Congresso
Novas Fronteiras em Cardiologia
8 a 10 fevereiro.2013
Hotel Vila Galé Ericeira

A PROVA DE ESFORÇO É INDISPENSÁVEL NO ALGORITMO DIAGNÓSTICO DE ISQUEMIA

Luís Martins Brízida
Assistente Hospitalar Graduado de Cardiologia
Serviço de Cardiologia
Hospital Fernando da Fonseca – Amadora/Sintra
HPP- Hospital dos Lusíadas

PROF. DOUTOR FERNANDO FONSECA EPE
HOSPITAL

HPP HOSPITAL
DOS LUSÍADAS

PERGUNTA

- A PROVA DE ESFORÇO É INDISPENSÁVEL NO ALGORITMO DIAGNÓSTICO DE ISQUEMIA?

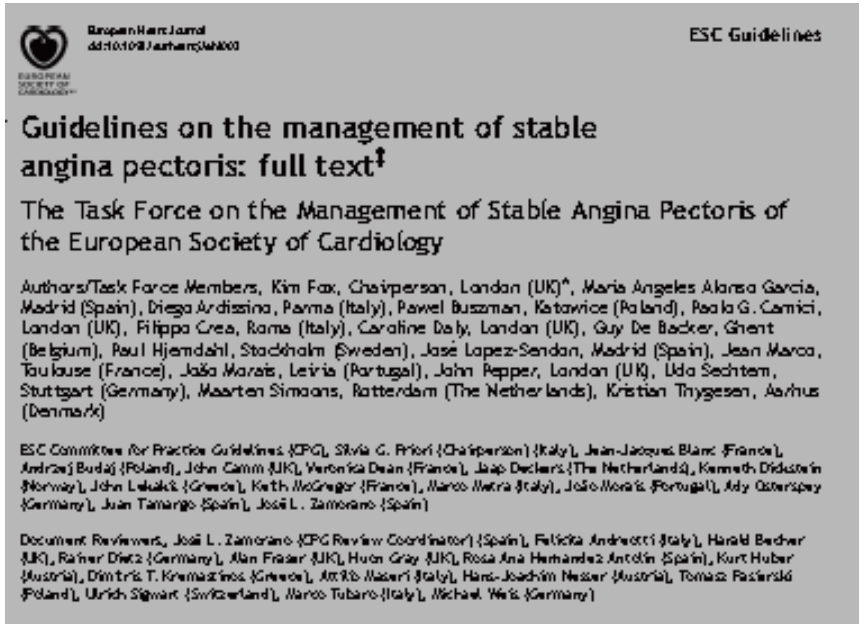
Congresso
Novas Fronteiras em Cardiologia
8 a 10 fevereiro.2013
Hotel Vila Galé Ericeira

PERGUNTA

- A PROVA DE ESFORÇO É INDISPENSÁVEL NO ALGORITMO DIAGNÓSTICO DE ISQUEMIA?

- SIM, MAS NÃO EM TODOS OS DOENTES.

Congresso
Novas Fronteiras em Cardiologia
8 a 10 fevereiro.2013
Hotel Vila Galé Ericeira



European Heart Journal
doi:10.1093/eurheartj/ehs000

ESC Guidelines

Guidelines on the management of stable angina pectoris: full text‡

The Task Force on the Management of Stable Angina Pectoris of the European Society of Cardiology

Authors/Task Force Members, Kim Fox, Chairperson, London (UK)*, Maria Angeles Alonso Garcia, Madrid (Spain), Diego Ardissino, Parma (Italy), Pawel Buszman, Katowice (Poland), Paola G. Camici, London (UK), Filippo Crea, Roma (Italy), Caroline Daly, London (UK), Guy De Backer, Ghent (Belgium), Paul Hjemdahl, Stockholm (Sweden), José Lopez-Sendon, Madrid (Spain), Jean Marco, Toulouse (France), João Morais, Leiria (Portugal), John Pepper, London (UK), Udo Sechtem, Stuttgart (Germany), Maarten Simoons, Rotterdam (The Netherlands), Kristian Thygesen, Aarhus (Denmark)

ESC Committee for Practice Guidelines (CPG), Silvia G. Priori (Chairperson) (Italy), Jean-Jacques Blanc (France), Andrzej Budaj (Poland), John Camm (UK), Veronica Dean (France), Jaap Deckers (The Netherlands), Kenneth Dickstein (Norway), John Lekakis (Greece), Keith McGregor (France), Marco Metra (Italy), João Morais (Portugal), Ady Osterspey (Germany), Juan Tamargo (Spain), José L. Zamorano (Spain)

Document Reviewers, José L. Zamorano (CPG Review Coordinator) (Spain), Felicita Andreotti (Italy), Harald Becher (UK), Rainer Dietz (Germany), Alan Fraser (UK), Huon Gray (UK), Rosa Ana Hernandez Antolin (Spain), Kurt Huber (Austria), Dimitris T. Kremastinos (Greece), Attilio Maseri (Italy), Hans-Joachim Nesser (Austria), Tomasz Pasierski (Poland), Ulrich Sigwart (Switzerland), Marco Tubaro (Italy), Michael Weis (Germany)

Guidelines ESC (2006)

Recommendations for exercise ECG for initial diagnostic assessment of angina

Class I

(1) Patients with symptoms of angina and intermediate pre-test probability of coronary disease based on age, gender, and symptoms, unless unable to exercise or displays ECG changes which make ECG non-evaluable (level of evidence B)

Class IIb

(1) Patients with ≥1 mm ST-depression on resting ECG or taking digoxin (level of evidence B)
(2) In patients with low pre-test probability (<10% probability) of coronary disease based on age, gender, and symptoms (level of evidence B)

