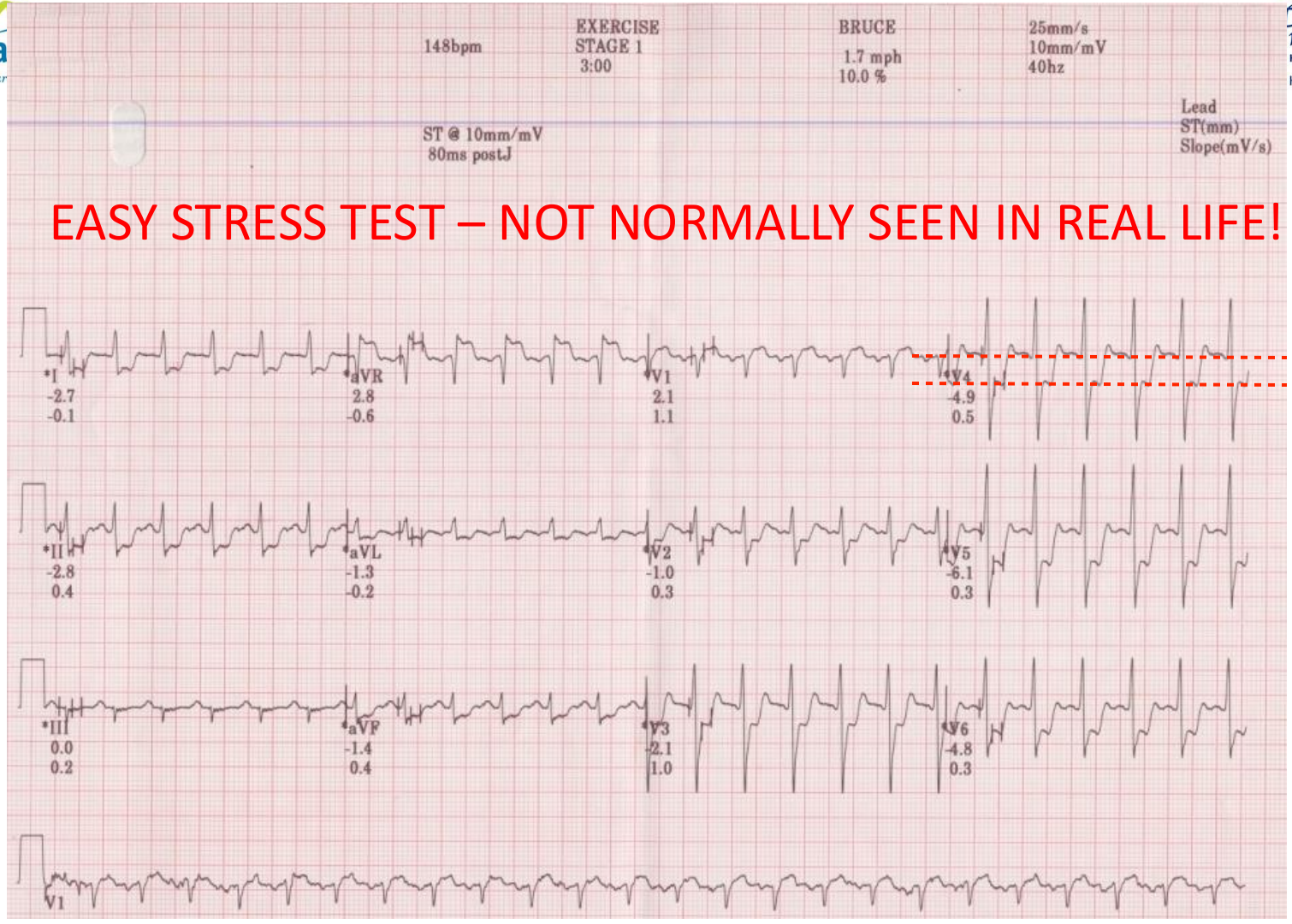
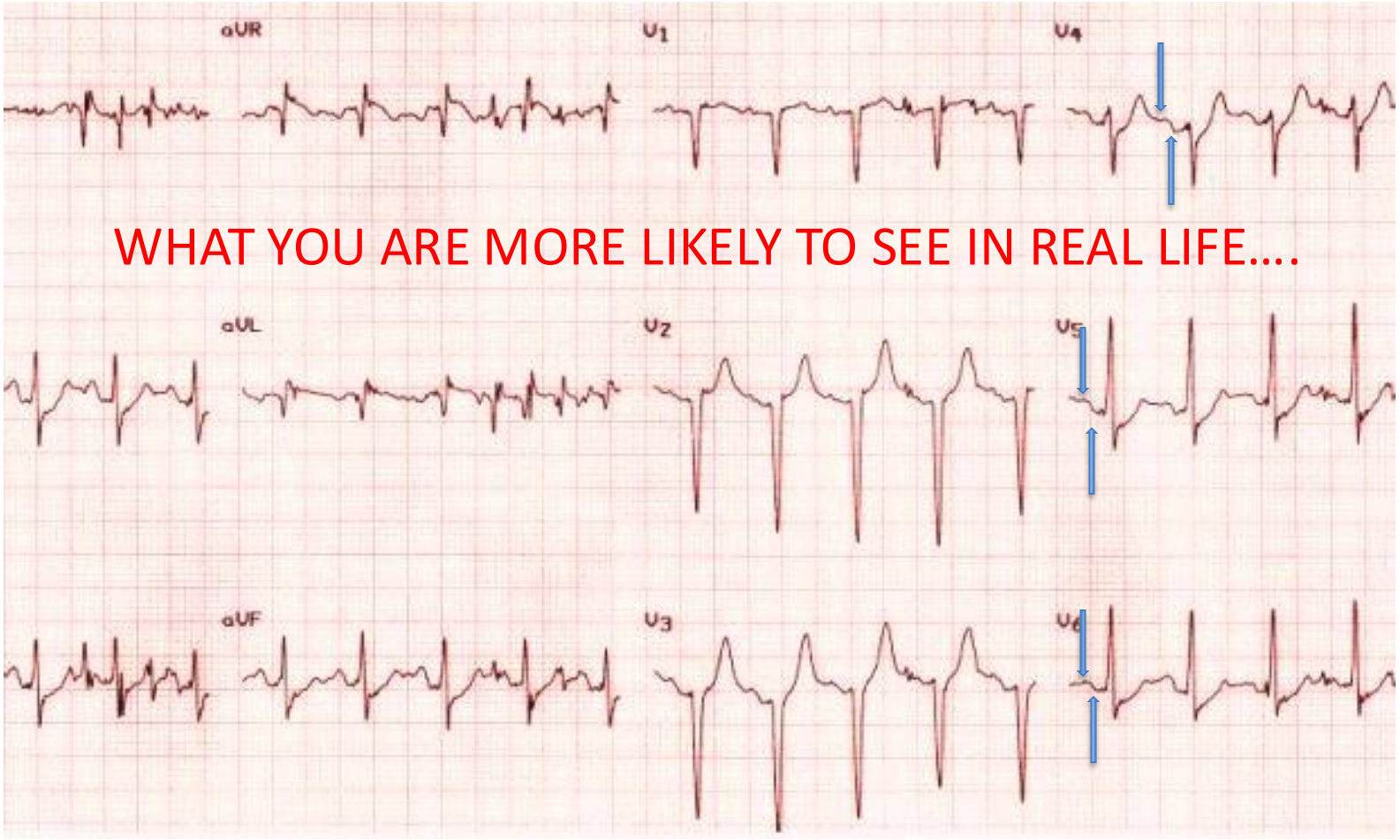



aVR
V1
V4
WHAT YOU ARE MORE LIKELY TO SEE IN REAL LIFE….
aVL
V2
V5
aVF
V3
V6

Sooooo.....

Are all "positive stress tests" the same in terms of risk? Should you treat all patients with abnormal (positive) treadmill exams the same way?

We Return with Mr. and Mrs. Smith….

