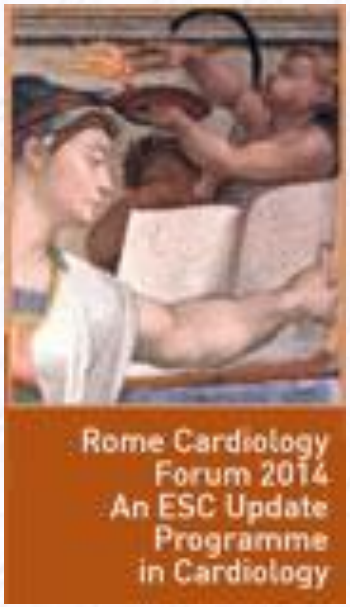
Diagnostic Algorithms



Udo Sechtem
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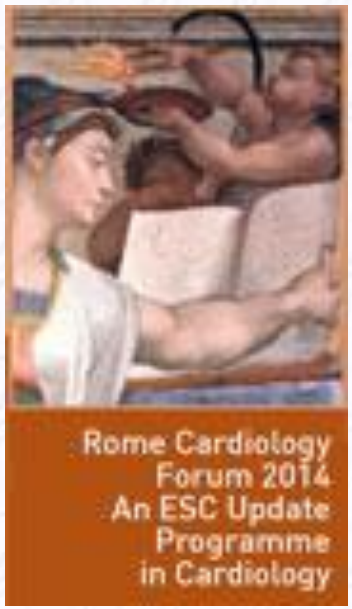

Montalescot G et al.
ESC Guideline on the Management of Stable Coronary Artery Disease
Eur Heart J. 2013;34:2949-3003.

European Heart Journal 2013 - doi:10.1093/eurheartj/eht296
http://www.escardio.org/guidelines-surveys/esc-guidelines/Pages/stable-angina-pectoris.aspx

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European Heart Journal
doi:10.1093/eurheartj/eht296

2013 ESC guidelines on the management of stable coronary artery disease

Authors/Task Force Members: Gilles Montalescot* (Chairperson) (France), Udo Sechtem* (Chairperson) (Germany), Stephan Achenbach (Germany), Felicita Andreotti (Italy), Chris Arden (UK), Andrzej Budaj (Poland), Raffaele Bugiardini (Italy), Filippo Crea (Italy), Thomas Cuisset (France), Carlo Di Mario (UK), J. Rafael Ferreira (Portugal), Bernard J. Gersh (USA), Anselm K. Gitt (Germany), Jean-Sebastien Hulot (France), Nikolaus Marx (Germany), Lionel H. Opie (South Africa), Matthias Pfisterer (Switzerland), Eva Prescott (Denmark), Frank Ruschitzka (Switzerland), Manel Sabaté (Spain), Roxy Senior (UK), David Paul Taggart (UK), Ernst E. van derWall (Netherlands), Christiaan J.M. Vrints (Belgium).

Diagnosis of Stable CAD: What is new as compared to 2006?

- Separate consideration of the processes of diagnosis and risk stratification
- Diagnostic process based on pretest probabilities of SCAD
- New data on pretest probabilities
- Broader consideration of functional CAD as cause of symptoms
- Larger role for modern imaging techniques such as CMR and CCTA but with critical appraisal of their limitations

www.escardio.org/guidelines

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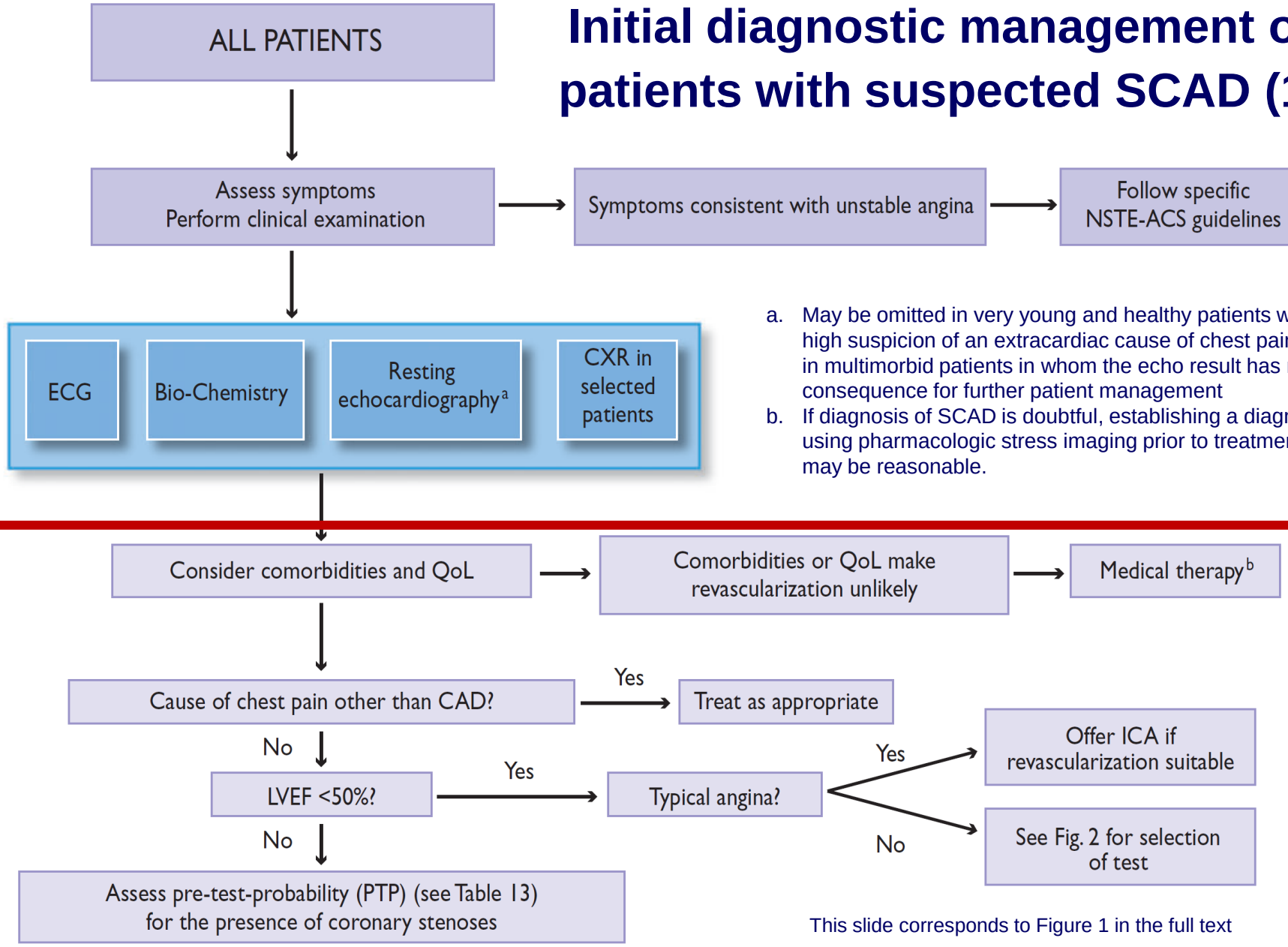
CASE

- **59y old patient - thoracic discomfort since 3M only with intense jogging → cardiologist**

Initial diagnostic management of patients with suspected SCAD (1)



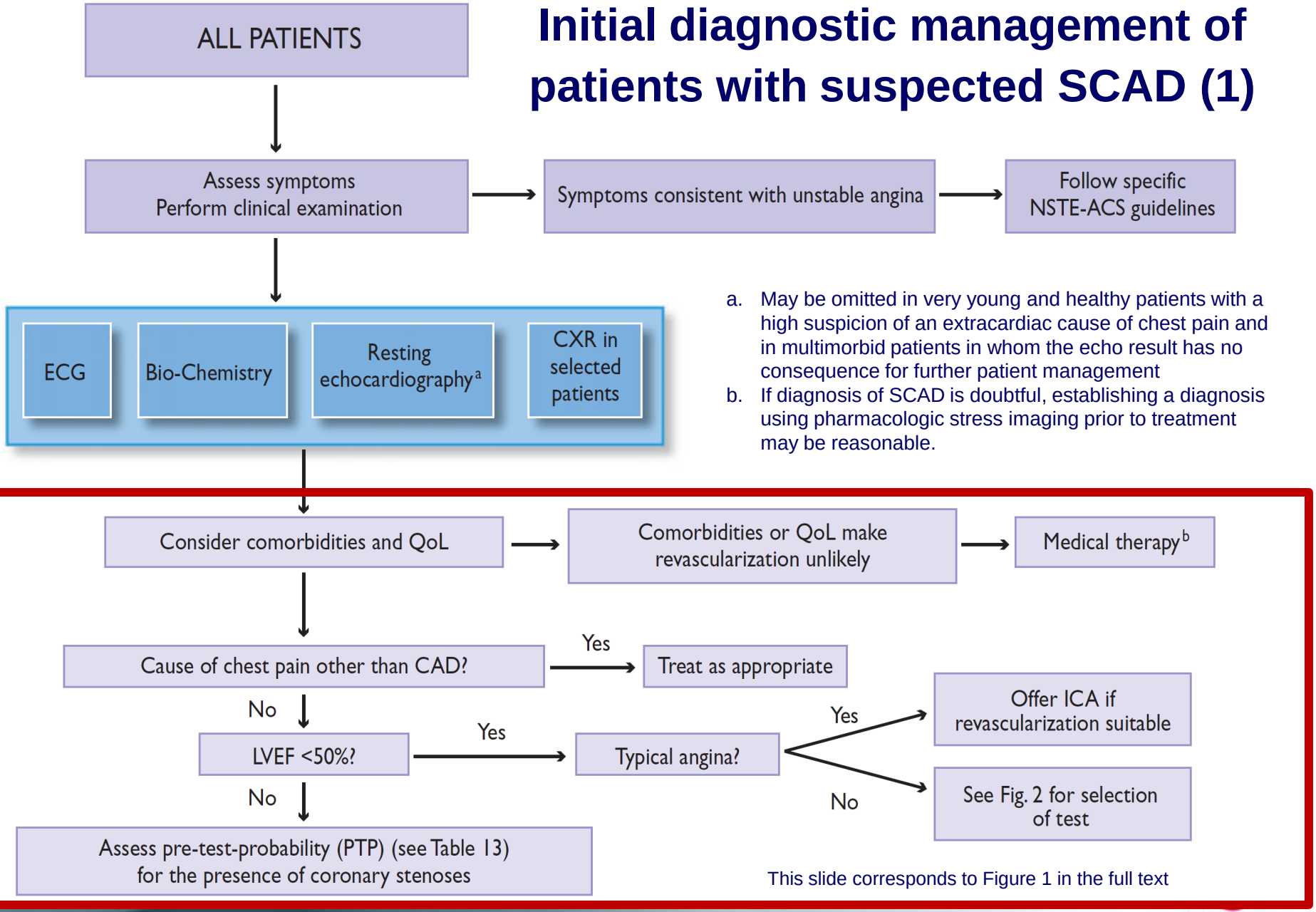
a. May be omitted in very young and healthy patients with a high suspicion of an extracardiac cause of chest pain and in multimorbid patients in whom the echo result has no consequence for further patient management
b. If diagnosis of SCAD is doubtful, establishing a diagnosis using pharmacologic stress imaging prior to treatment may be reasonable.

This slide corresponds to Figure 1 in the full text

CASE

- 59y old patient - thoracic discomfort since 3M with intense jogging → cardiologist
- **Resting ECG: sinus rhythm, HR 98/min, normal.**
- **Normal values for troponin, FBC, blood sugar, creatinine.**
- **Resting echocardiogram: normal**
- **Carotid ultrasound: IMT 1,2 mm, otherwise normal**

Initial diagnostic management of patients with suspected SCAD (1)



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b. If diagnosis of SCAD is doubtful, establishing a diagnosis using pharmacologic stress imaging prior to treatment may be reasonable.

This slide corresponds to Figure 1 in the full text

Traditional clinical classification of chest pain

Typical angina (definite)	Meets all three of the following characteristics: • substernal chest discomfort of characteristic quality and duration; • provoked by exertion or emotional stress; • relieved by rest and/or nitrates within minutes.
Atypical angina (probable)	Meets two of these characteristics.
Non-anginal chest pain	Lacks or meets only one or none of the characteristics.