Recommendations for exercise ECG for routine re-assessment in patients with chronic stable angina

Class IIb

(1) Routine periodic exercise ECG in the absence of clinical change (level of evidence C)

Congresso
Novas Fronteiras em Cardiologia
8 a 10 fevereiro.2013
Hotel Vila Galé Ericeira

Guidelines ESC (2006)

Recommendations for exercise ECG for initial diagnostic assessment of angina

Class I

(1) Patients with symptoms of angina and intermediate pre-test probability of coronary disease based on age, gender, and symptoms, unless unable to exercise or displays ECG changes which make ECG non-evaluable (level of evidence B)

Class IIb

(1) Patients with ≥1 mm ST-depression on resting ECG or taking digoxin (level of evidence B)
(2) In patients with low pre-test probability (<10% probability) of coronary disease based on age, gender, and symptoms (level of evidence B)

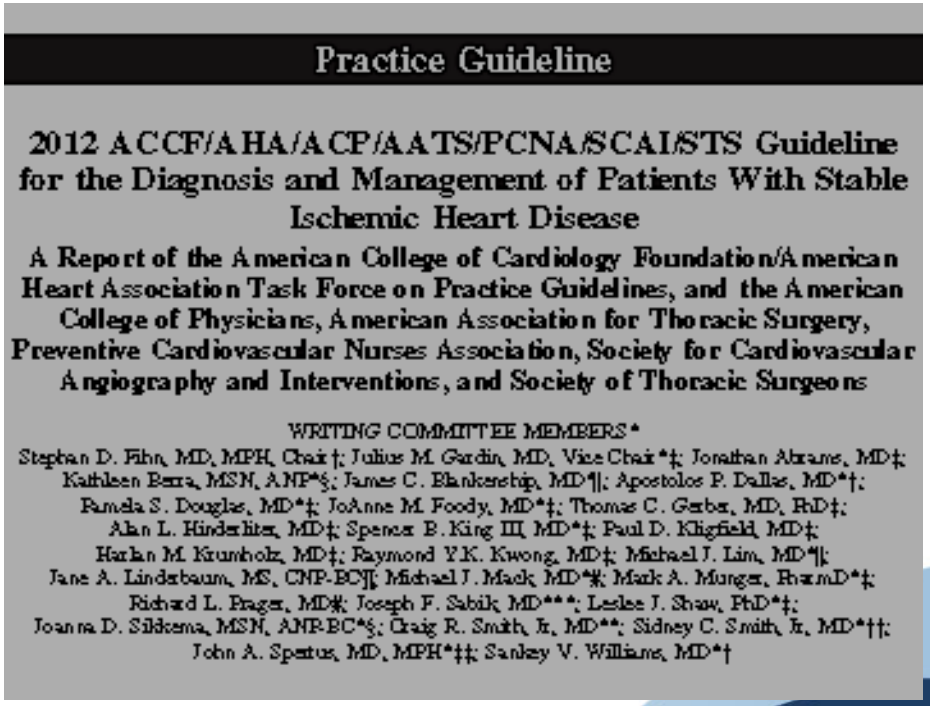
Recommendations for exercise ECG for routine re-assessment in patients with chronic stable angina

Class IIb

(1) Routine periodic exercise ECG in the absence of clinical change (level of evidence C)

Congresso
Novas Fronteiras em Cardiologia
8 a 10 fevereiro.2013
Hotel Vila Galé Ericeira

ACC/AHA 2012



Practice Guideline

2012 ACCF/AHA/ACP/AATS/PCNA/SCAI/STS Guideline for the Diagnosis and Management of Patients With Stable Ischemic Heart Disease

A Report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines, and the American College of Physicians, American Association for Thoracic Surgery, Preventive Cardiovascular Nurses Association, Society for Cardiovascular Angiography and Interventions, and Society of Thoracic Surgeons

WRITING COMMITTEE MEMBERS*

Stephan D. Fihn, MD, MPH, Chair†; Julius M. Gardin, MD, Vice Chair*‡; Jonathan Abrams, MD‡; Kathleen Berra, MSN, ANP*§; James C. Blankenship, MD¶; Apostolos P. Dallas, MD*†; Pamela S. Douglas, MD*‡; JoAnne M. Foody, MD*‡; Thomas C. Gerber, MD, PhD‡; Alan L. Hinderliter, MD‡; Spencer B. King III, MD*‡; Paul D. Kligfield, MD‡; Harlan M. Krumholz, MD‡; Raymond Y.K. Kwong, MD‡; Michael J. Lim, MD*¶; Jane A. Linderbaum, MS, CNP-BC¶; Michael J. Mack, MD*#; Mark A. Munger, PharmD*‡; Richard L. Prager, MD#; Joseph F. Sabik, MD**; Leslee J. Shaw, PhD*‡; Joanna D. Sikkema, MSN, ANP-BC*§; Craig R. Smith, Jr, MD**; Sidney C. Smith, Jr, MD*††; John A. Spertus, MD, MPH*‡‡; Sankey V. Williams, MD*†