Exercises 3 min

2mm ST SHIFT

DEVELOPS CLASSIC ANGINA

(BUT COULD KEEP GOING)

Exercises 18 min

2mm ST SHIFT

DEVELOPS CLASSIC ANGINA

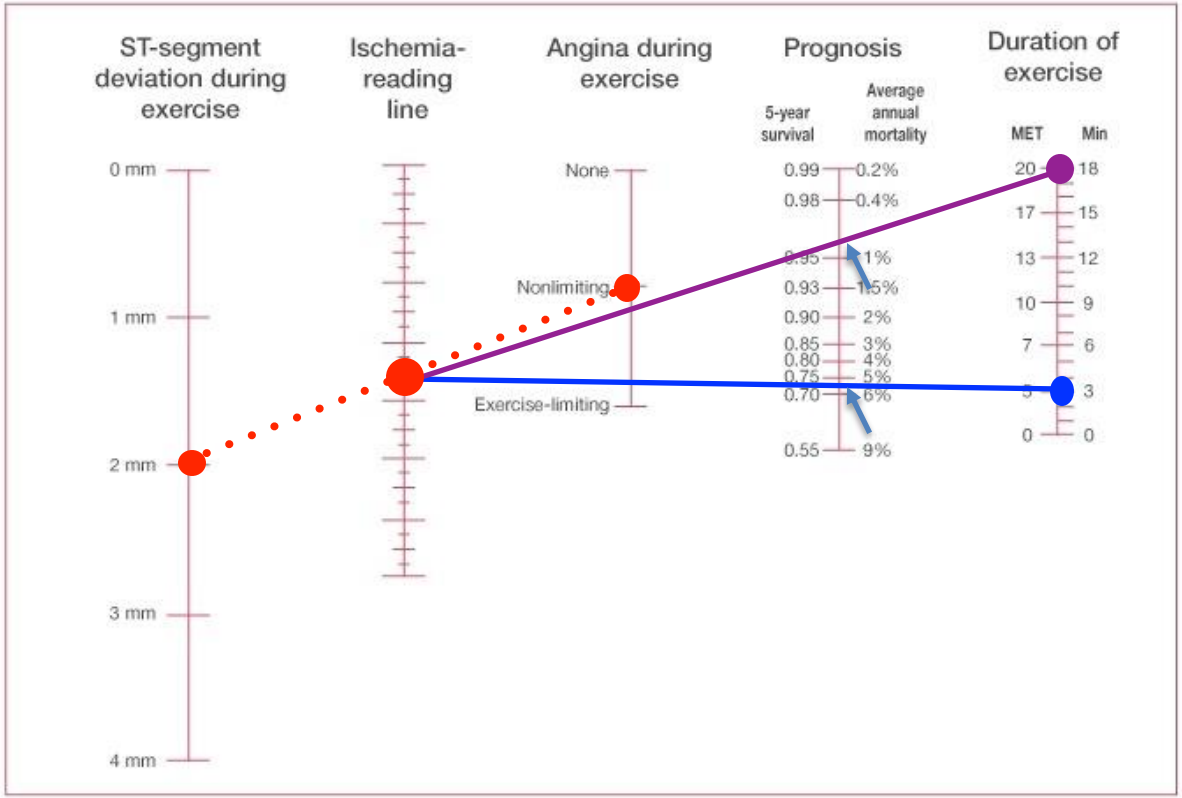
(BUT COULD KEEP GOING)

BOTH HAD THE EXACT SAME ISCHEMIC RESPONSE

POSITIVE STRESS TEST? **POSITIVE STRESS TEST?**

WHO ARE YOU WORRIED ABOUT MORE?

THE DUKE TREADMILL SCORE:
WHY TIME ON TREADMILL IS A PROGNOSTIC FACTOR



<1% annual mortality

5X difference in mortality, only difference is exercise time!!

~5% annual mortality

Low risk: <1% mortality
Moderate risk: 1-3% mortality
High risk: >3% mortality

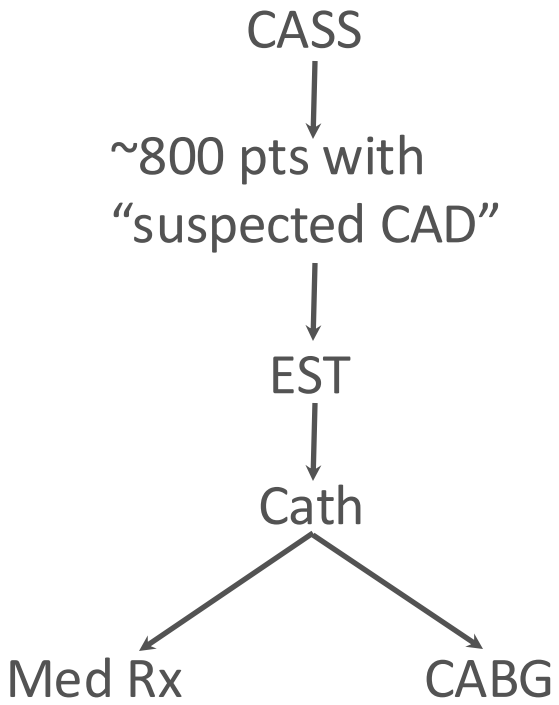
CALCULATION OF THE DTS

DTS= (EXERCISE TIME [MIN]) - 5 x (MAX ST-SEGMENT DEPRESSION) - 4 x (TREADMILL ANGINA INDEX)*

> 5	Low risk
-10 to 4	Intermediate risk
≤ -10	High risk

* 0=No angina
1=Nonlimiting angina
2=Limiting angina

WHO SHOULD YOU CATH BASED ON THE STRESS TEST RESULTS? (PRE **ISCHEMIA** TRIAL)



1. Left main >50%*
2. 3VD ± LV dysfunction
3. 2VD with prox LAD

1. Inability to get out of Stage I without ischemia
2. Failure to raise BP >10mmHg with exercise
3. >5mm ST depression
4. Widespread ST depression
5. ST elevation
6. ST depression >5min into recovery

Able to achieve ≥ Stage 2 (7 METs):
Med Rx = Intervention

*excluded from main CASS and included in CASS Registry

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Faculty of Medicine

Providence HEALTH CARE
How you want to be treated.

WHO SHOULD YOU CATH BASED ON THE STRESS TEST RESULTS (POST **ISCHEMIA** TRIAL)?

Clinical and Stress Test Eligibility Criteria

Inclusion Criteria

Age ≥21 years

Moderate or severe ischemia*

- Nuclear ≥10% LV ischemia (summed difference score ≥7)
- Echo ≥3 segments stress-induced moderate or severe hypokinesis, or akinesis
- CMR
  - Perfusion: ≥12% myocardium ischemic, and/or
  - Wall motion: ≥3/16 segments with stress-induced severe hypokinesis or akinesis
- Exercise Tolerance Testing (ETT) ≥1.5mm ST depression in ≥2 leads or ≥2mm ST depression in single lead at <7 METS, with angina

Major Exclusion Criteria

- NYHA Class III-IV HF
- Unacceptable angina despite medical therapy
- EF < 35%
- ACS within 2 months
- PCI or CABG within 1 year
- eGFR <30 mL/min or on dialysis

CCTA Eligibility Criteria

Inclusion Criteria

- ≥50% stenosis in a major epicardial vessel (stress imaging participants)
- ≥70% stenosis in a proximal or mid vessel (ETT participants)

Major Exclusion Criteria

- ≥50% stenosis in unprotected left main

ISCHEMIA trial Eligibility Criteria

**Ischemia eligibility determined by sites. All stress tests interpreted at core labs.*

Who should you cath based on the stress test results (post **ISCHEMIA** trial)?

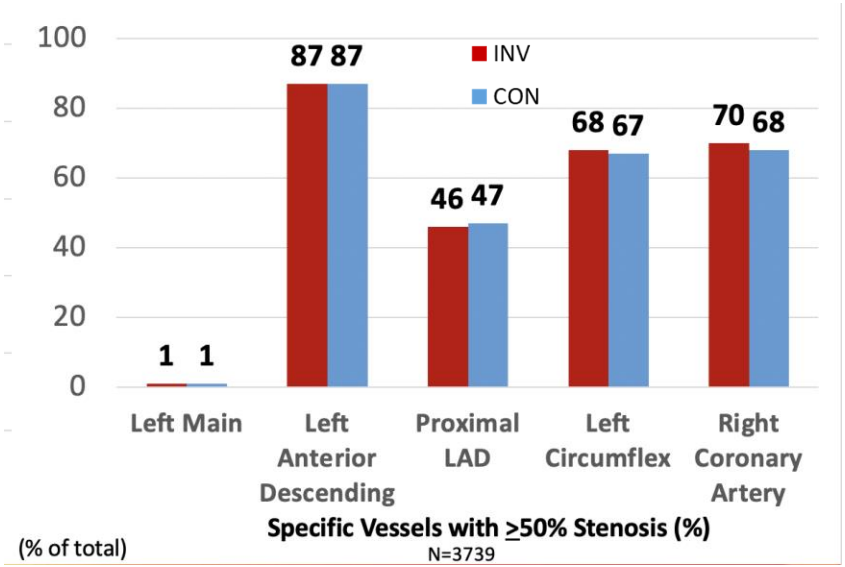
Screen Failure (3339)

Major Reasons:

- Insufficient ischemia (N = 1350)
- No obstructive CAD (N = 1218)
- Unprotected LMD (N =434)