European Heart Journ

oi:10.1093/eurheartj/eht296

Clinical pre-test probabilities[a] in patients with stable chest pain symptoms

	Typical angina		Atypical angina		Non-anginal pain	
Age	Men	Women	Men	Women	Men	Women
30-39	59	28	29	10	18	5
40-49	69	37	38	14	25	8
50-59	77	47	49	20	34	12
60-69	84	58	59	28	44	17
70-79	89	68	69	37	54	24
>80	93	76	78	47	65	32

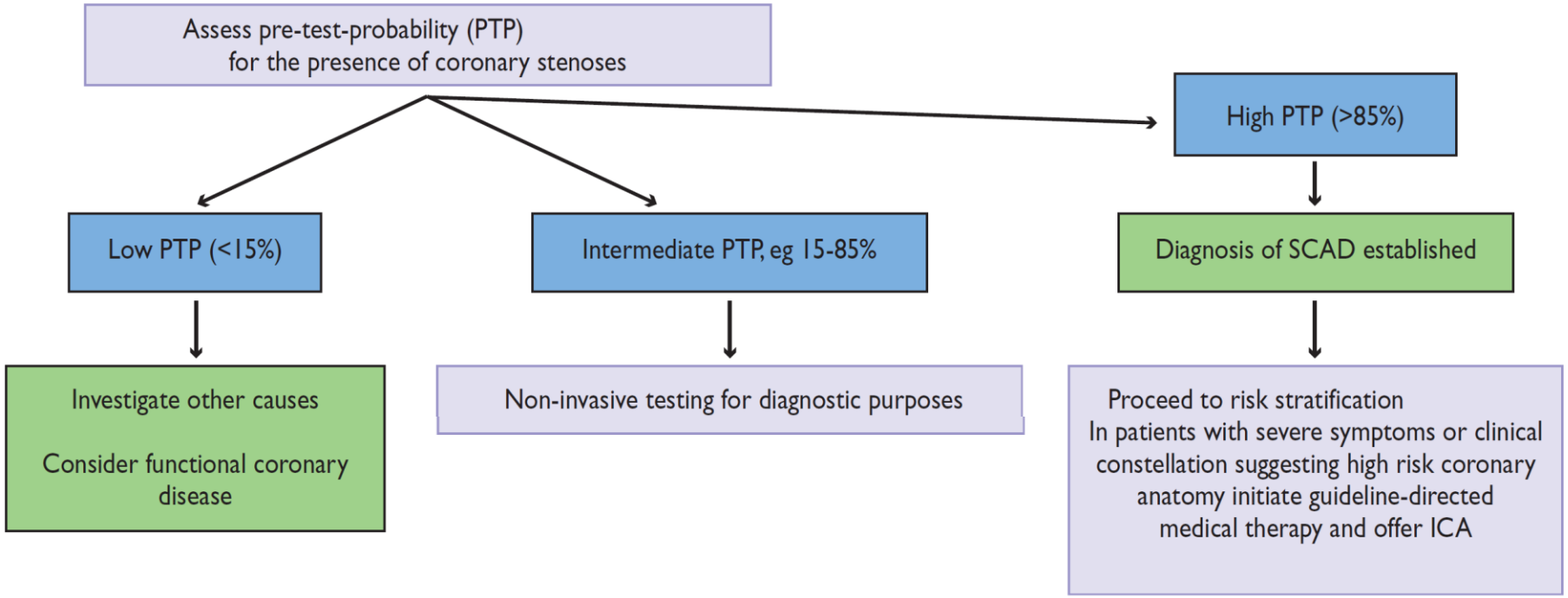
[a] Probabilities of obstructive coronary disease shown reflect the estimates for patients aged 35, 45, 55, 65, 75, and 85 years..

This slide corresponds to Table 13 in the full text

From:
Genders TS et al. – Eur Heart J 2011;32:1316–1330.

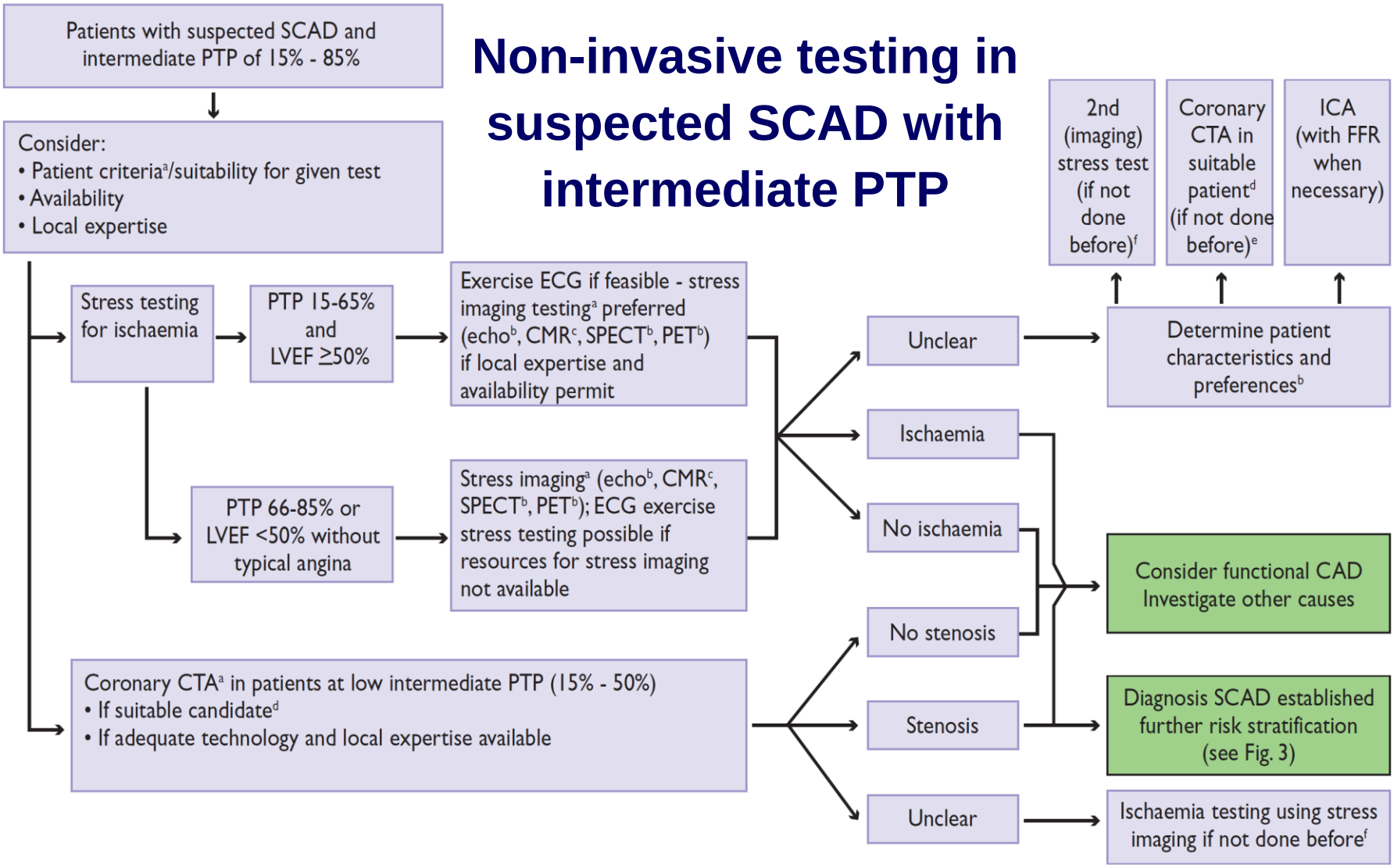
European Heart Journal 2013 - doi:10.1093/eurheartj/eht296

Initial diagnostic management of patients with suspected SCAD (2)



This slide corresponds to Figure 1 in the full text

Non-invasive testing in suspected SCAD with intermediate PTP



a. Consider age of patient versus radiation exposure.
b. In patients unable to exercise use echo or SPECT/PET with pharmacologic stress instead.
c. CMR is only performed using pharmacologic stress.
d. Patient characteristics should make a fully diagnostic coronary CTA scan highly probable (see section 6.2.5.1.2) consider result to be unclear in patients with severe diffuse or focal calcification.
e. Proceed as in lower left coronary CTA box.
f. Proceed as in stress testing for ischaemia box.

This slide corresponds to Figure 2 in the full text

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CASE 1

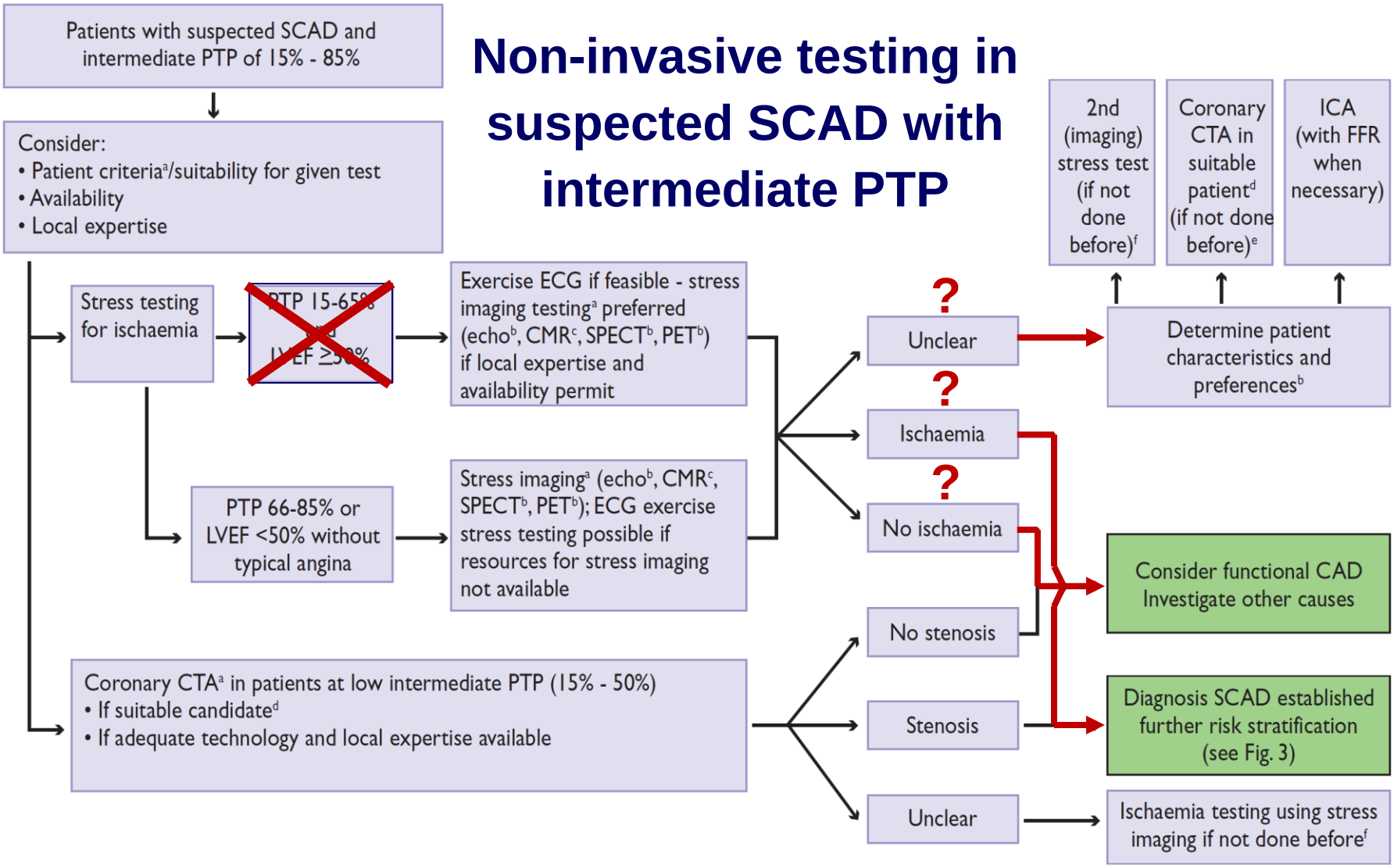
- 59y old patient - thoracic discomfort since 3M with intense jogging → cardiologist
- Resting ECG: sinus rhythm, HR 98/min, normal.
- Resting echocardiogram: normal
- Carotid ultrasound: IMT 1,2 mm, otherwise normal
- **Exercise ECG:**
  - 175 W, HR 160/min
  - terminated due to dyspnoea and mild angina
  - No ST-segment depression

When is an exercise ECG pathologic?