ACC/AHA 2012

SIZE OF TREATMENT EFFECT →

ESTIMATE OF CERTAINTY (PRECISION) OF TREATMENT EFFECT	CLASS I *Benefit >>> Risk* Procedure/Treatment **SHOULD** be performed/ administered	CLASS IIa *Benefit >> Risk* *Additional studies with focused objectives needed* **IT IS REASONABLE** to perform procedure/administer treatment	CLASS IIb *Benefit ≥ Risk* *Additional studies with broad objectives needed; additional registry data would be helpful* Procedure/Treatment **MAY BE CONSIDERED**	CLASS III *Risk ≥ Benefit* Procedure/Treatment should **NOT** be performed/administered **SINCE IT IS NOT HELPFUL AND MAY BE HARMFUL**
LEVEL A Multiple populations evaluated* Data derived from multiple randomized clinical trials or meta-analyses	■ Recommendation that procedure or treatment is useful/effective ■ Sufficient evidence from multiple randomized trials or meta-analyses	■ Recommendation in favor of treatment or procedure being useful/effective ■ Some conflicting evidence from multiple randomized trials or meta-analyses	■ Recommendation's usefulness/efficacy less well established ■ Greater conflicting evidence from multiple randomized trials or meta-analyses	■ Recommendation that procedure or treatment is not useful/effective and may be harmful ■ Sufficient evidence from multiple randomized trials or meta-analyses
LEVEL B Limited populations evaluated* Data derived from a single randomized trial or nonrandomized studies	■ Recommendation that procedure or treatment is useful/effective ■ Evidence from single randomized trial or nonrandomized studies	■ Recommendation in favor of treatment or procedure being useful/effective ■ Some conflicting evidence from single randomized trial or nonrandomized studies	■ Recommendation's usefulness/efficacy less well established ■ Greater conflicting evidence from single randomized trial or nonrandomized studies	■ Recommendation that procedure or treatment is not useful/effective and may be harmful ■ Evidence from single randomized trial or nonrandomized studies
LEVEL C Very limited populations evaluated* Only consensus opinion of experts, case studies, or standard of care	■ Recommendation that procedure or treatment is useful/effective ■ Only expert opinion, case studies, or standard of care	■ Recommendation in favor of treatment or procedure being useful/effective ■ Only diverging expert opinion, case studies, or standard of care	■ Recommendation's usefulness/efficacy less well established ■ Only diverging expert opinion, case studies, or standard of care	■ Recommendation that procedure or treatment is not useful/effective and may be harmful ■ Only expert opinion, case studies, or standard of care
Suggested phrases for writing recommendations†	should is recommended is indicated is useful/effective/beneficial	is reasonable can be useful/effective/beneficial is probably recommended or indicated	may/might be considered may/might be reasonable usefulness/effectiveness is unknown/unclear/uncertain or not well established	is not recommended is not indicated should not is not useful/effective/beneficial may be harmful

Congresso
Novas Fronteiras em Cardiologia
8 a 10 fevereiro.2013
Hotel Vila Galé Ericeira

ACC/AHA 2012

2.2.2.1. Able to Exercise

Class I

1. **Standard exercise ECG testing is recommended for patients with an intermediate pretest probability of IHD who have an interpretable ECG and at least moderate physical functioning or no disabling comorbidity.[114,145–147] (*Level of Evidence: A*)**
2. **Exercise stress with nuclear MPI or echocardiography is recommended for patients with an intermediate to high pretest probability of IHD who have an uninterpretable ECG and at least moderate physical functioning or no disabling comorbidity.[91,132,148–156] (*Level of Evidence: B*)**

Class IIa

1. **For patients with a low pretest probability of obstructive IHD who do require testing, standard exercise ECG testing can be useful, provided the patient has an interpretable ECG and at least moderate physical functioning or no disabling comorbidity. (*Level of Evidence: C*)**
2. **Exercise stress with nuclear MPI or echocardiography is reasonable for patients with an intermediate to high pretest probability of obstructive IHD who have an interpretable ECG and at least moderate physical functioning or no disabling comorbidity.[91,132,148–156] (*Level of Evidence: B*)**
3. **Pharmacological stress with CMR can be useful for patients with an intermediate to high pretest probability of obstructive IHD who have an *un*interpretable ECG and at least moderate physical functioning or no disabling comorbidity.[153,157,158] (*Level of Evidence: B*)**

Class IIb

1. **CCTA might be reasonable for patients with an intermediate pretest probability of IHD who have at IHD who require testing and are incapable of at least moderate physical functioning or have disabling comorbidity. (*Level of Evidence: C*)**
2. **CCTA is reasonable for patients with a low to intermediate pretest probability of IHD who are incapable of at least moderate physical functioning or have disabling comorbidity.[158–166] (*Level of Evidence: B*)**
3. **Pharmacological stress CMR is reasonable for patients with an intermediate to high pretest probability of IHD who are incapable of at least moderate physical functioning or have disabling comorbidity.[153,157,158,169–172] (*Level of Evidence: B*)**

Class III: No Benefit

1. **Standard exercise ECG testing is not recommended for patients who have an *un*interpretable ECG or are incapable of at least moderate physical functioning or have disabling comorbidity.[91,132,148–156,161] (*Level of Evidence: C*)**

2.2.2.3. Other

Class IIa

1. **CCTA is reasonable for patients with an intermediate pretest probability of IHD who a) have continued symptoms with prior normal test findings, or b) have inconclusive results from prior exercise or pharmacological stress testing, or c) are unable to undergo stress with nuclear MPI or echocardiography.[173] (*Level of Evidence: C*)**

Class IIb

1. **For patients with a low to intermediate pretest probability of obstructive IHD, noncontrast cardiac CT to determine the CAC score may be considered.[174] (*Level of Evidence: C*)**

Congresso
Novas Fronteiras em Cardiologia
8 a 10 fevereiro.2013
Hotel Vila Galé Ericeira

ACC/AHA 2012

2.2.2.1. Able to Exercise

Cl

1. **Standard exercise ECG testing is recommended for patients with an intermediate pretest probability of IHD who have an interpretable ECG and at least moderate physical functioning or no disabling comorbidity.[114,145–147] (*Level of Evidence: A*)**
2. **Exercise stress with nuclear MPI or echocardiogr… ph… …mmended for patients with… …ermediate to high pretest probability of IHD who have an uninterpretable ECG and at least moderate physical functioning or no disabling comorbidity.[91,132,148–156] (*Level of Evidence: B*)**