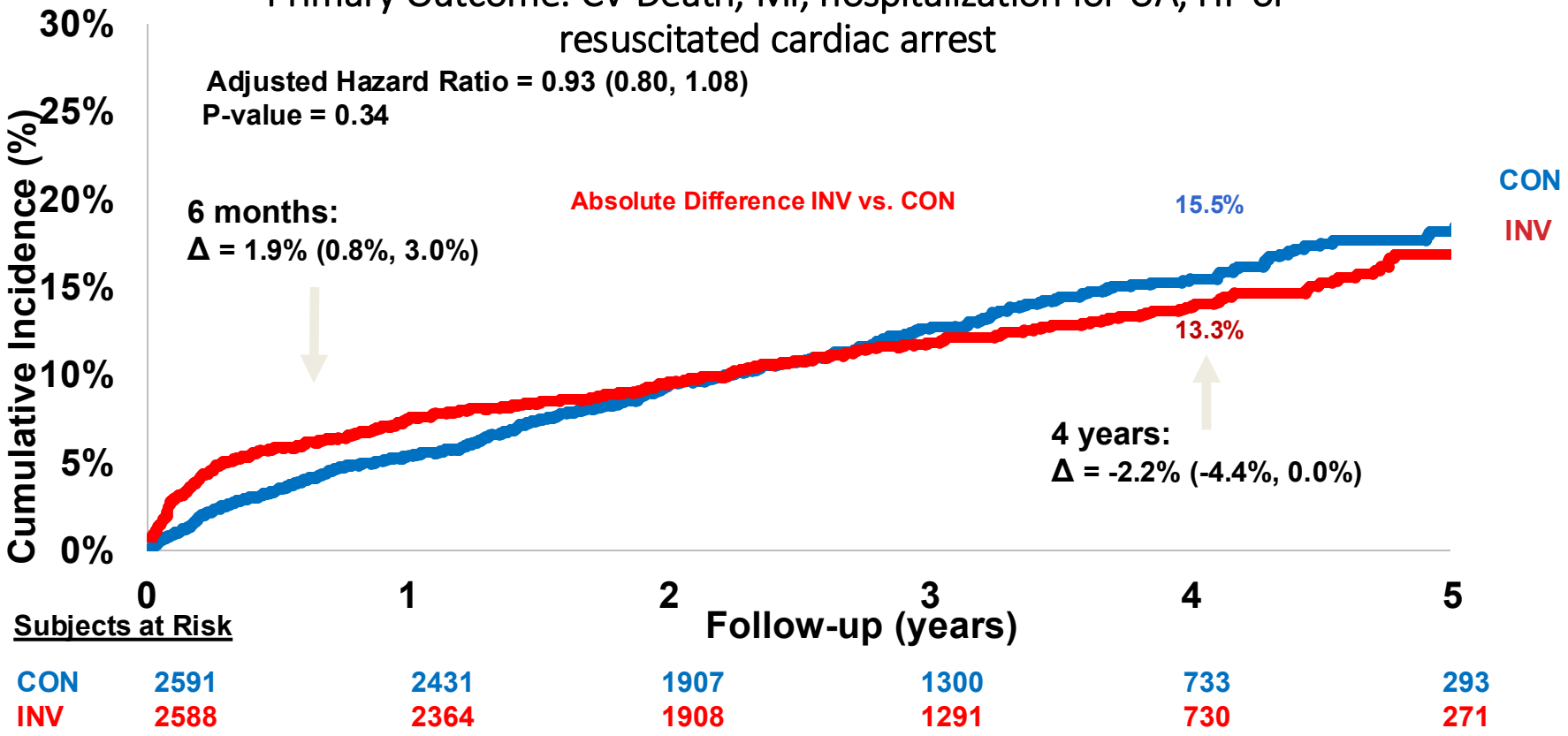
14% nonobstructive CAD

Only 2% Left main >50%



Maron et al. NEJM 2020; 382: 1395-1407

Primary Outcome: CV Death, MI, hospitalization for UA, HF or resuscitated cardiac arrest