Gibbons R et al. – JACC 1997;30:260-315.

- **Difficult question!**
  - Scores of clinical and exercise test variables ⇒ superior discrimination compared with using only the ST-segment response to diagnose CAD.
  - However, diagnostic interpretation of the exercise test still centers around the ST response, because the clinician remains uncertain about which other variables to apply and how to include them in prediction.

Non-invasive testing in suspected SCAD with intermediate PTP



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This slide corresponds to Figure 2 in the full text

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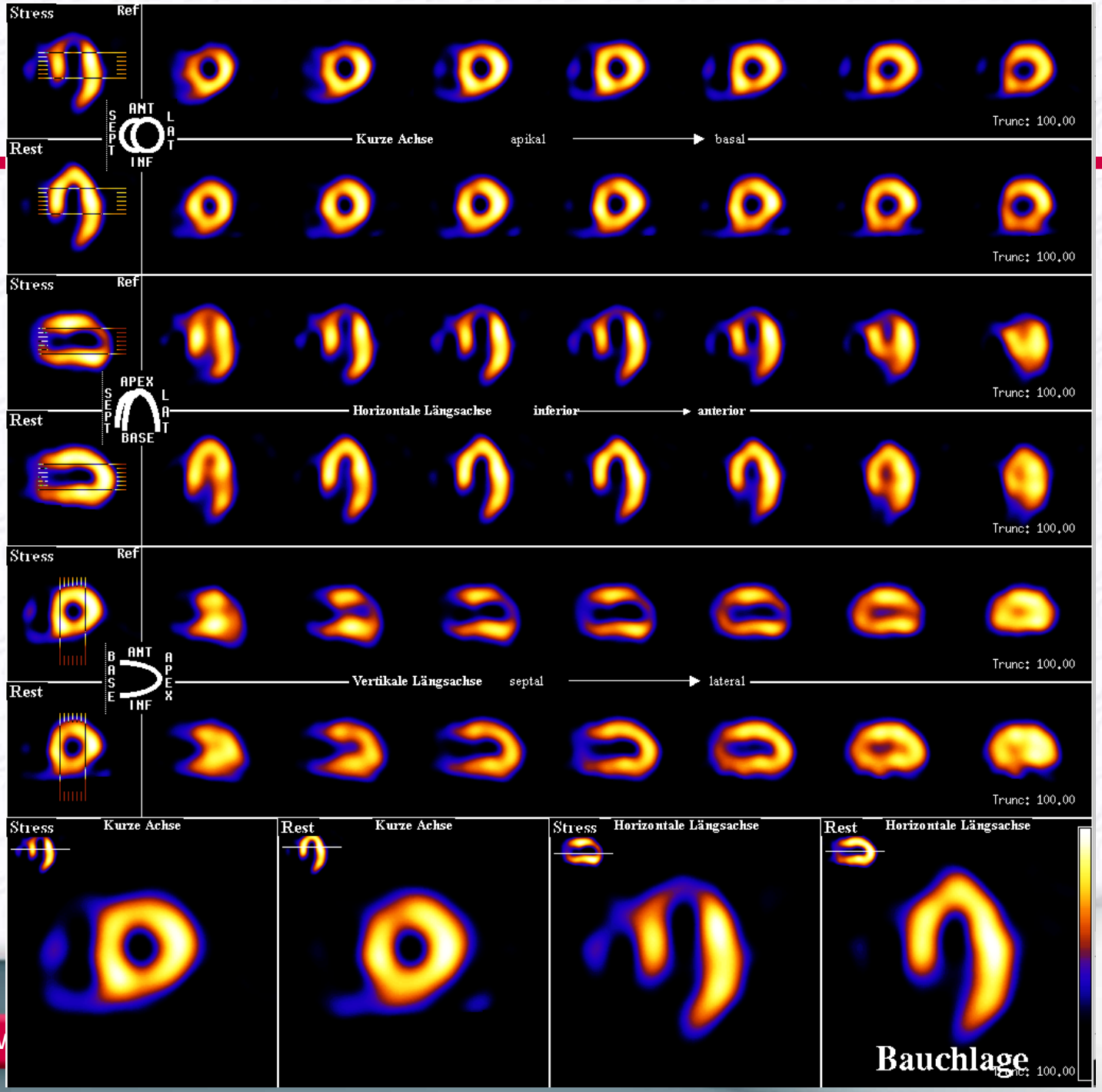
CASE

- 59y old patient - thoracic discomfort since 3M with intense jogging → cardiologist
- Resting ECG: sinus rhythm, HR 98/min, normal.
- Resting echocardiogram: normal
- Carotid ultrasound: IMT 1,2 mm, otherwise normal
- **MIBI-SPECT:**
  - 225 W, HR 158/min
  - terminated due to maximal HR reached, RR 205/95
  - No angina, no ST-segment depression



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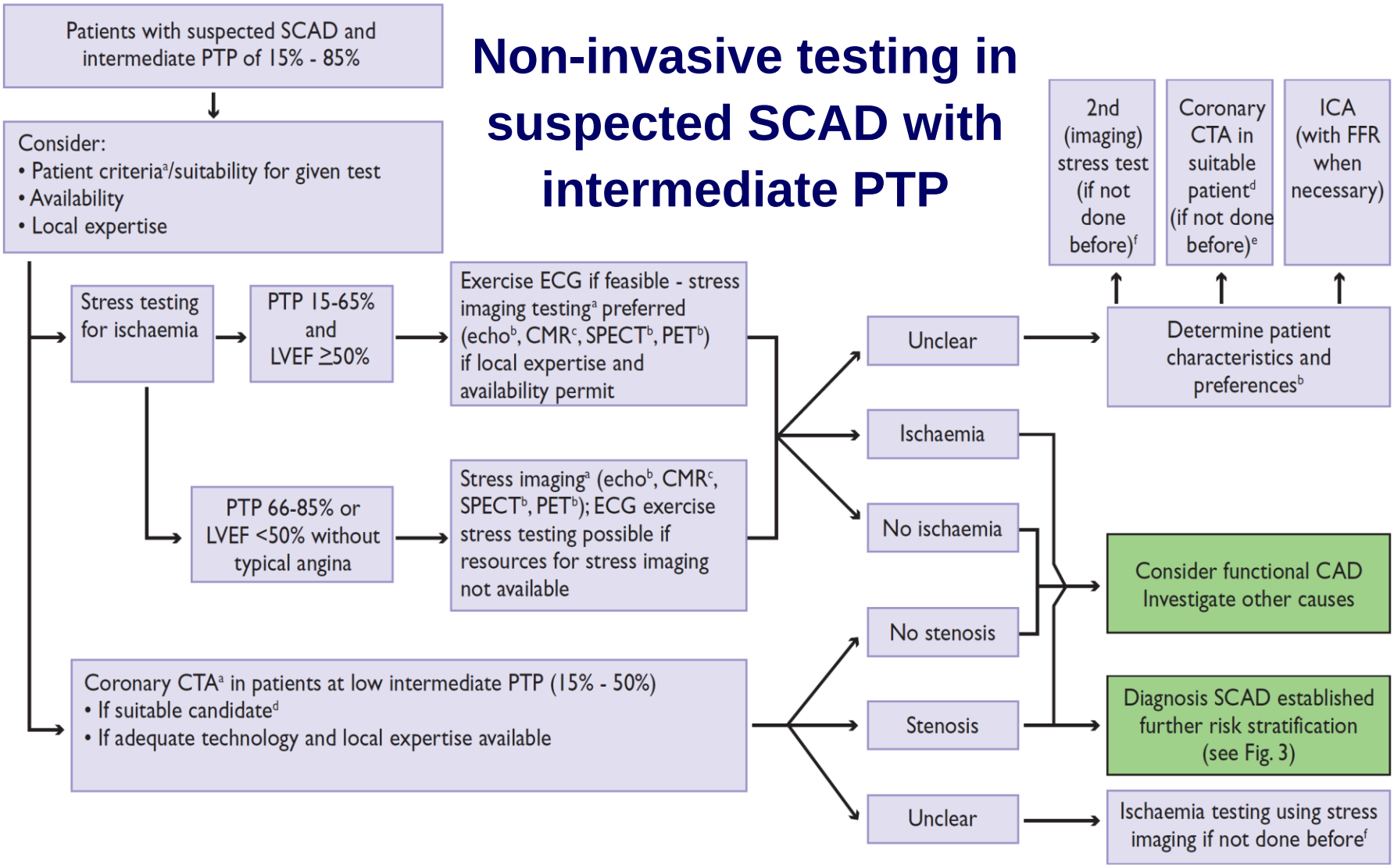

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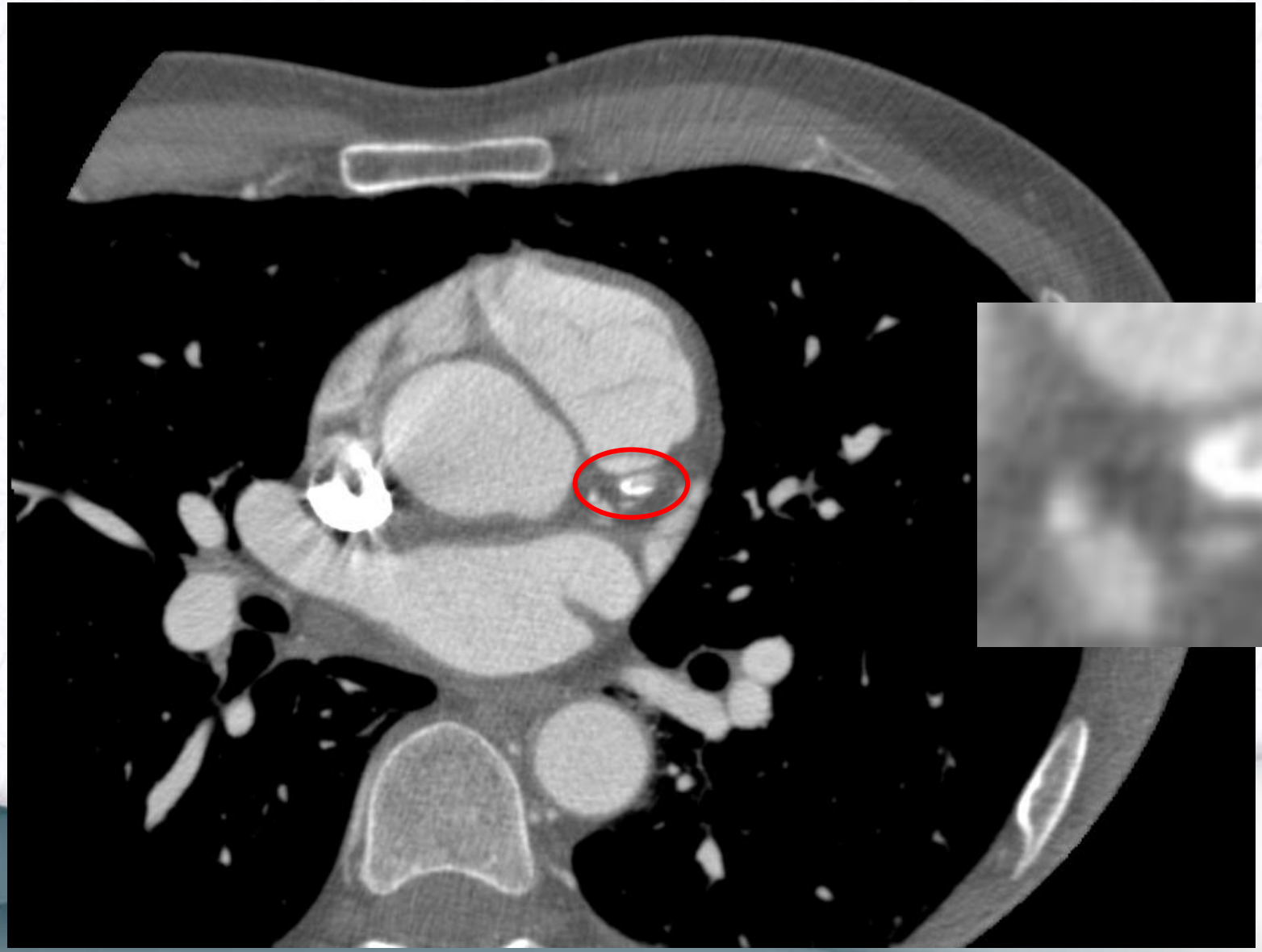
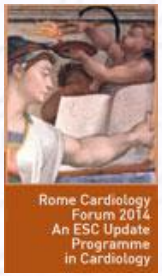
Obstructive Calcified Plaque by CCTA