Class IIa

1. **For patients with a low pretest probability of obstructive IHD who do require testing, standard exercise ECG testing can be useful, provided the patient has an interpretable ECG and at least moderate physical functioning or no disabling comorbidity. (*Level of Evidence: C*)**
2. **Exercise stress with nuclear MPI or echocardiography is reasonable for patients with an intermediate to high pretest probability of obstructive IHD who have an interpretable ECG and at least moderate physical functioning or no disabling comorbidity.[91,132,148–156] (*Level of Evidence: B*)**
3. **Pharmacological stress with CMR can be useful for patients with an intermediate to high pretest probability of obstructive IHD who have an *un*interpretable ECG and at least moderate physical functioning or no disabling comorbidity.[153,157,158] (*Level of Evidence: B*)**

Class IIb

1. **CCTA might be reasonable for patients with an intermediate pretest probability of IHD who have at IHD who require testing and are incapable of at least moderate physical functioning or have disabling comorbidity. (*Level of Evidence: C*)**
2. **CCTA is reasonable for patients with a low to intermediate pretest probability of IHD who are incapable of at least moderate physical functioning or have disabling comorbidity.[158–166] (*Level of Evidence: B*)**
3. **Pharmacological stress CMR is reasonable for patients with an intermediate to high pretest probability of IHD who are incapable of at least moderate physical functioning or have disabling comorbidity.[153,157,158,169–172] (*Level of Evidence: B*)**

Class III: No Benefit

1. **Standard exercise ECG testing is not recommended for patients who have an *un*interpretable ECG or are incapable of at least moderate physical functioning or have disabling comorbidity.[91,132,148–156,161] (*Level of Evidence: C*)**

2.2.2.3. Other

Class IIa

1. **CCTA is reasonable for patients with an intermediate pretest probability of IHD who a) have continued symptoms with prior normal test findings, or b) have inconclusive results from prior exercise or pharmacological stress testing, or c) are unable to undergo stress with nuclear MPI or echocardiography.[173] (*Level of Evidence: C*)**

Class IIb

1. **For patients with a low to intermediate pretest probability of obstructive IHD, noncontrast cardiac CT to determine the CAC score may be considered.[174] (*Level of Evidence: C*)**

Congresso
Novas Fronteiras em Cardiologia
8 a 10 fevereiro.2013
Hotel Vila Galé Ericeira

ACC/AHA 2012

2.2.2.1. Able to Exercise

Cl

1. **Standard exercise ECG testing is recommended for patients with an intermediate pretest probability of IHD who have an interpretable ECG and at least moderate physical functioning or no disabling comorbidity.[114,145–147] (*Level of Evidence: A*)**
2. **Exercise stress with nuclear MPI or echocardiogr… p… …mmended for patients with… …ermediate to high pretest probability of IHD who have an uninterpretable ECG and at least moderate physical functioning or no disabling comorbidity.[91,132,148–156] (*Level of Evidence: B*)**

Class IIa

1. **For patients with a low pretest probability of obstructive IHD who do require testing, standard exercise ECG testing can be useful, provided the patient has an interpretable ECG and at least moderate physical functioning or no disabling comorbidity. (*Level of Evidence: C*)**
2. **Exercise stress with nuclear MPI or echocardiography is reasonable for patients with an intermediate to high pretest probability of obstructive IHD who have an interpretable ECG and at least moderate physical functioning or no disabling comorbidity.[91,132,148–156] (*Level of Evidence: B*)**
3. **Pharmacological stress with CMR can be useful for patients with an intermediate to high pretest probability of obstructive IHD who have an *un*interpretable ECG and at least moderate physical functioning or no disabling comorbidity.[153,157,158] (*Level of Evidence: B*)**

Class IIb

1. **CCTA might be reasonable for patients with an intermediate pretest probability of IHD who have at IHD who require testing and are incapable of at least moderate physical functioning or have disabling comorbidity. (*Level of Evidence: C*)**
2. **CCTA is reasonable for patients with a low to intermediate pretest probability of IHD who are incapable of at least moderate physical functioning or have disabling comorbidity.[158–166] (*Level of Evidence: B*)**
3. **Pharmacological stress CMR is reasonable for patients with an intermediate to high pretest probability of IHD who are incapable of at least moderate physical functioning or have disabling comorbidity.[153,157,158,169–172] (*Level of Evidence: B*)**

Class III: No Benefit

1. **Standard exercise ECG testing is not recommended for patients who have an *un*interpretable ECG or are incapable of at least moderate physical functioning or have disabling comorbidity.[91,132,148–156,161] (*Level of Evidence: C*)**

2.2.2.3. Other

Class IIa

1. **CCTA is reasonable for patients with an intermediate pretest probability of IHD who a) have continued symptoms with prior normal test findings, or b) have inconclusive results from prior exercise or pharmacological stress testing, or c) are unable to undergo stress with nuclear MPI or echocardiography.[173] (*Level of Evidence: C*)**

Class IIb

1. **For patients with a low to intermediate pretest probability of obstructive IHD, noncontrast cardiac CT to determine the CAC score may be considered.[174] (*Level of Evidence: C*)**

Congresso
Novas Fronteiras em Cardiologia
8 a 10 fevereiro.2013
Hotel Vila Galé Ericeira

EM QUE DOENTES?