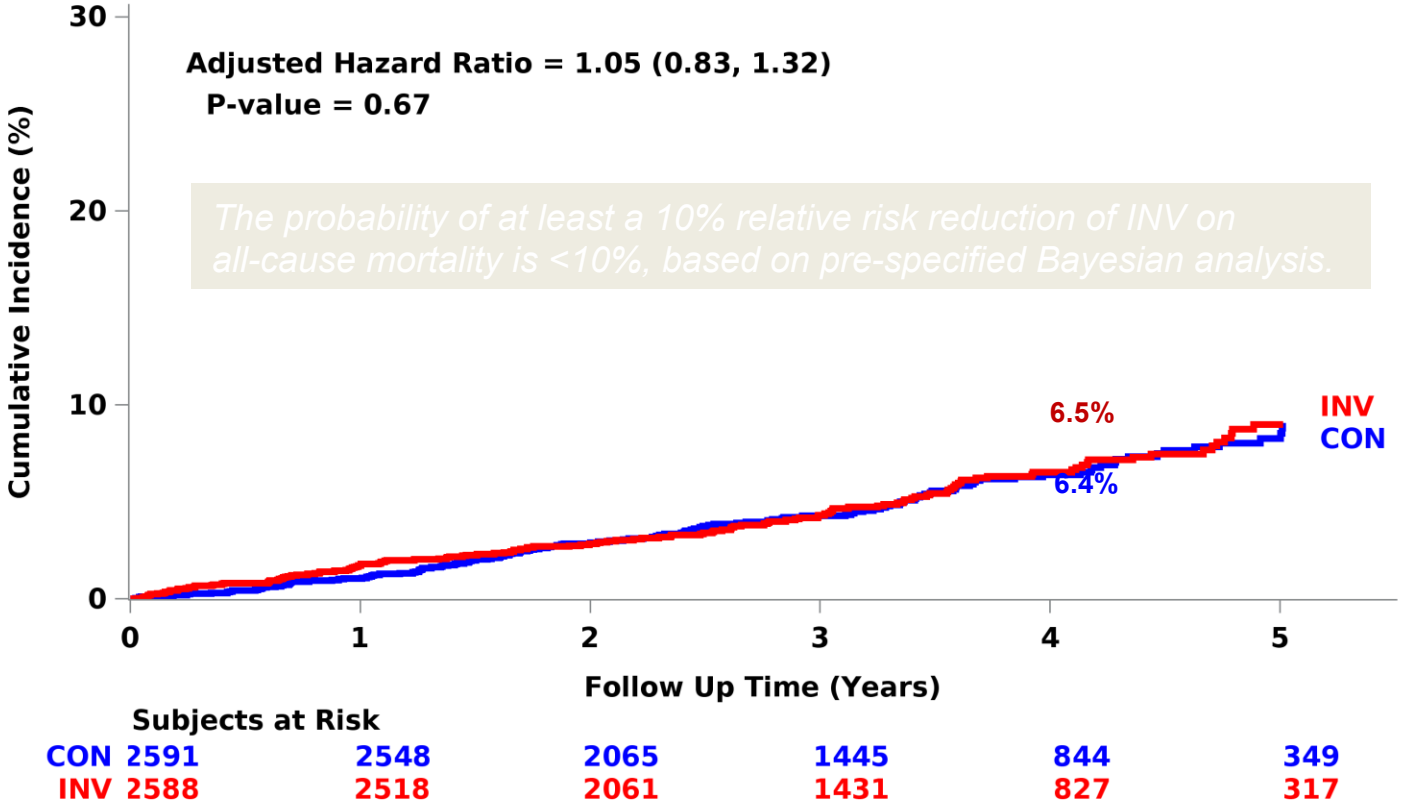


Subjects at Risk

CON	2591	2431	1907	1300	733	293
INV	2588	2364	1908	1291	730	271

Maron et al. NEJM 2020; 382: 1395-1407

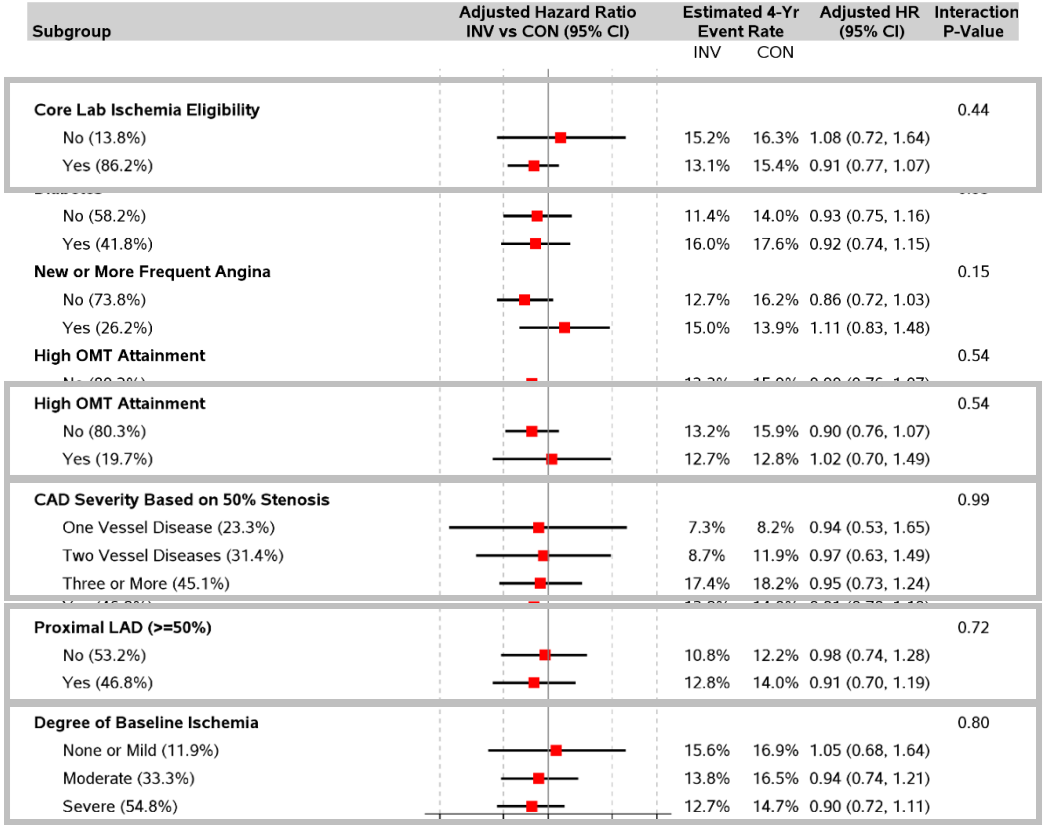
All-Cause Death



Maron et al. NEJM 2020; 382: 1395-1407

Primary endpoint: Pre-specified Important Subgroups

There was no heterogeneity of treatment effect



Subgroup	Adjusted Hazard Ratio INV vs CON (95% CI)	Estimated 4-Yr Event Rate INV	Estimated 4-Yr Event Rate CON	Adjusted HR (95% CI)	Interaction P-Value
Core Lab Ischemia Eligibility					0.44
No (13.8%)		15.2%	16.3%	1.08 (0.72, 1.64)	
Yes (86.2%)		13.1%	15.4%	0.91 (0.77, 1.07)	
No (58.2%)		11.4%	14.0%	0.93 (0.75, 1.16)	
Yes (41.8%)		16.0%	17.6%	0.92 (0.74, 1.15)	
New or More Frequent Angina					0.15
No (73.8%)		12.7%	16.2%	0.86 (0.72, 1.03)	
Yes (26.2%)		15.0%	13.9%	1.11 (0.83, 1.48)	
High OMT Attainment					0.54
High OMT Attainment					0.54
No (80.3%)		13.2%	15.9%	0.90 (0.76, 1.07)	
Yes (19.7%)		12.7%	12.8%	1.02 (0.70, 1.49)	
CAD Severity Based on 50% Stenosis					0.99
One Vessel Disease (23.3%)		7.3%	8.2%	0.94 (0.53, 1.65)	
Two Vessel Diseases (31.4%)		8.7%	11.9%	0.97 (0.63, 1.49)	
Three or More (45.1%)		17.4%	18.2%	0.95 (0.73, 1.24)	
Proximal LAD (>=50%)					0.72
No (53.2%)		10.8%	12.2%	0.98 (0.74, 1.28)	
Yes (46.8%)		12.8%	14.0%	0.91 (0.70, 1.19)	
Degree of Baseline Ischemia					0.80
None or Mild (11.9%)		15.6%	16.9%	1.05 (0.68, 1.64)	
Moderate (33.3%)		13.8%	16.5%	0.94 (0.74, 1.21)	
Severe (54.8%)		12.7%	14.7%	0.90 (0.72, 1.11)	

N=2982 for # diseased vessels

N=3739 for Prox LAD Y/N

Maron et al. NEJM 2020; 382: 1395-1407

WHO SHOULD YOU CATH BASED ON THE STRESS TEST RESULTS (POST **ISCHEMIA** TRIAL)?

Answer

We don't really know anymore……

WHEN IS A REGULAR STRESS TEST NOT APPROPRIATE OR USEFUL?

Uninterpretable electrocardiogram (LBBB, paced rhythm)
Patient unable/unwilling to exercise to THR
High likelihood of a false positive test (women, abnormal baseline EST)

REASONS FOR A FALSE POSITIVE STRESS TEST:

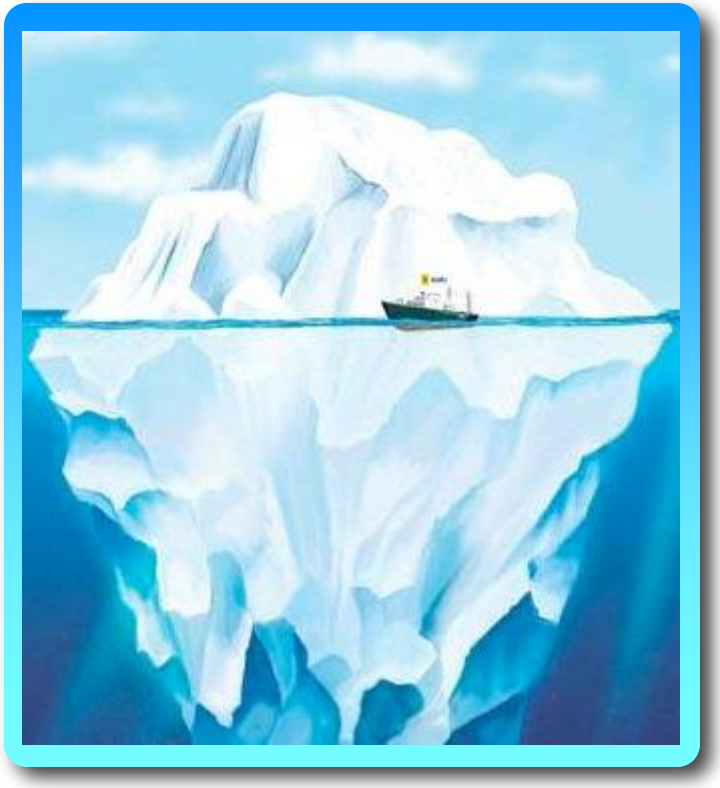
HYPERTENSION
AORTIC STENOSIS
DIGOXIN
HYPOKALEMIA
HYPOXEMIA

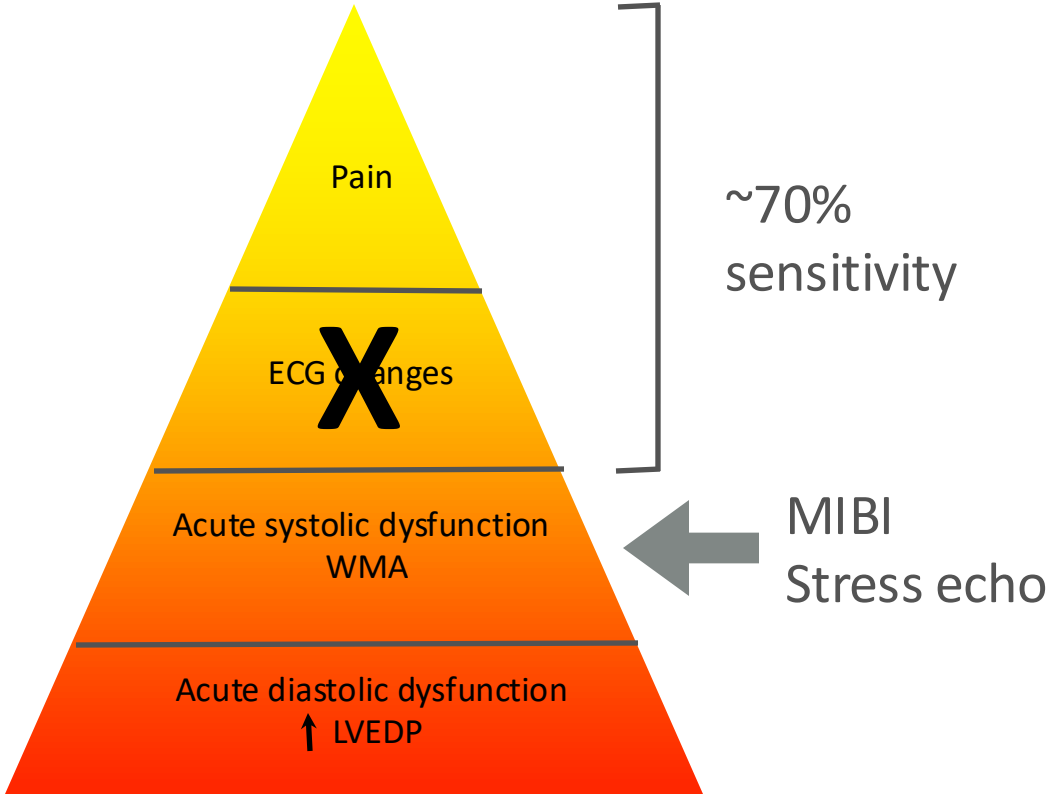
LVH
ANEMIA
CARDIOMYOPATHY
MITRAL VALVE PROLAPSE
ACUTE GLUCOSE LOAD

HYPERVENTILATION
IVCD
WPW
SVT
SEVERE LV VOLUME OVERLOAD

WRITTEN IN RED: Pretty common reasons

REMEMBER THE THINGS THAT WE CAN MEASURE ON A FUNCTIONAL/NONINVASIVE TEST





CHOICES FOR WHEN AN EST WON'T HELP YOU

STRESS PROTOCOL

EXERCISE
PHARMACOLOGICAL
- -DOBUTAMINE
- -ADENOSINE
- -PERSANTINE

+

IMAGING TECHNIQUE

MIBI
ECHO

NO PHARMACOLOGICAL AGENT IS A PERFECT SURROGATE FOR EXERCISE!