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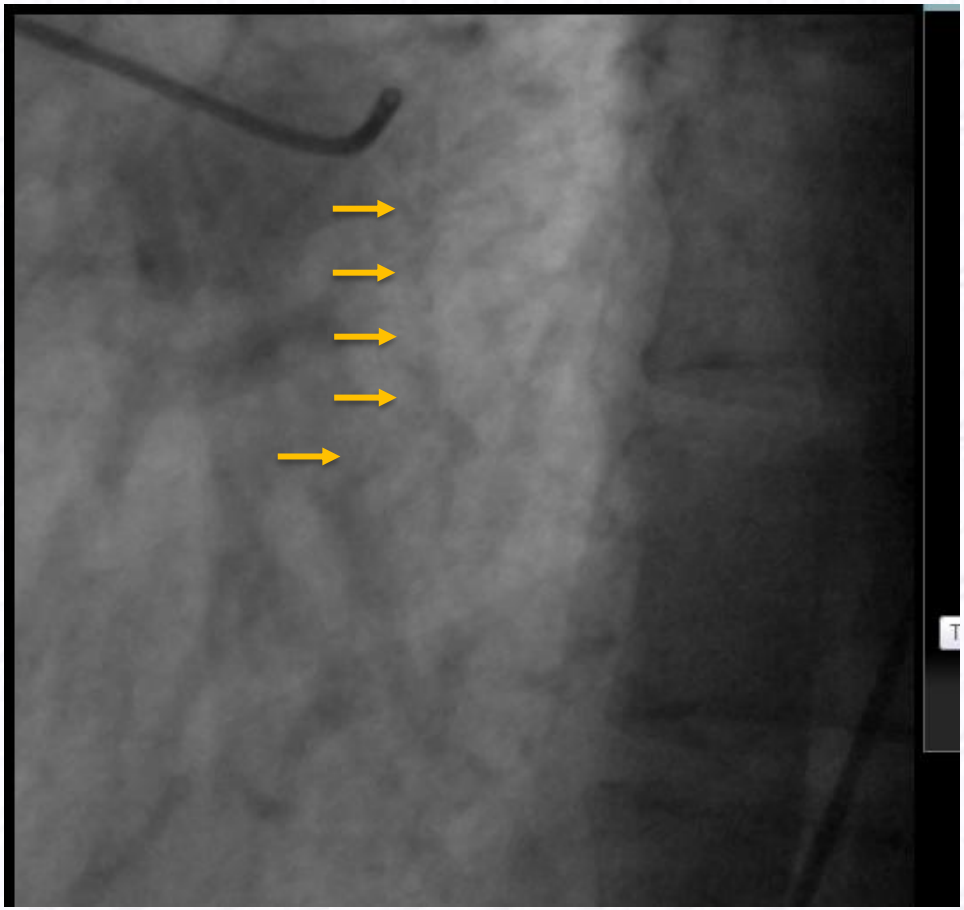
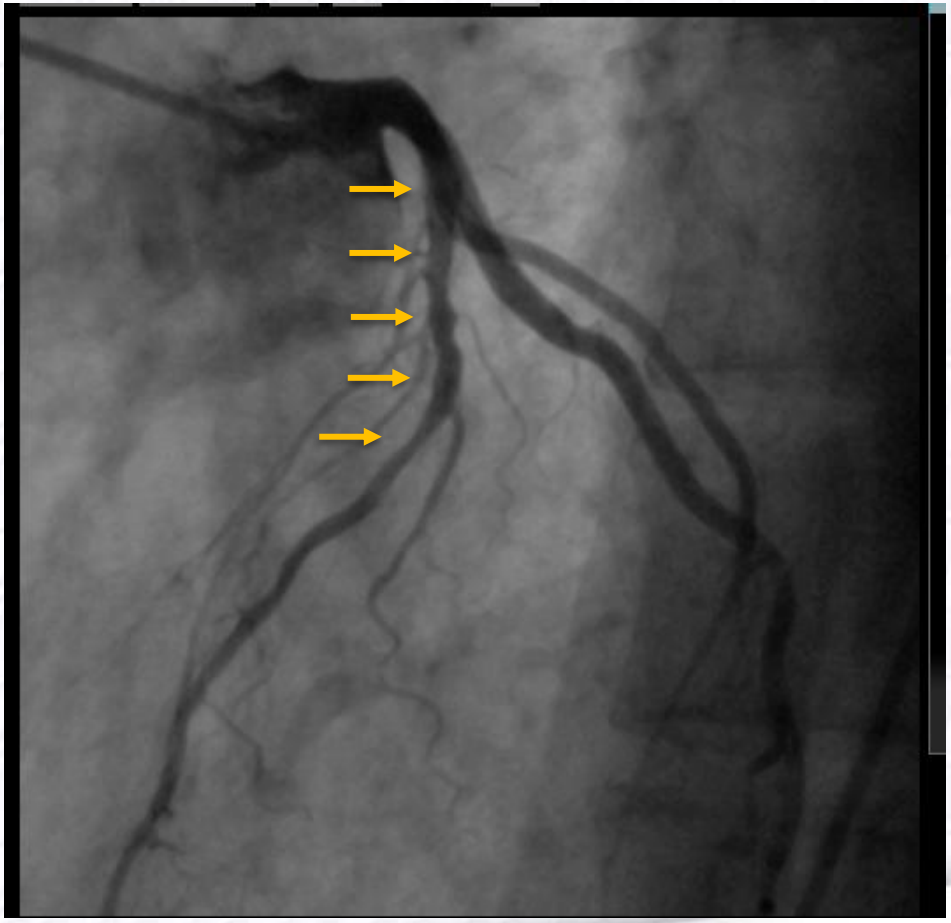
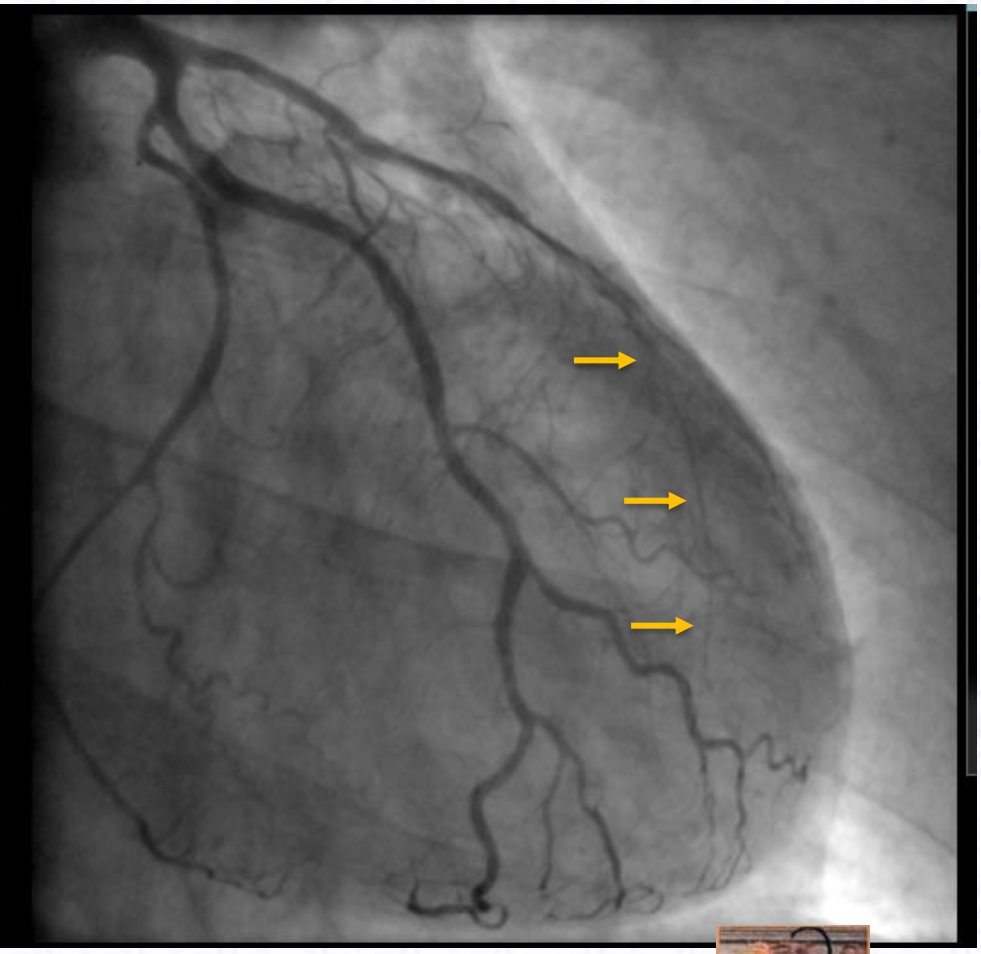
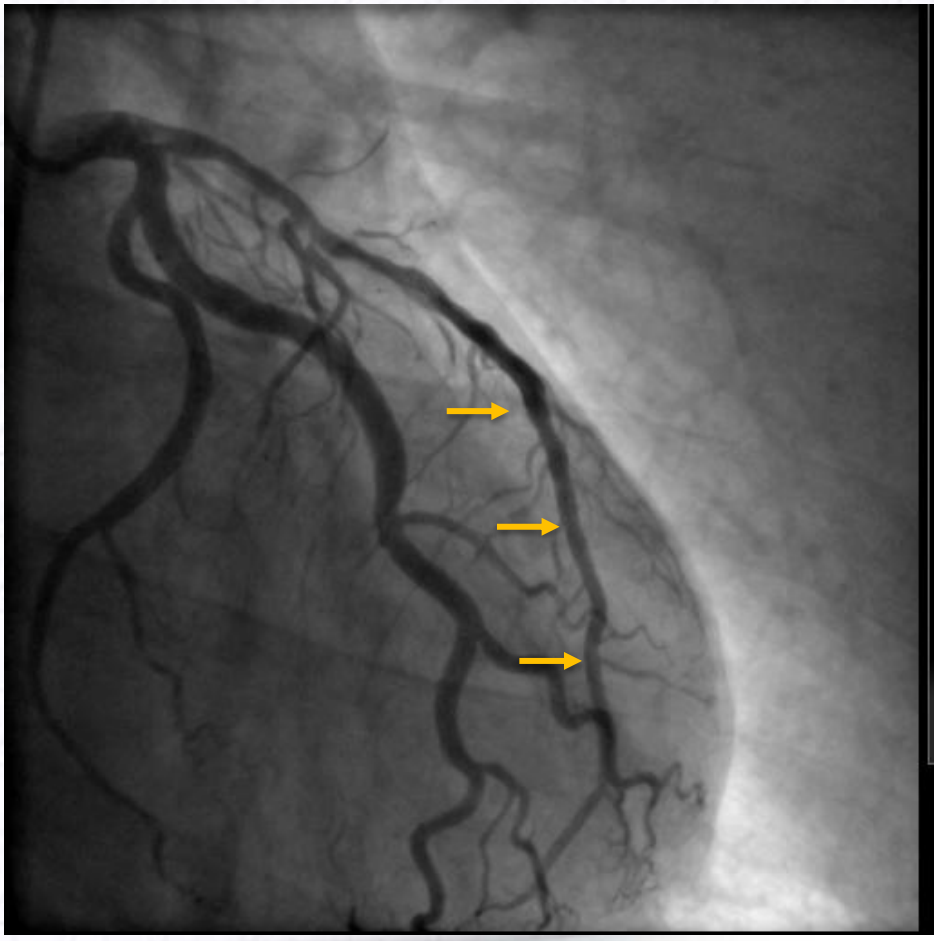
Extensive Calcifications – No Stenosis