- PROBABILIDADE PRÉ-TESTE
  - SINTOMAS
  - SEXO
  - IDADE
  - FACTORES DE RISCO
  - PREVALÊNCIA DA DOENÇA NA POPULAÇÃO (TEOREMA DE BAYES)
- ECG
  - INTERPRETÁVEL OU NÃO? ALTERAÇÃO BASAL?
- CAPACIDADE DO DOENTE SE EXERCITAR?

Congresso
Novas Fronteiras em Cardiologia
8 a 10 fevereiro.2013
Hotel Vila Galé Ericeira

EM QUE DOENTES?

- PROBABILIDADE PRÉ-TESTE
  - SINTOMAS
  - SEXO
  - IDADE
  - FACTORES DE RISCO
  - PREVALÊNCIA DA DOENÇA NA POPULAÇÃO (TEOREMA DE BAYES)
- ECG
  - INTERPRETÁVEL OU NÃO? ALTERAÇÃO BASAL?
- CAPACIDADE DO DOENTE SE EXERCITAR?

Congresso
Novas Fronteiras em Cardiologia
8 a 10 fevereiro.2013
Hotel Vila Galé Ericeira

EM QUE DOENTES?

- PROBABILIDADE PRÉ-TESTE
  - SINTOMAS
  - SEXO
  - IDADE
  - FACTORES DE RISCO
  - PREVALÊNCIA DA DOENÇA NA POPULAÇÃO (TEOREMA DE BAYES)
- ECG
  - INTERPRETÁVEL OU NÃO? ALTERAÇÃO BASAL?
- CAPACIDADE DO DOENTE SE EXERCITAR?

EM QUE DOENTES?

- PROBABILIDADE PRÉ-TESTE
  - SINTOMAS
  - SEXO
  - IDADE
  - FACTORES DE RISCO
  - PREVALÊNCIA DA DOENÇA NA POPULAÇÃO (TEOREMA DE BAYES)

Sintomas

Angor típico: 3 critérios – desconforto retrosternal
Precipitado pelo exercício
Alívio em <10 min pelo repouso ou TNG

Angor atípico ou provável: pelo menos 2 dos 3 critérios

"Walk-through angina": Angina típica ocorrendo durante o exercício e que desaparece apesar da manutenção ou incremento do exercício

Dôr inespecífica: 1 dos critérios

Appendix Table 1. **Clinical Classification of Chest Pain**

Typical angina (definite)
1. Substernal chest discomfort with a characteristic quality and duration that is
2. Provoked by exertion or emotional stress and
3. Relieved by rest or nitroglycerin

Atypical angina (probable)
Meets 2 of the above characteristics

Noncardiac chest pain
Meets 1 or none of the typical anginal characteristics

Adapted from Braunwald et al (9) with permission.

Congresso
Novas Fronteiras em Cardiologia
8 a 10 fevereiro.2013
Hotel Vila Galé Ericeira

PROBABILIDADE PRÉ-TESTE DE DOENÇA CORONÁRIA

HOMEM	ANGOR (3 CRITÉRIOS)	ANG.ATIPICO/ PROVÁVEL (2 CRITÉRIOS)	INESPECIFICA	ASSINTOMATICO
30-39				
40-49				
50-59				
60-69				

	ALTO RISCO	>90%
	INTERMÉDIO	10-90%
	BAIXO	< 10%
	MUITO BAIXO	< 5%

Modified from ACC/AHA 2002 Guideline Update for Exercise Testing

Congresso
Novas Fronteiras em Cardiologia
8 a 10 fevereiro.2013
Hotel Vila Galé Ericeira

PROBABILIDADE PRÉ-TESTE DE DOENÇA CORONÁRIA

MULHER	ANGOR (3 CRITÉRIOS)	ANG.ATIPICO/ PROVÁVEL (2 CRITÉRIOS)	INESPECIFICA	ASSINTOMATICO
30-39				
40-49				
50-59				
60-69				

	ALTO RISCO	>90%
	INTERMÉDIO	10-90%
	BAIXO	< 10%
	MUITO BAIXO	< 5%

Modified from ACC/AHA 2002 Guideline Update for Exercise Testing

Congresso
Novas Fronteiras em Cardiologia
8 a 10 fevereiro.2013
Hotel Vila Galé Ericeira

PROBABILIDADE PRÉ-TESTE DE DOENÇA CORONÁRIA

Appendix Table 4. **Pretest Likelihood of Coronary Artery Disease in Symptomatic Patients According to Age and Sex***

Age, y	Nonanginal Chest Pain, %		Atypical Angina, %		Typical Angina, %	
	Men	Women	Men	Women	Men	Women
30–39	4	2	34	12	76	26
40–49	13	3	51	22	87	55
50–59	20	7	65	31	93	73
60–69	27	14	72	51	94	86

* Combined data from Diamond and Forrester's study (13) and Coronary Artery Surgery Study (14). Each value represents the percentage with significant coronary artery disease on catheterization. Adapted from Diamond and Forrester (13) with permission.

Appendix Table 5. **Comparing Pretest Likelihoods of Coronary Artery Disease in Low-Risk Symptomatic Patients and High-Risk Symptomatic Patients***

Age, y	Nonanginal Chest Pain, %		Atypical Angina, %		Typical Angina, %	
	Men	Women	Men	Women	Men	Women
35	3–35	1–19	8–59	2–39	30–88	10–78
45	9–47	2–22	21–70	5–43	51–92	20–79
55	23–59	4–21	45–79	10–47	80–95	38–82
65	49–69	9–29	71–86	20–51	93–97	56–84

* From the Duke Database. Each value represents the percentage with significant coronary artery disease. The first is the percentage for a low-risk, mid-decade patient without diabetes, smoking, or hyperlipidemia. The second is that of the same-age patient with diabetes, smoking, and hyperlipidemia. Both high- and low-risk patients have normal results on resting electrocardiography. If ST-T wave changes or Q waves had been present, the likelihood of coronary artery disease would be higher in each entry of the table. Reprinted from Pryor et al (16) with permission.