Dobutamine: increases HR and contractility but decreases afterload and preload
Adenosine and persantine merely causes vasodilation (decreased afterload and preload) and has no effect on HR or contractility

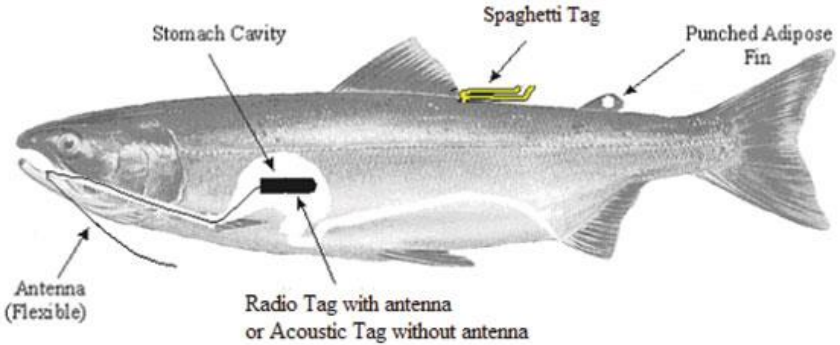
Sensitivity and specificity of stress perfusion imaging and stress echo

TEST	SENSITIVITY	SPECIFICITY
EXERCISE MIBI (^{99}TC)	73-92%	63-87%
PERSANTINE MIBI (^{99}TC)	90%	75-87%
STRESS ECHO (DOBUTAMINE)	80-85%	80-88%
STRESS ECHO (EXERCISE)	80-85%	80-86%

GENERALLY SPEAKING, MIBI IS MORE SENSITIVE, ECHO IS MORE SPECIFIC

Nuclear Imaging

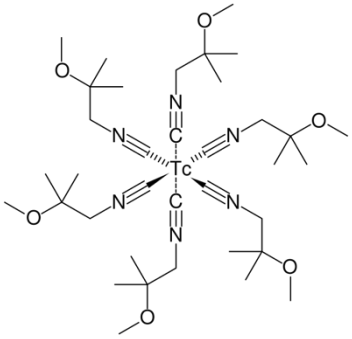
Fisheries and Oceans Canada



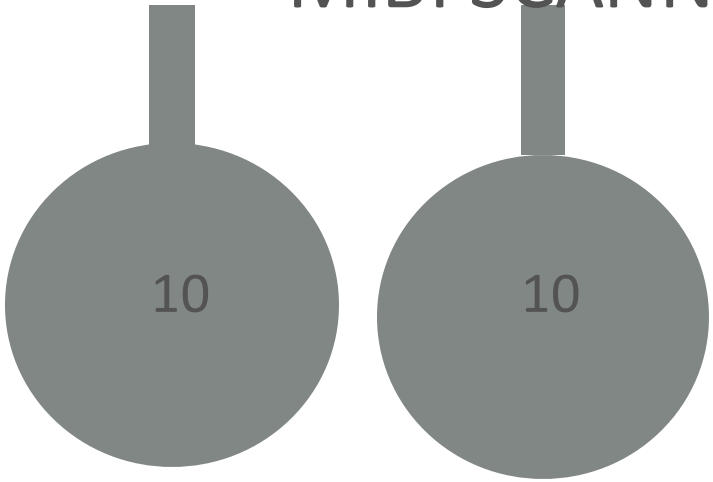
Lotsa salmon…
Lotsa beeps…

Not a lot of salmon…
Not a lot of beeps…

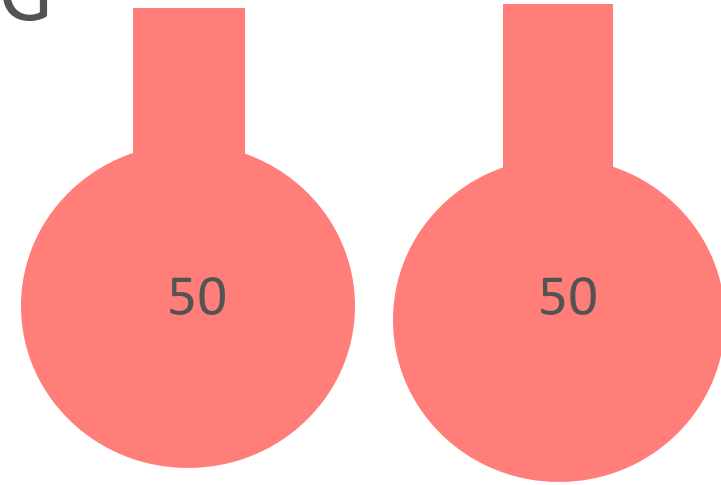
MIBI SCANNING



^{99}Tc MIBI



Anterior wall Inferior wall

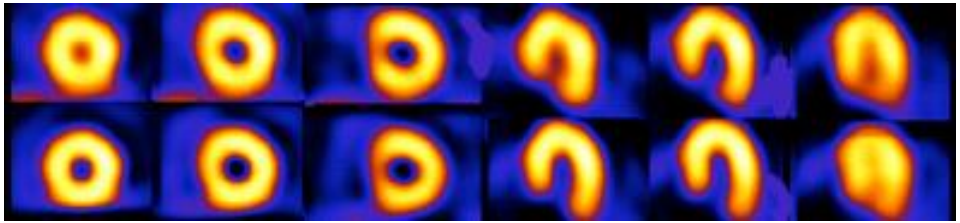


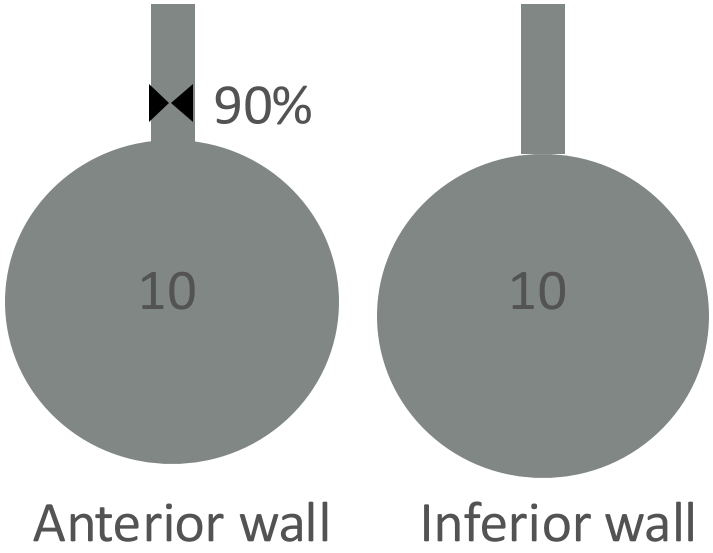
Anterior wall Inferior wall

REST STRESS

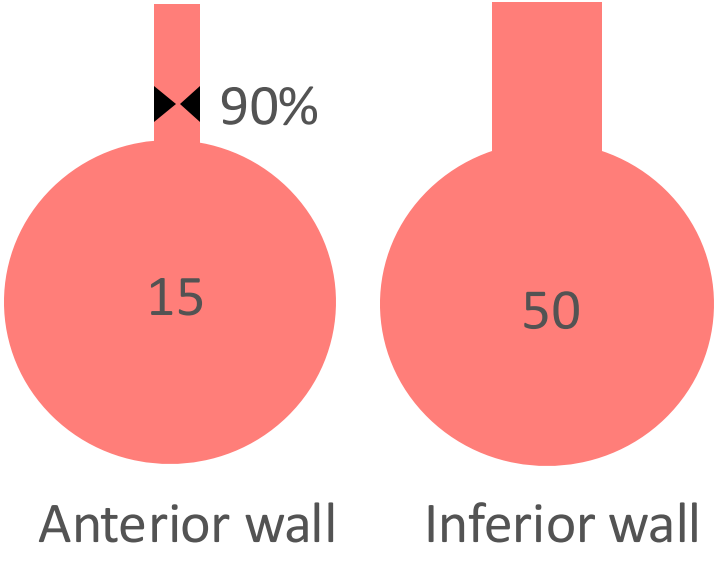
Stress

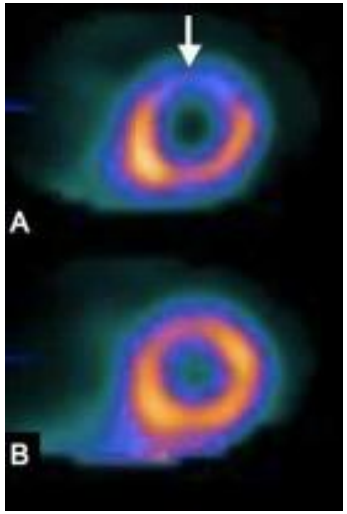
Rest




90%
10
10
Anterior wall
Inferior wall

REST


90%
15
50
Anterior wall
Inferior wall


A
B

STRESS

What is considered a ”high risk” MIBI?