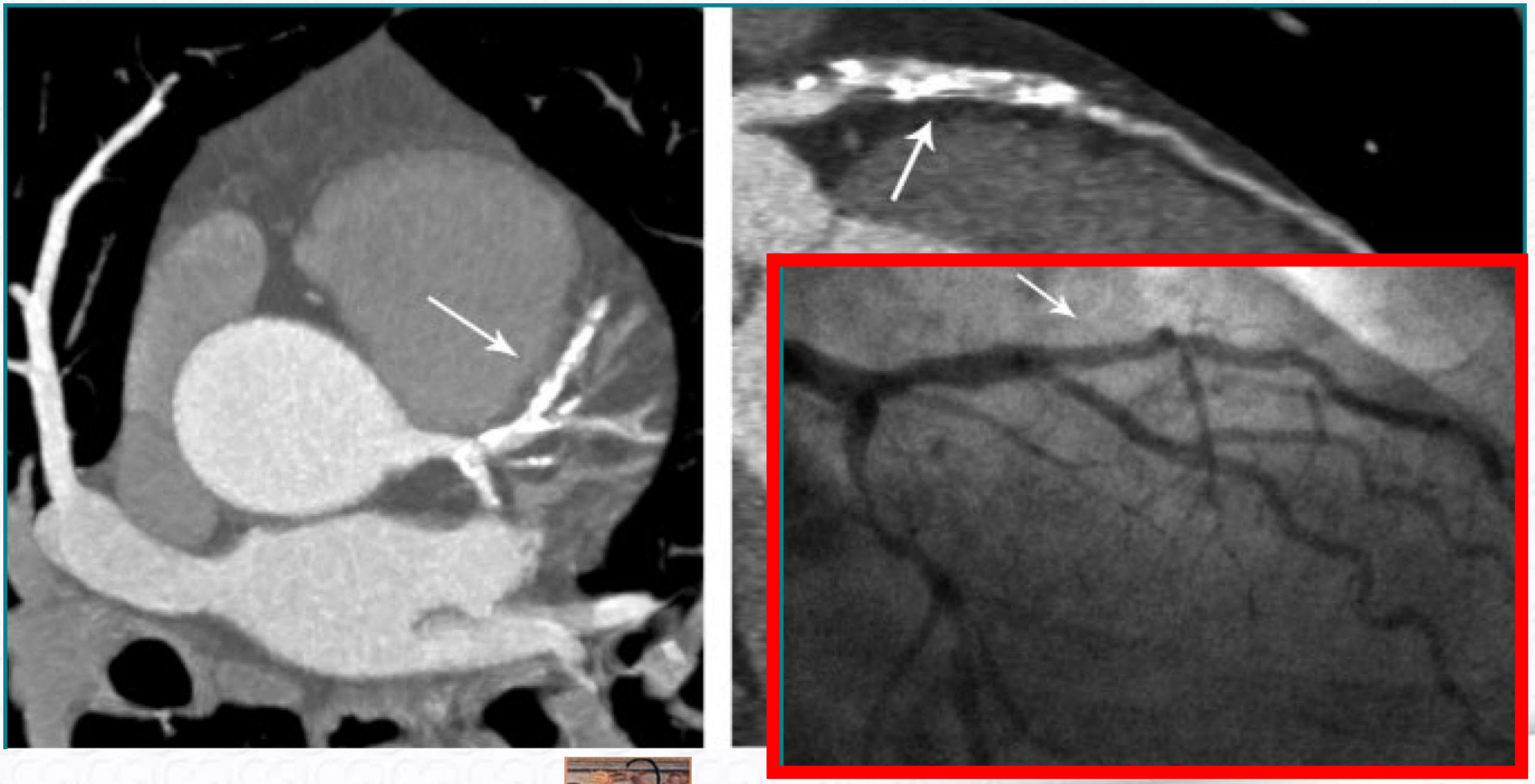


Resting Angina Caused by Epicardial Spasm



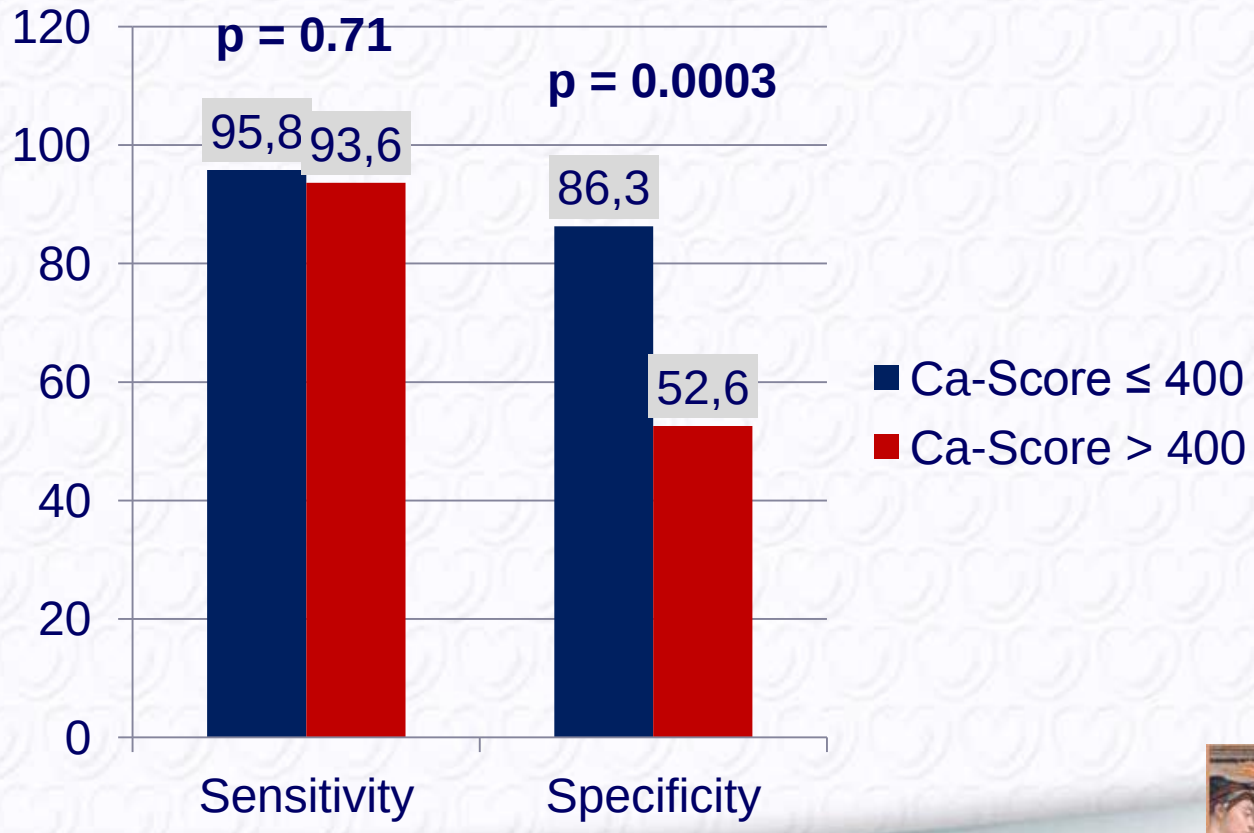


CCTA and Calcifications



↓Specificity of CCTA with Calcifications

Budoff MJ et al. – J Am Coll Cardiol 2008;52:1724–32



Characteristics of tests commonly used to diagnose the presence of CAD

	Diagnosis of CAD	
	Sensitivity (%)	Specificity (%)
Exercise ECG [a, 91, 94, 95]	45–50	85–90
Exercise stress echocardiography[96]	80–85	80–88
Exercise stress SPECT[96-99]	73–92	63–87
Dobutamine stress echocardiography[96]	79–83	82–86
Dobutamine stress MRI[b,100]	79–88	81–91
Vasodilator stress echocardiography[96]	72–79	92–95
Vasodilator stress SPECT[96, 99]	90–91	75–84
Vasodilator stress MRI[b,98, 100-102]	67–94	61–85
Coronary CTA[c,103-105]	95–99	64–83
Vasodilator stress PET[97, 99, 106]	81–97	74–91

a. Results without/with minimal referral bias.
b. Results obtained in populations with medium-to-high prevalence of disease without compensation for referral bias.
c. Results obtained in populations with low-to-medium prevalence of disease.

CAD = coronary artery disease; CTA = computed tomography angiography; ECG = electrocardiogram; MRI = magnetic resonance imaging; PET = positron emission tomography; SPECT = single photon emission computed tomography.

Referral Bias

Test = exercise stress echocardiography
Gold standard = ICA

Strategy:
all pts with positive stress echo ⇒ ICA
all pts with normal stress echo ⇒ no ICA

Result:
all pts with stenosis ⇒ positive stress echo
all pts without stenosis ⇒ positive stress echo

Consequence:
Sensitivity stress echo ⇒ 100%
Specificity ⇒ 0%

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Referral Bias

Lapado JA et al. – J Am Heart Assoc 2013;2:e000505 doi: 10.1161/JAHA.113.000505

Diagnostic Effectiveness of Exercise ECHO With and Without Adjustment for Referral

	ECHO	
	Sensitivity, % (95% CI)	Specificity, % (95% CI)
Unadjusted*	84 (80 to 89)	77 (69 to 86)
Adjusted†	34 (27 to 41)	99 (99 to 100)

ECHO = echocardiography.

*Diagnostic effectiveness based on random-effects meta-analysis of sensitivity and specificity reported in 15 studies of exercise ECHO and 30 studies of exercise MPI (45 studies in total).

†Adjusted for referral rates to cardiac catheterization after abnormal or normal exercise test result.

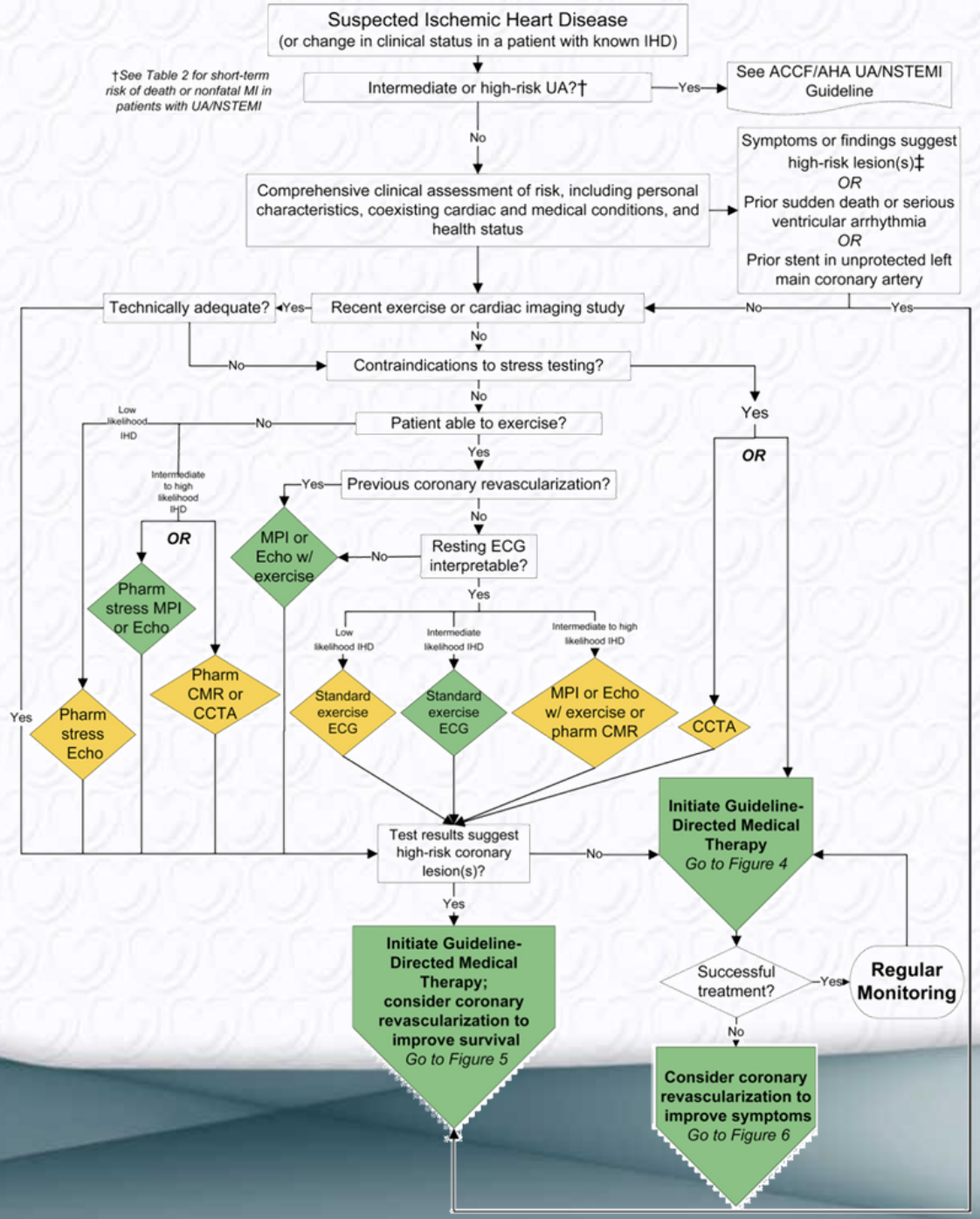
Referral Bias

Lapado JA et al. – J Am Heart Assoc 2013;2:e000505 doi: 10.1161/JAHA.113.000505

Diagnostic Effectiveness of Exercise MPI With and Without Adjustment for Referral