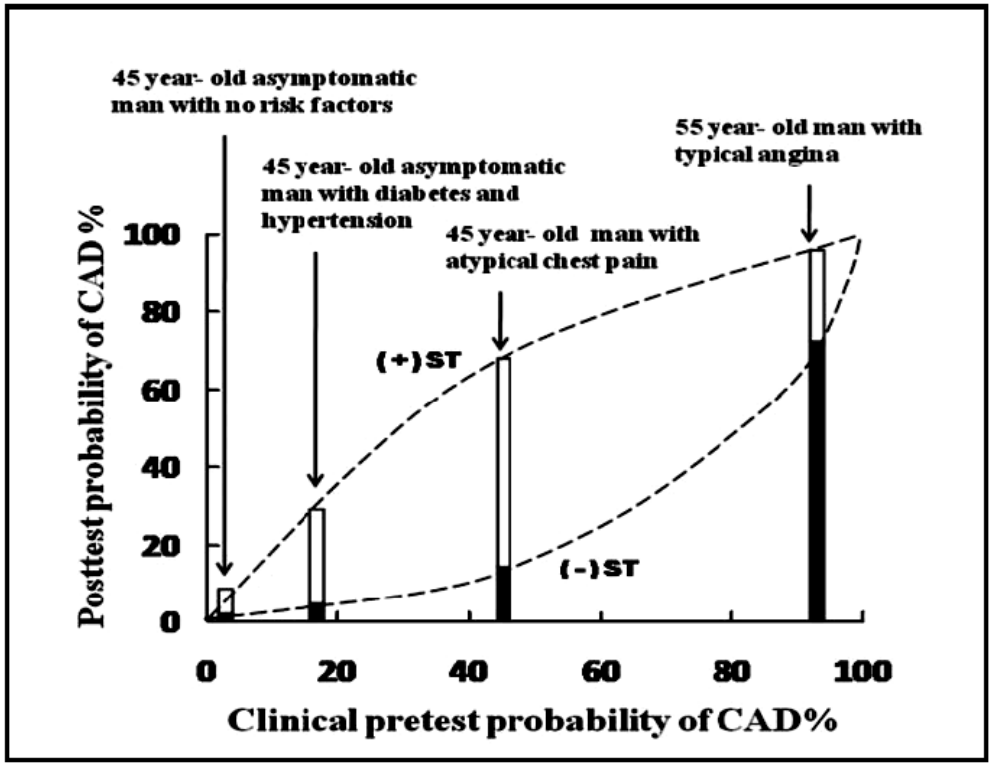
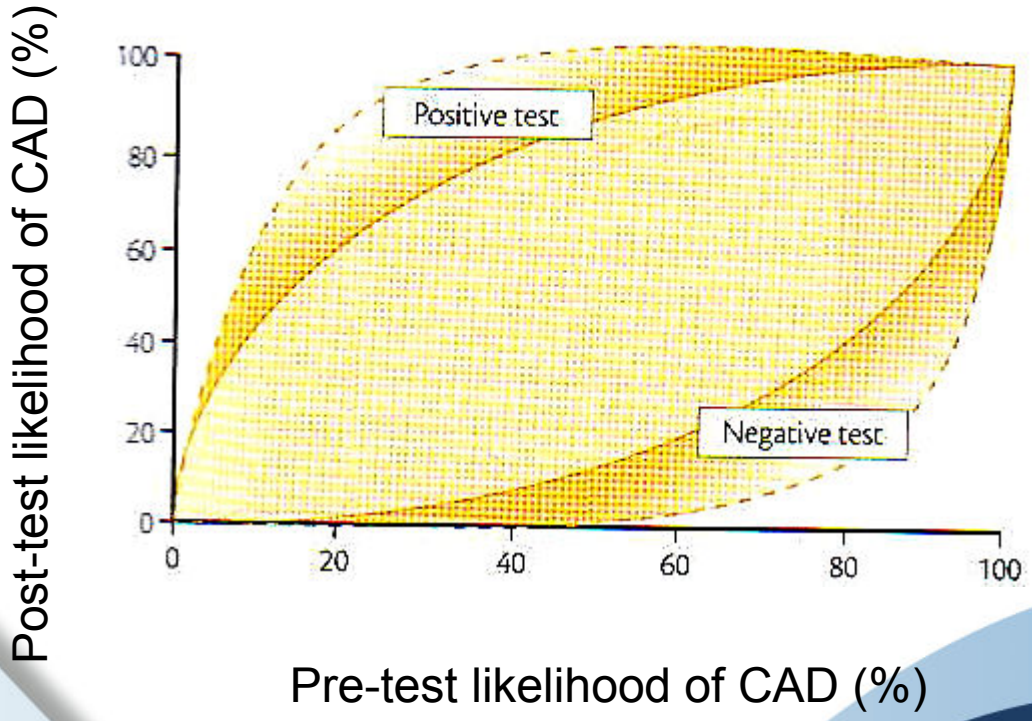


FIGURE 2. *The post-test probability of CAD is dependent upon pretest likelihood of CAD and test results. Reprinted from the* Journal of the American College of Cardiology, *Vol 13 / edition 7, Patterson RE, Horowitz SF, Importance of epidemiology and biostatistics in deciding clinical strategies for using diagnostic tests: A simplified approach using examples from coronary artery disease, 1653-1665, 1989, with permission from Elsevier.*