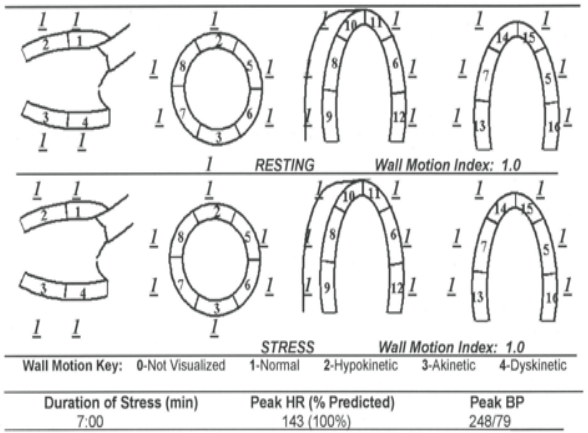
- Large (>10%) of LV myocardium is ischemic
- Transient ischemic dilation (TID) of LV
- Multiple perfusion abnormalities (MVD)

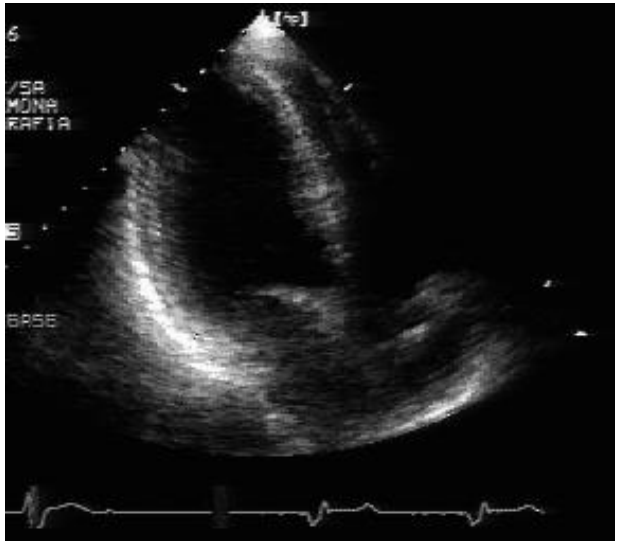
STRESS ECHO: INDICATIONS

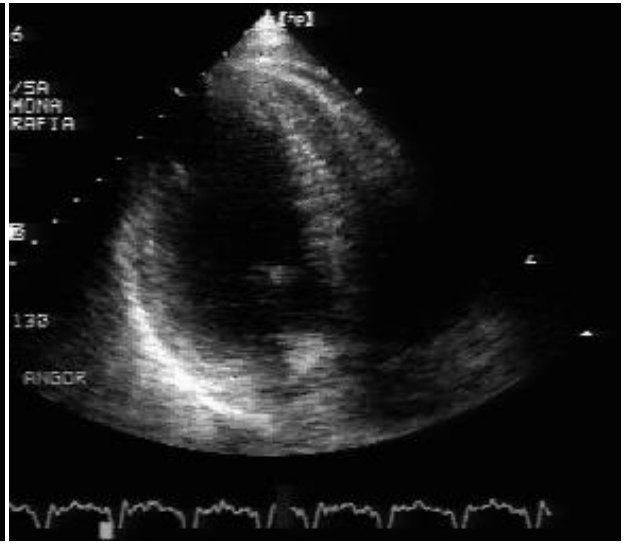
http://content.onlinejacc.org/cgi/reprint/51/11/1127.pdf

46 indications!
All ranked by appropriateness from 1-9

STRESS ECHO







BASELINE STRESS

Protocol: Exercise or dobutamine if unable to exercise

increasing dobutamine to 60 ug/kg to achieve THR

may need atropine if maxed out on dobutamine

What is considered a ”high risk” stress echo?

- Exercise induced LV dysfunction/drop in EF
- Large amount of ischemic myocardium (>3/16 segments)
- Exercise induced hypotension

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Cardiac CT Angiography

ELSEVIER

Contents lists available at ScienceDirect

Journal of Cardiovascular Computed Tomography

journal homepage: www.JournalofCardiovascularCT.com

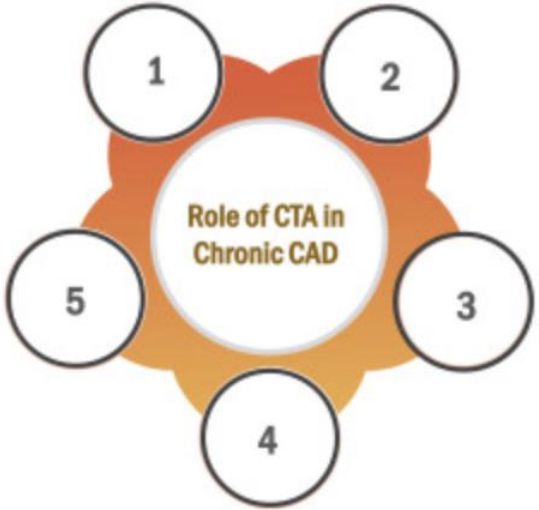
Guidelines

SCCT 2021 Expert Consensus Document on Coronary Computed Tomographic Angiography: A Report of the Society of Cardiovascular Computed Tomography

Jagat Narula [a, 1], Y. Chandrashekhar [b, 1], Amir Ahmadi [a], Suhny Abbara [c], Daniel S. Berman [d], Ron Blankstein [e], Jonathon Leipsic [f], David Newby [g], Edward D. Nicol [h], Koen Nieman [i], Leslee Shaw [j], Todd C. Villines [k], Michelle Williams [g], Harvey S. Hecht [a, *, 1]

[a] Icahn School of Medicine at Mount Sinai, New York, NY, USA

First line test for evaluating patients with:
- No known CAD and Stable Typical or Atypical Chest Pain, or Anginal Equivalent



First line test for evaluating patients with:
- Coronary Anomalies
- Prior CABG, particularly if graft patency or location of LIMA is the primary objective

Reasonable test for evaluating patients with:
- Known CAD and Stable Typical or Atypical Chest Pain, or Angina Equivalent

Reasonable test for evaluating patients with:
- A non-conclusive functional test; to obtain more precision regarding diagnosis and prognosis

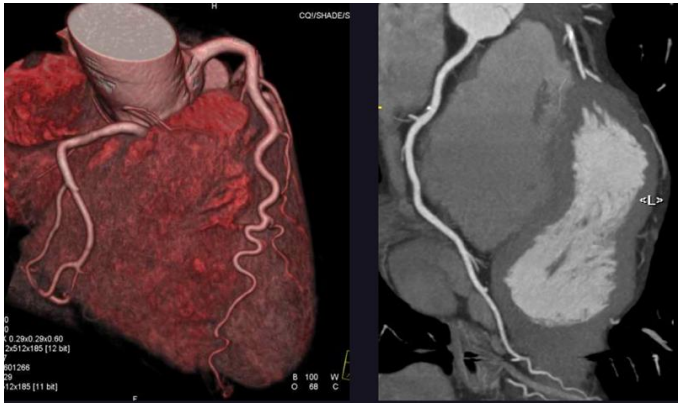
Reasonable test for evaluating patients with:
- Coronary Stents > 3.0 mm
- Proximal, Non Bifurcation thin strut Stents < 3.0 mm
- Prior to Non Cardiac Surgery in younger patients with low-intermediate probability of CAD
- Evaluating Coronary Anatomy in patients with suspected Dissection of the Aorta

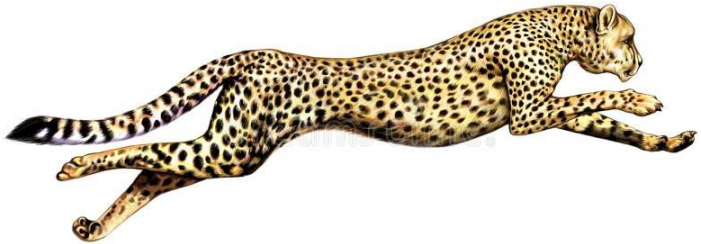
It is the best “rule out” diagnostic test that we have short of catheter based diagnostic angiography with excellent negative predictive value but relatively poor positive predictive value