	MPI	
	Sensitivity, % (95% CI)	Specificity, % (95% CI)
Unadjusted*	85 (81 to 88)	69 (61 to 78)
Adjusted†	38 (31 to 44)	99 (99 to 100)

MPI = myocardial perfusion imaging.
*Diagnostic effectiveness based on random-effects meta-analysis of sensitivity and specificity reported in 15 studies of exercise ECHO and 30 studies of exercise MPI (45 studies in total).
†Adjusted for referral rates to cardiac catheterization after abnormal or normal exercise test result.



Guideline SIHD ACC/AHA

Fihn SD et al. –
J Am Coll Cardiol
2012; 60:e44–e164

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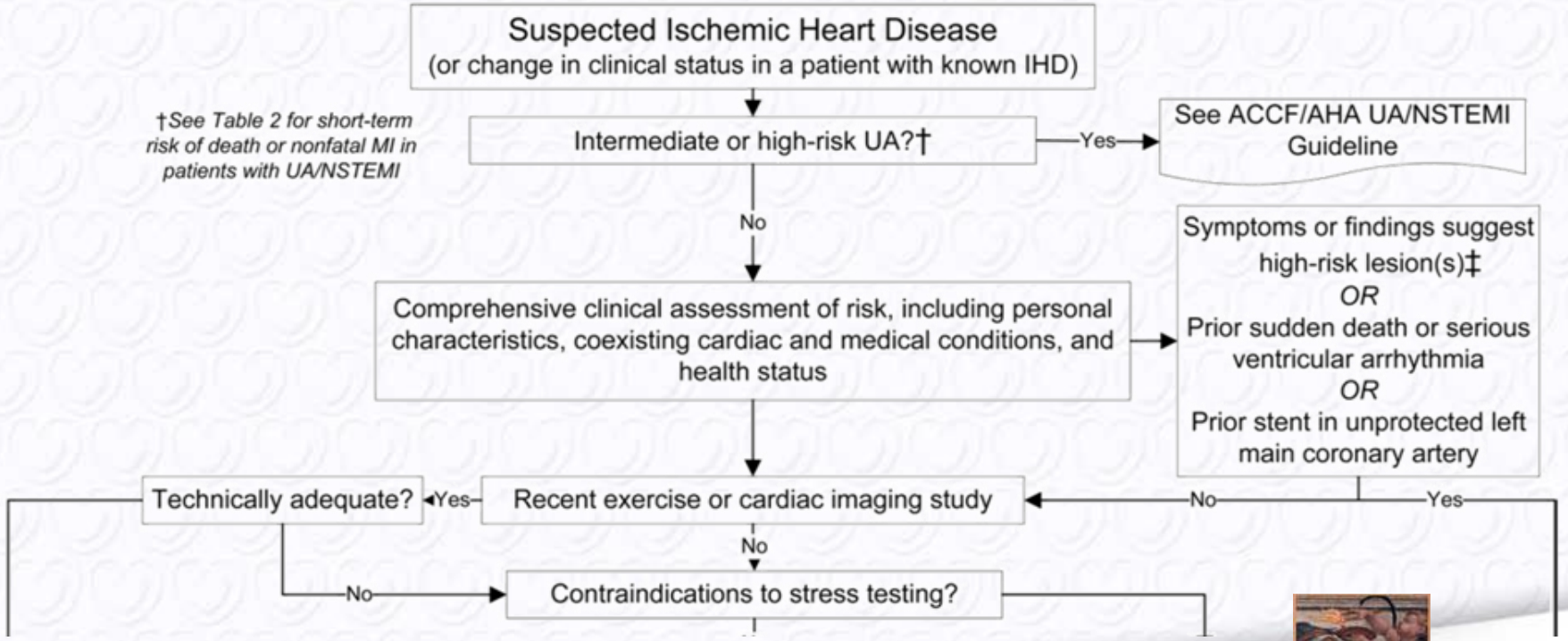
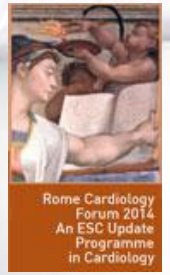
Guideline SIHD ACC/AHA

Fihn SD et al. – J Am Coll Cardiol 2012; 60:e44–e164





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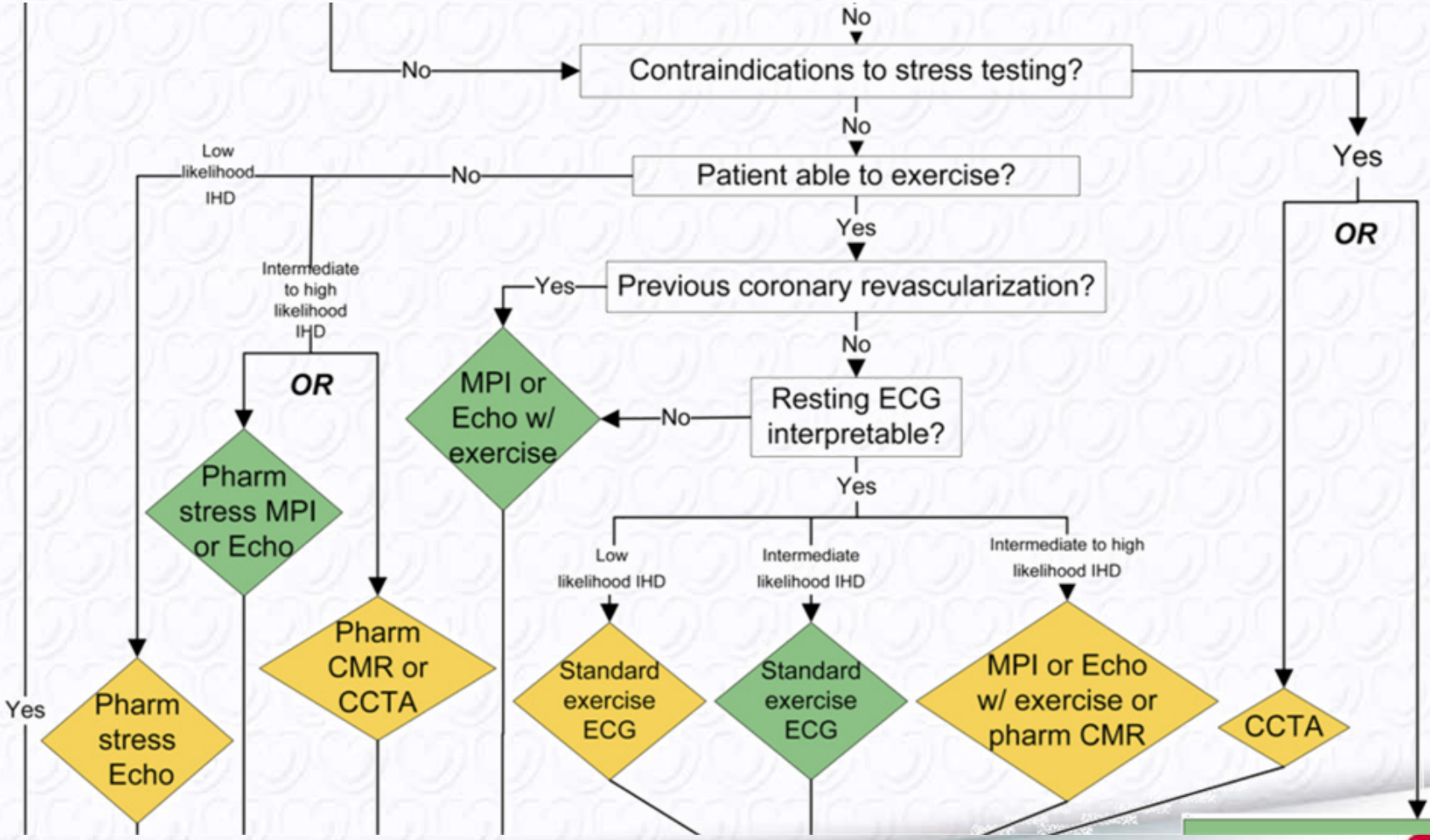

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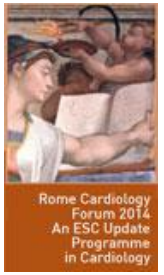
NICE Diagnostic Pathway in Stable Chest Pain



Stable chest pain pathway

2. Diagnostic testing for people in whom stable angina cannot be diagnosed or excluded by clinical assessment alone

Estimated likelihood of CAD 10 to 29%

CT calcium scoring

- score is zero → **Investigate other causes of chest pain****
- score is more than 400 → Follow pathway for 61-90% CAD
- score is 1- 400 → 64-slice (or above) CT coronary angiography → Significant CAD **See box 4**
  - NO → **Investigate other causes of chest pain****
  - Uncertain → Appropriate functional imaging test (**see box 5 overleaf**). If reversible myocardial ischaemia found, treat as stable angina. If not, investigate other causes of chest pain**
  - YES → **Treat as stable angina**

Estimated likelihood of CAD 30-60%

Appropriate functional imaging test (**see box 5 overleaf**)

Reversible myocardial ischaemia

- NO → **Investigate other causes of chest pain ****
- Yes → **Treat as stable angina**
- Uncertain → Invasive coronary angiography → Significant CAD **See box 4**
  - NO → **Investigate other causes of chest pain****
  - YES → **Treat as stable angina**

Estimated likelihood of CAD 61-90%

Invasive coronary angiography if appropriate*

Significant CAD **See box 4**

- YES → **Treat as stable angina**
- NO → **Investigate other causes of chest pain ****
- Uncertain → Appropriate functional imaging test (**see box 5 overleaf**) → Reversible myocardial ischaemia
  - NO → **Investigate other causes of chest pain ****
  - YES → **Treat as stable angina**

Box 4 Definition of significant coronary artery disease

Significant coronary artery disease (CAD) found during invasive coronary angiography is ≥ 70% diameter stenosis of at least one major epicardial artery segment or ≥50% diameter stenosis in the left main coronary artery.

a) Factors intensifying ischaemia. Such factors allow less severe lesions (for example ≥50%) to produce angina.

- Reduced oxygen delivery: anaemia, coronary spasm
- Increased oxygen demand: tachycardia, left ventricular hypertrophy
- Large mass of ischaemic myocardium: proximally located lesions
- Longer lesion length

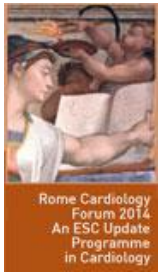
b) Factors reducing ischaemia. Such factors may render severe lesions (≥70%) asymptomatic.

- Well developed collateral supply
- Small mass of ischaemic myocardium: distally located lesions, old infarction in the territory of coronary supply.

http://www.nice.org.uk/CG95

* If coronary revascularisation is not being considered or invasive coronary angiography is not appropriate or acceptable to the person, offer non-invasive functional imaging

**Consider investigating other causes of angina, such as hypertrophic cardiomyopathy or syndrome X in people with typical angina-like chest pain if investigation excludes flow-limiting disease in the epicardial coronary arteries.