- Am J Cardiol 1980, 46, 491-9



ESTATÍSTICA

Table 5. Definitions and Calculation of the Terms Used to Quantify the Diagnostic Accuracy of a Test

$$\text{Sensitivity} = [TP/(TP + FN)] \times 100 \quad \text{Specificity} = [TN/(FP + TN)] \times 100$$

$$\text{Predictive value of an abnormal test (PV+)} = \frac{\text{Sensitivity} \times P(CAD)}{[\text{Sensitivity} \times P(CAD)] + [(1 - \text{Specificity})[1 - P(CAD)]]}$$

$$\text{Predictive accuracy} = [\text{Sensitivity} \times P(CAD)] + [\text{Specificity} \times [1 - P(CAD)]]$$

TP indicates those with an abnormal test result and disease (true-positives); TN, those with a normal test result and no disease (true-negatives); FP, those with an abnormal test result but no disease (false-positives); FN, those with a normal test result but disease (false-negatives); PV1, the percentage of those with an abnormal (1) test result who have disease; predictive accuracy, the percentage of correct classifications, both 1 and 2; and P(CAD), pretest probability.

ESTATÍSTICA

Table 6. Effect of Disease Prevalence on Predictive Value of a Positive Test

Prevalence of CAD (%)	Subjects	Test Characteristics	Number With Abnormal Test Result	Number With Normal Test Result	Predictive Value of a Positive Result
5	500 with CAD	50% sensitive	250 (TP)	250 (FN)	250/(250 + 950)
	9500 without CAD	90% specific	950 (FP)	8550 (TN)	= 21%
50	5000 with CAD	50% sensitive	2500 (TP)	2500 (FN)	2500/(2500 + 500)
	5000 without CAD	90% specific	500 (FP)	4500 (TN)	= 83%

Calculation of the predictive value of an abnormal test (positive predictive value) using a test with a sensitivity of 50% and a specificity of 90% in two populations of 10,000 patients, one with a CAD prevalence of 5% and the other with a prevalence of 50%. In a test with characteristics like the exercise ECG, the predictive value of 1 mm of ST depression increases from 21% when there is a 5% prevalence of disease to 83% when there is a 50% prevalence of disease. Thus, four times as many of those with an abnormal test result will be found to have coronary disease when the patient population increases from a 5% prevalence of CAD to a 50% prevalence. These calculations demonstrate the important influence that prevalence has on the positive predictive value. PV+ is the test performance characteristic most apparent to the clinician using the test. This explains the greater percentage of false-positive results found when the test is used as a screening procedure in an asymptomatic group (with a low prevalence of CAD) as opposed to when it is used as a diagnostic procedure in patients with symptoms most likely due to CAD (higher prevalence of CAD). For 5% prevalence: PV+ = 250/(250 + 950) = 21%. For 50% prevalence: PV+ = 2500/(2500 + 500) = 83%. CAD indicates coronary artery disease; TP, true-positive; FN, false-negative; FP, false-positive; and TN, true-negative.

Congresso
Novas Fronteiras em Cardiologia
8 a 10 fevereiro.2013
Hotel Vila Galé Ericeira

EM QUE DOENTES?

- PROBABILIDADE PRÉ-TESTE
  - SINTOMAS
  - SEXO
  - IDADE
  - FACTORES DE RISCO
  - PREVALÊNCIA DA DOENÇA NA POPULAÇÃO (TEOREMA DE BAYES)
- ECG
  - INTERPRETÁVEL OU NÃO ?ALTERAÇÃO BASAL?

CAUSAS DE FALSOS POSITIVOS E NEGATIVOS

Table 25.9 Causes of false-positive and false-negative exercise test

False-positive
Left ventricular hypertrophy
Resting repolarization abnormalities (left bundle branch block, WPW pre-excitation, etc.)
Non-ischaemic cardiomyopathy
Digoxin
Systemic hypertension
Mitral valve prolapse
Pericardial disease
Hypokalaemia
Anaemia
Female sex
Interpretative error
False-negative
Lack of ischaemic threshold attainment
Lack of appreciation of symptoms or non-ECG signs possibly associated with CAD
Significant obstructive CAD well compensated by collateral circulation
Interpretation error

CAUSAS DE FALSOS POSITIVOS E NEGATIVOS

Table 25.9 Causes of false-positive and false-negative exercise test

False-positive
Left ventricular hypertrophy
Resting repolarization abnormalities (left bundle branch block, WPW pre-excitation, etc.)
Non-ischaemic cardiomyopathy
Digoxin
Systemic hypertension
Mitral valve prolapse
Pericardial disease
Hypokalaemia
Anaemia
Female sex
Interpretative error
False-negative
Lack of ischaemic threshold attainment
Lack of appreciation of symptoms or non-ECG signs possibly associated with CAD
Significant obstructive CAD well compensated by collateral circulation
Interpretation error

CAUSAS DE FALSOS POSITIVOS E NEGATIVOS

Table 25.9 Causes of false-positive and false-negative exercise test

False-positive
Left ventricular hypertrophy
Resting repolarization abnormalities (left bundle branch block, WPW pre-excitation, etc.)
Non-ischaemic cardiomyopathy
Digoxin
Systemic hypertension
Mitral valve prolapse
Pericardial disease
Hypokalaemia
Anaemia
Female sex
Interpretative error
False-negative
Lack of ischaemic threshold attainment
Lack of appreciation of symptoms or non-ECG signs possibly associated with CAD
Significant obstructive CAD well compensated by collateral circulation
Interpretation error

META-ANÁLISES: SENSIBILIDADE E ESPECIFICIDADE

68%

77%

Table 7. Meta-Analyses of Exercise Testing[25,26]

Grouping	Number of Studies	Total Number of Patients	Sens (%)	Spec (%)	Predictive Accuracy (%)
Meta-analysis of standard exercise test	147	24,047	68	77	73
Meta-analysis without MI	58	11,691	67	72	69
Meta-analysis without workup bias	3	>1000	50	90	69
Meta-analysis with ST depression	22	9153	69	70	69
Meta-analysis without ST depression	3	840	67	84	75
Meta-analysis with digoxin	15	6338	68	74	71
Meta-analysis without digoxin	9	3548	72	69	70
Meta-analysis with LVH	15	8016	68	69	68
Meta-analysis without LVH	10	1977	72	77	74

Sens indicates sensitivity; Spec, specificity; MI, myocardial infarction; and LVH, left ventricular hypertrophy.