Very useful if you have a potential false positive noninvasive test

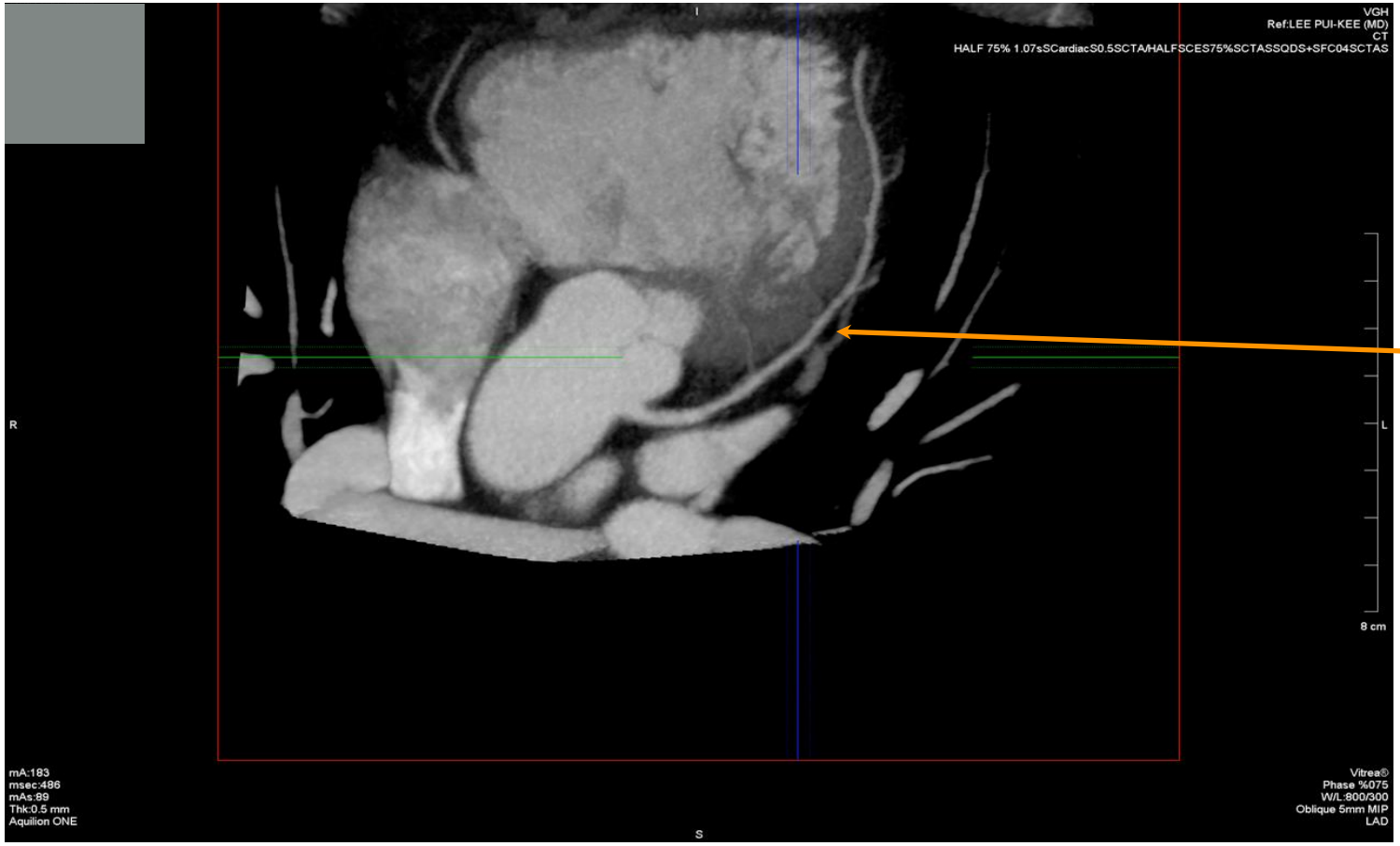
Not very useful if you have someone who has a high pretest likelihood of preexisting CAD (ie usually not done in pts age >75)