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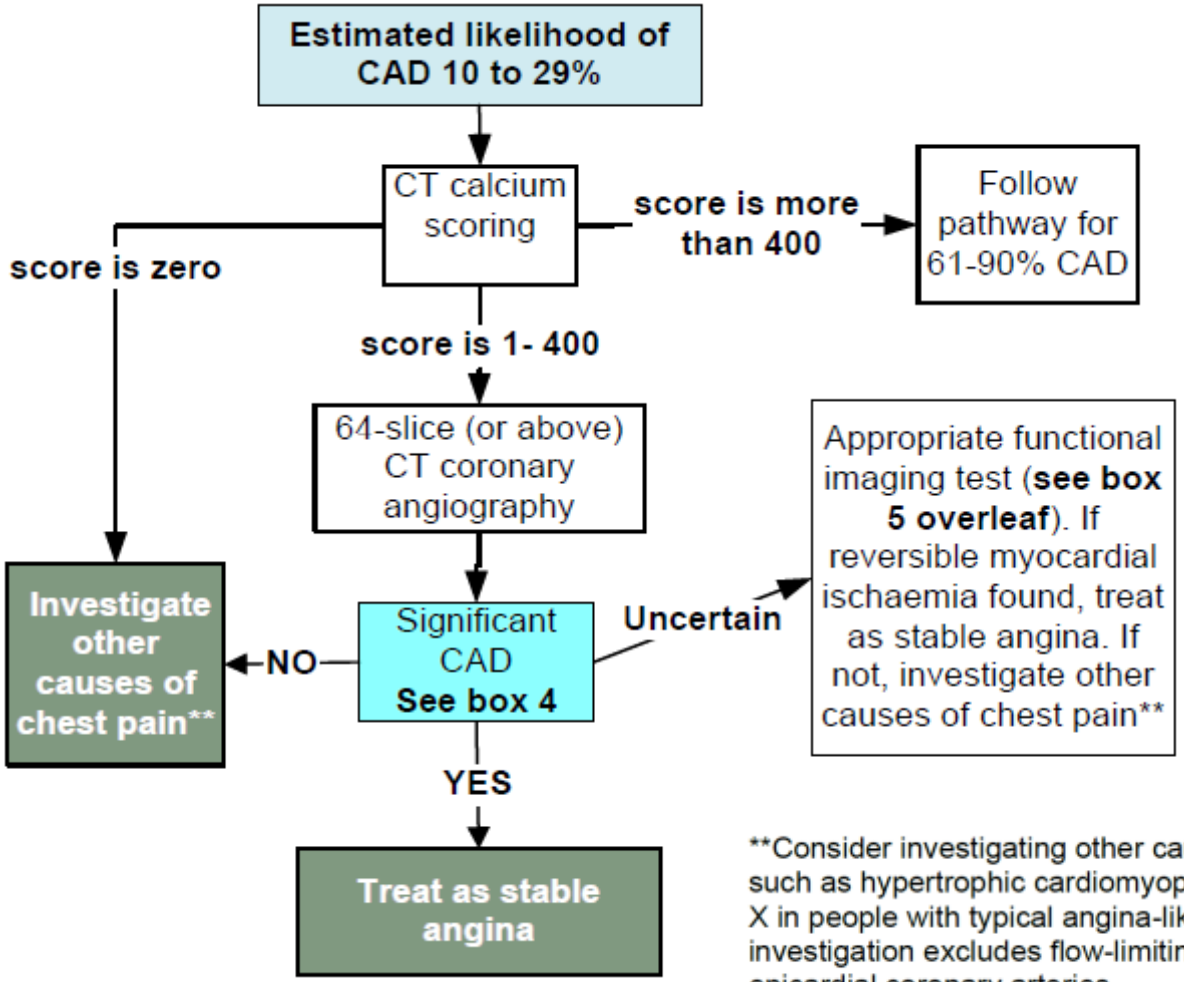

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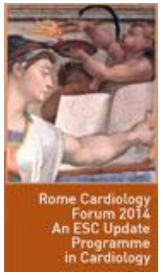
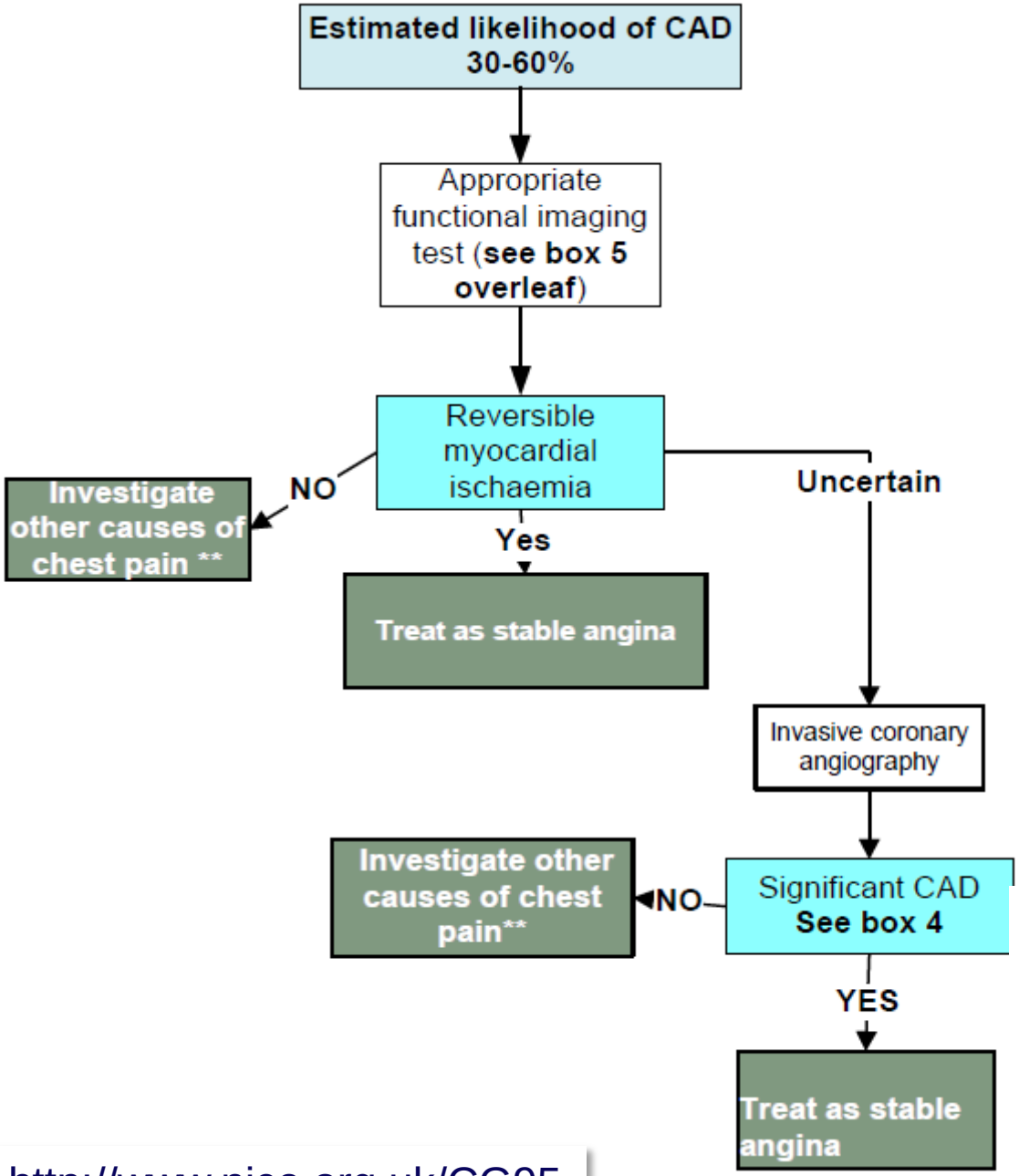
Testing in Patients with stable AP and 10–29% PTP

http://www.nice.org.uk/CG95



Testing in Patients with stable AP and 30–60% PTP



http://www.nice.org.uk/CG95

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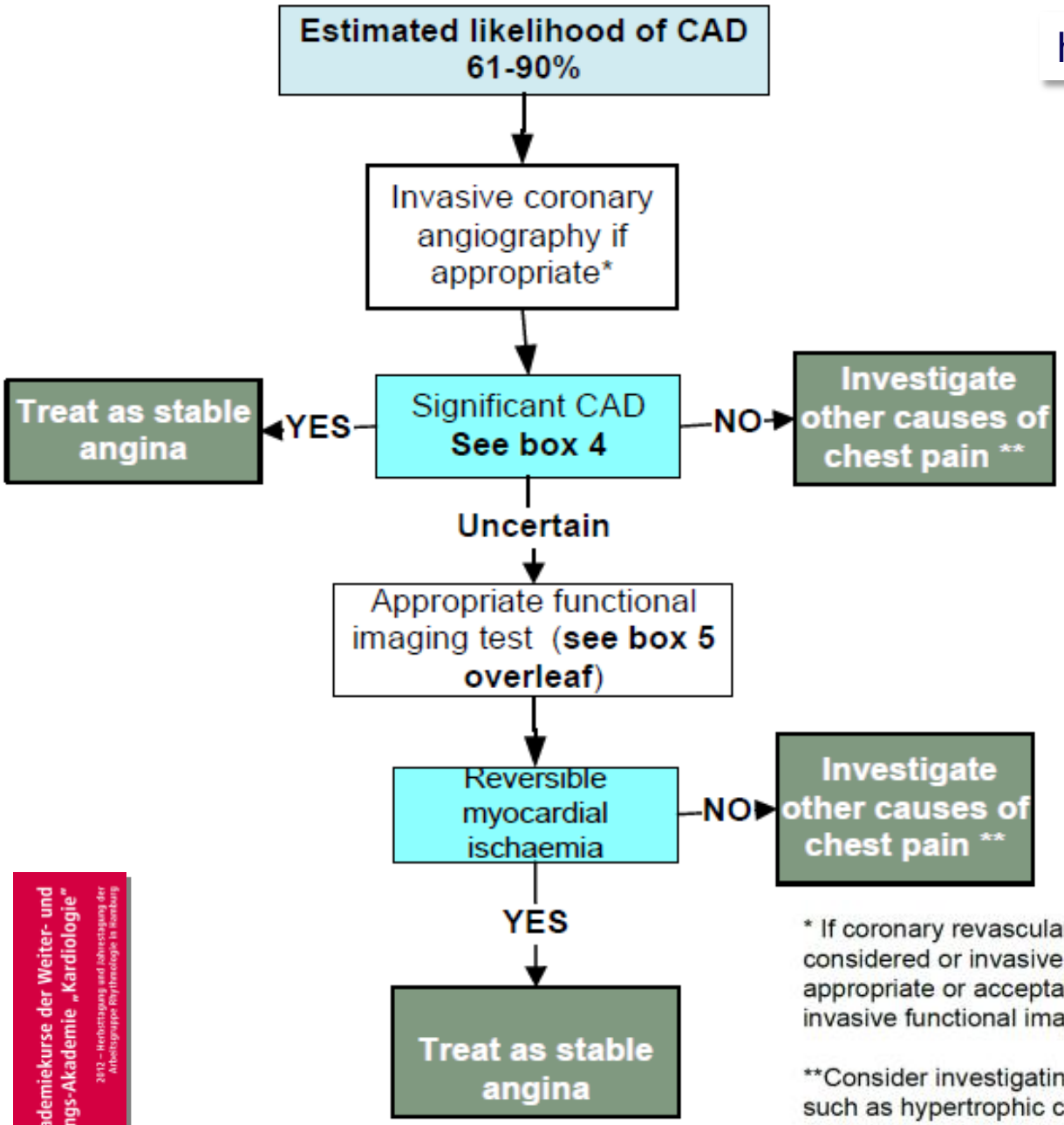
http://www.nice.org.uk/CG95

Testing in Patients with stable AP and 61–90% PTP



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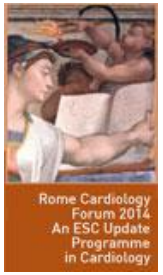
Summary

- PTP cornerstone of diagnostic algorithms in new guidelines
- Exercise ECG
  - ESC: allowed, not promoted
  - ACC/AHA: promoted
  - NICE: forbidden
- Imaging
  - ESC: stress suggested for all, mandatory in high PTP
  - ACC/AHA: MPI, stress echo promoted, CMR/CCTA restrictive
  - NICE: CTCS mandatory in low PTP, ICA in high PTP
- Referral bias likely to be present in studies determining test characteristics of diagnostic imaging

THE END



What Is A Significant Stenosis?