Nuts and bolts: Why we need to beta block pts for CCTA



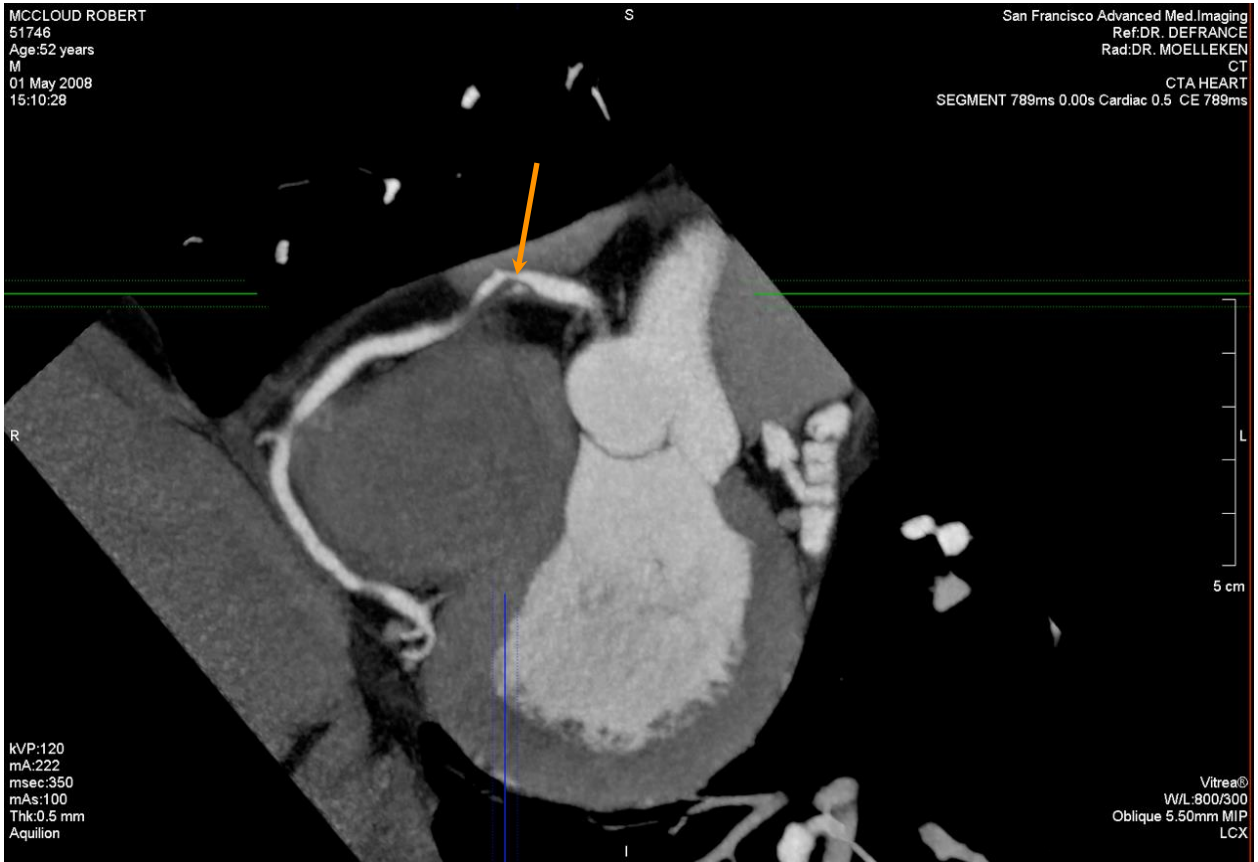


Normal CTA

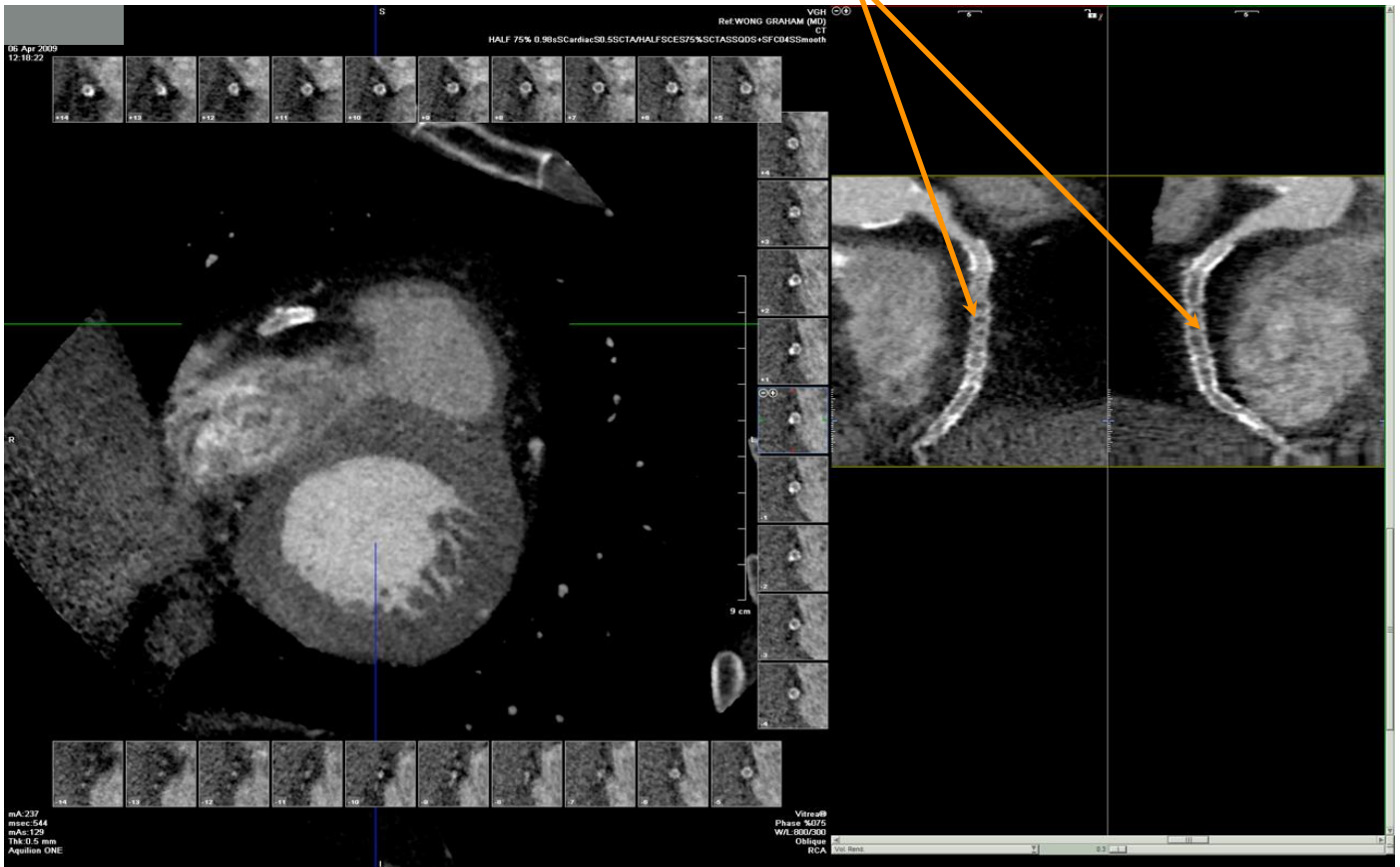


LAD

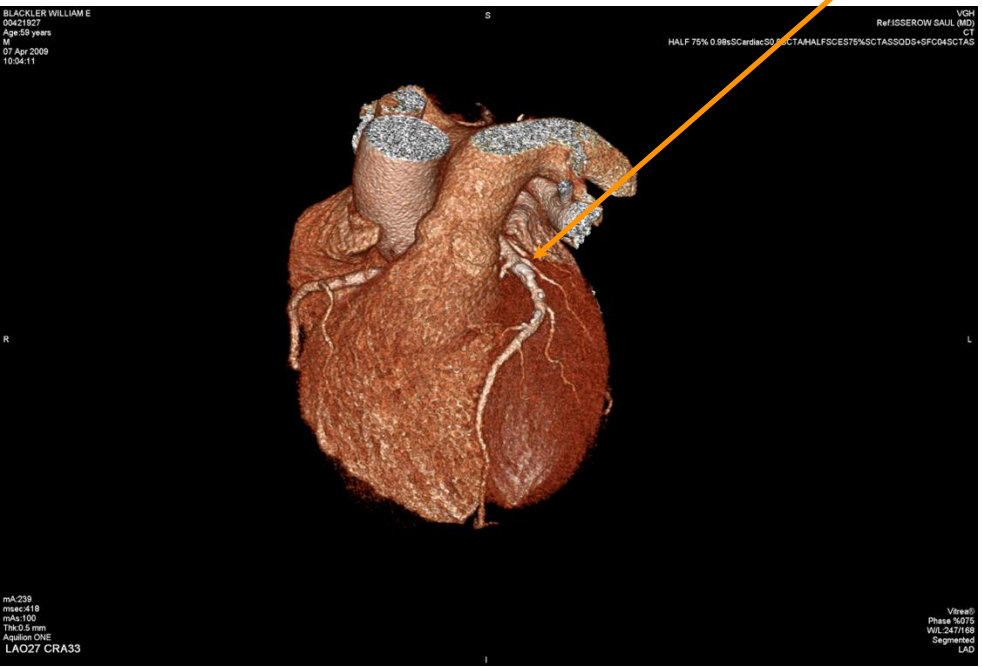
MIXED OBSTRUCTIVE CAD: RCA

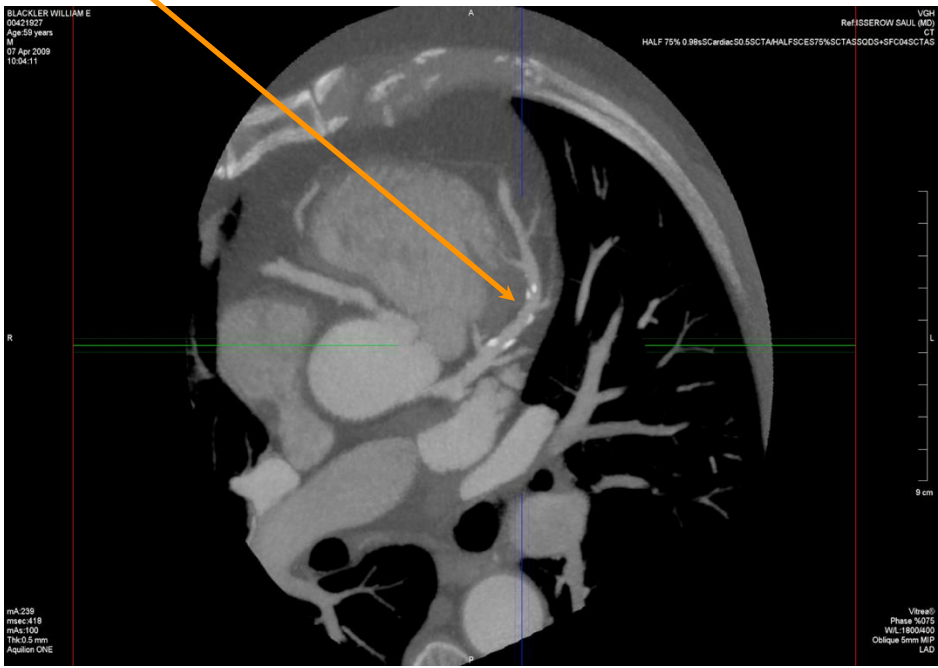


In stent restenosis



Calcified LAD with positive vessel remodeling





A WORD ABOUT RADIATION....

TEST	RADIATION DOSE
(BACKGROUND ANNUAL EXPOSURE)	2.5 mSv
CHEST X RAY (PA AND LATERAL)	0.02 mSv
DIAGNOSTIC CATHETER BASED ANGIOGRAM	2-3 mSv
PERSANTINE MIBI	12-15 mSv
PERSANTINE MIBI (2 DAY PROTOCOL)	25 mSv
CORONARY CALCIUM SCANNING	1-2 mSv
HELICAL CT CHEST	6-8 mSv
64 SLICE CCTA (RETROSPECTIVE GATING)	12-15 mSv
64 SLICE CCTA (PROSPECTIVE GATING)	3-4 mSv
RADIATION EXPOSURE IN ATOMIC BOMB SURVIVORS	~360mSv (1 mile from blast centre)

Lowest annual radiation dose clearly linked to malignancy: 100m Sv

Purpose of testing for CAD: the question are you posing will determine the answer you get

(ASYMPTOMATIC PT)

Detection of subclinical atherosclerosis

Carotid IMT ultrasonography
Coronary calcium scanning
hsCRP

STATIN YES OR NO

(SYMPTOMATIC PT)

Detection of flow-limiting atherosclerosis

FUNCTIONAL

Exercise stress testing
Stress imaging (MIBI, Echo)

ANATOMICAL

Coronary CTA
Traditional angiogram

TREAT FOR ISCHEMIA YES OR NO

How to choose?

- **Exercise stress testing**
  - PRO: easy to do and safe
  - CON: up to 30% false positive and false negative, “furthest away” from the “truth” in the artery
- **Exercise/pharmacological nuclear imaging**
  - PRO: increased sensitivity & specificity compared to EST
  - CON: lots of radiation, subject to postprocessing erros
- **Exercise/pharmacological stress echocardiography**
  - PRO: increased sensitivity & specificity compared to EST, real time evaluation of ischemia and valvular function
  - CON: not all patients are echogenic
- **CCTA**
  - PRO: very high ”rule out” power; can detect subclinical CAD external to lumen
  - CON: small radiation exposure, sensitive to arrhythmias, subject to postprocessing errors
- **Diagnostic angiography**
  - PRO: gold standard
  - CON: invasive test (1/1000 risk of death, MI or CVA)

Final Thoughts

- Think about what kind of information that you want before ordering a noninvasive test: Are you looking for the possibility of flow limiting CAD that is causing symptoms, or an assessment of atherosclerotic burden for RF modification in an asymptomatic pt?
- Consider the following:
  - What are the chances of a nondiagnostic test?
  - What are the chances of a false positive/negative?
  - Will this test change my management of the patient?


That's all Folks!