Box 4 Definition of significant coronary artery disease

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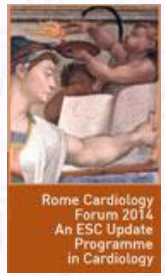
- Well developed collateral supply
- Small mass of ischaemic myocardium: distally located lesions, old infarction in the territory of coronary supply.

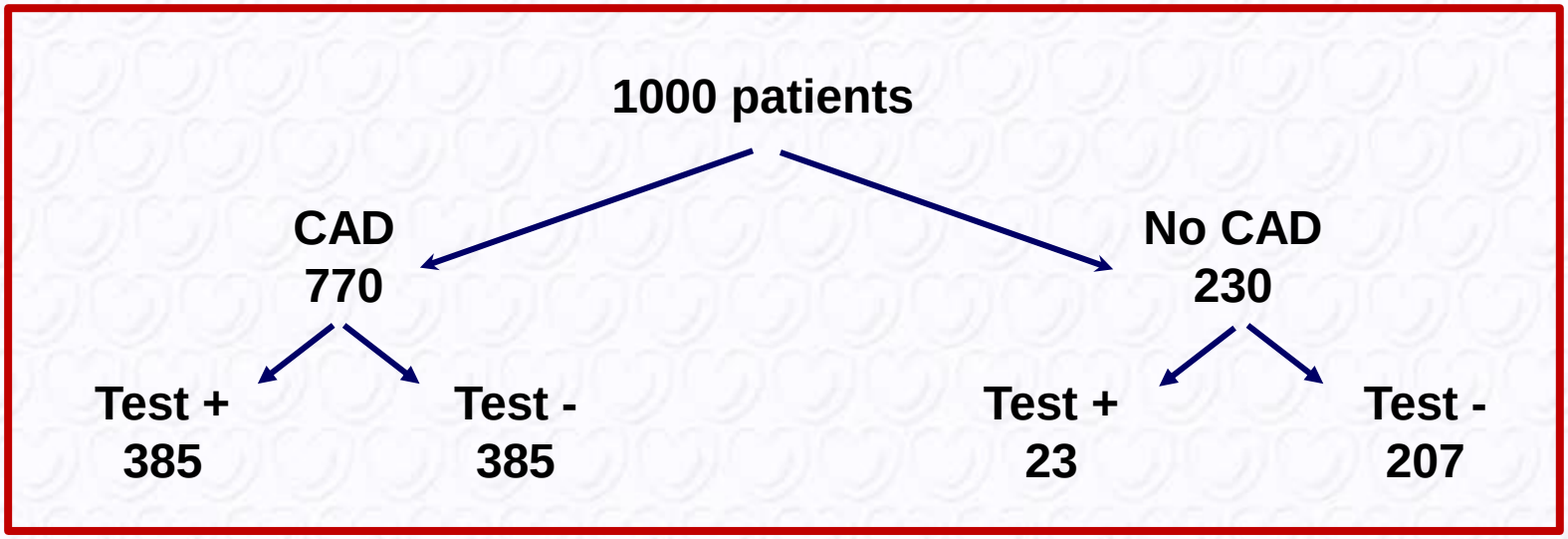
http://www.nice.org.uk/CG95

Which test increases the pretest probability for this patient?



Test = Exercise ECG
(sensitivity ≈ 50%, specificity ≈ 90%)

Pretest probability in this patient = 77%



Posttest probability „CAD“ for positive test = 385/408 = 94%

Posttest probability „No CAD“ for negative test = 207/592 = 35%

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Characteristics of tests commonly used to diagnose the presence of CAD

	Diagnosis of CAD	
	Sensitivity (%)	Specificity (%)
Exercise ECG [a, 91, 94, 95]	45–50	85–90
Exercise stress echocardiography[96]	80–85	80–88
Exercise stress SPECT[96-99]	73–92	63–87
Dobutamine stress echocardiography[96]	79–83	82–86
Dobutamine stress MRI[b,100]	79–88	81–91
Vasodilator stress echocardiography[96]	72–79	92–95
Vasodilator stress SPECT[96, 99]	90–91	75–84
Vasodilator stress MRI[b,98, 100-102]	67–94	61–85
Coronary CTA[c,103-105]	95–99	64–83
Vasodilator stress PET[97, 99, 106]	81–97	74–91

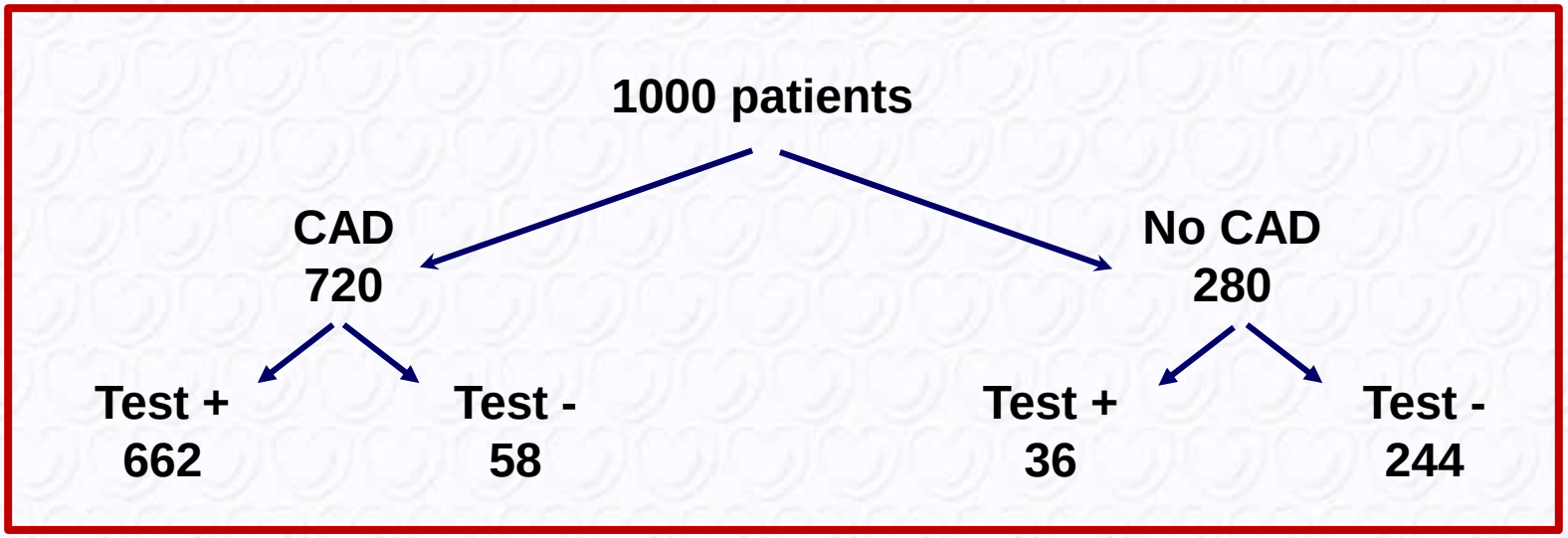
a. Results without/with minimal referral bias.
b. Results obtained in populations with medium-to-high prevalence of disease without compensation for referral bias.
c. Results obtained in populations with low-to-medium prevalence of disease.

CAD = coronary artery disease; CTA = computed tomography angiography; ECG = electrocardiogram; MRI = magnetic resonance imaging; PET = positron emission tomography; SPECT = single photon emission computed tomography.

Which test increases the pretest probability for this patient?

Test = Exercise stress SPECT (sensitivity ≈ 92%, specificity ≈ 87%)

Pretest probability in this patient = 72%



Posttest probability „CAD“ for positive test = 662/692 = 96%

Posttest probability „No CAD“ for negative test = 244/302 = 81%

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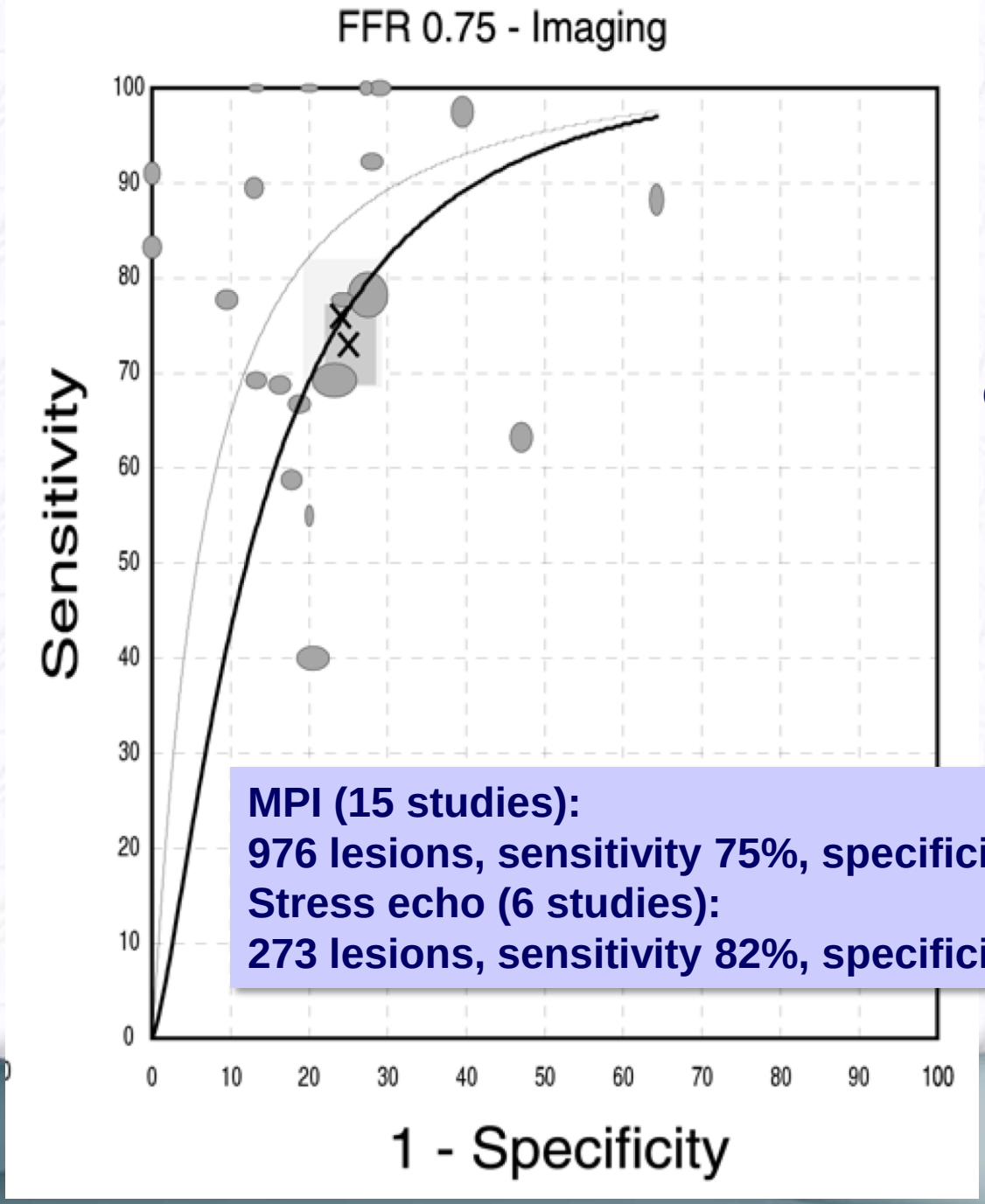

Gold Standard Anatomy or FFR?

Christou MAC et al. – Am J Cardiol 2007; 99:450–456

Meta-analysis of FFR against noninvasive imaging

MPI (15 studies):
976 lesions, sensitivity 75%, specificity 77%.
Stress echo (6 studies):
273 lesions, sensitivity 82%, specificity 74%.

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