73%

META-ANÁLISES: SENSIBILIDADE E ESPECIFICIDADE

Table 7. Meta-Analyses of Exercise Testing[25,26]

Grouping	Number of Studies	Total Number of Patients	Sens (%)	Spec (%)	Predictive Accuracy (%)
Meta-analysis of standard exercise test	147	24,047	68	77	73
Meta-analysis without MI	58	11,691	67	72	69
Meta-analysis without workup bias	3	>1000	50	90	69
Meta-analysis with ST depression	22	9153	69	70	69
Meta-analysis without ST depression	3	840	67	84	75
Meta-analysis with digoxin	15	6338	68	74	71
Meta-analysis without digoxin	9	3548	72	69	70
Meta-analysis with LVH	15	8016	68	69	68
Meta-analysis without LVH	10	1977	72	77	74

Sens indicates sensitivity; Spec, specificity; MI, myocardial infarction; and LVH, left ventricular hypertrophy.

META-ANÁLISES: SENSIBILIDADE E ESPECIFICIDADE

Table 7. Meta-Analyses of Exercise Testing[25,26]

Grouping	Number of Studies	Total Number of Patients	Sens (%)	Spec (%)	Predictive Accuracy (%)
Meta-analysis of standard exercise test	147	24,047	68	77	73
Meta-analysis without MI	58	11,691	67	72	69
Meta-analysis without workup bias	3	>1000	50	90	69
Meta-analysis with ST depression	22	9153	69	70	69
Meta-analysis without ST depression	3	840	67	84	75
Meta-analysis with digoxin	15	6338	68	74	71
Meta-analysis without digoxin	9	3548	72	69	70
Meta-analysis with LVH	15	8016	68	69	68
Meta-analysis without LVH	10	1977	72	77	74

Sens indicates sensitivity; Spec, specificity; MI, myocardial infarction; and LVH, left ventricular hypertrophy.

META-ANÁLISES: SENSIBILIDADE E ESPECIFICIDADE

Table 7. Meta-Analyses of Exercise Testing[25,26]

Grouping	Number of Studies	Total Number of Patients	Sens (%)	Spec (%)	Predictive Accuracy (%)
Meta-analysis of standard exercise test	147	24,047	68	77	73
Meta-analysis without MI	58	11,691	67	72	69
Meta-analysis without workup bias	3	>1000	50	90	69
Meta-analysis with ST depression	22	9153	69	70	69
Meta-analysis without ST depression	3	840	67	84	75
Meta-analysis with digoxin	15	6338	68	74	71
Meta-analysis without digoxin	9	3548	72	69	70
Meta-analysis with LVH	15	8016	68	69	68
Meta-analysis without LVH	10	1977	72	77	74

Sens indicates sensitivity; Spec, specificity; MI, myocardial infarction; and LVH, left ventricular hypertrophy.

Congresso
Novas Fronteiras em Cardiologia
8 a 10 fevereiro.2013
Hotel Vila Galé Ericeira

EM QUE DOENTES?

- PROBABILIDADE PRÉ-TESTE
  - SINTOMAS
  - SEXO
  - IDADE
  - FACTORES DE RISCO
  - PREVALÊNCIA DA DOENÇA NA POPULAÇÃO (TEOREMA DE BAYES)
- ECG
  - INTERPRETÁVEL OU NÃO ?
- CAPACIDADE DO DOENTE SE EXERCITAR?

CAUSAS DE FALSOS POSITIVOS E NEGATIVOS

Table 25.9 Causes of false-positive and false-negative exercise test

False-positive
Left ventricular hypertrophy
Resting repolarization abnormalities (left bundle branch block, WPW pre-excitation, etc.)
Non-ischaemic cardiomyopathy
Digoxin
Systemic hypertension
Mitral valve prolapse
Pericardial disease
Hypokalaemia
Anaemia
Female sex
Interpretative error
False-negative
Lack of ischaemic threshold attainment
Lack of appreciation of symptoms or non-ECG signs possibly associated with CAD
Significant obstructive CAD well compensated by collateral circulation
Interpretation error

Congresso
Novas Fronteiras em Cardiologia
8 a 10 fevereiro.2013
Hotel Vila Galé Ericeira

CAUSAS DE FALSOS NEGATIVOS

Tabela 1 – Equações de predição da freqüência cardíaca máxima

Equação	Aplicação	Referência
FC máx. = 220 - idade	Geral	Karvonen et al., 1957
FC máx. = 210 – 0,65 * idade	Geral	Jones et al., 1975
FC máx. = 206 – 0,597 * idade	Mulheres	Hossack et al., 1981
FC máx. = 205 – 0,41 * idade	Homens Sedentários	Sheffield et al., 1965
FC máx. = 198 – 0,41 * idade	Homens Ativos	Sheffield et al., 1965
FC máx. = 201 – 0,6 * idade	Homens	Calvert et al., 1977
FC máx. = 192 – 0,7 * idade	Mulheres	Calvert et al., 1977
FC máx. = 209 - 0,7 * idade	Homens	Univer. de Ball State
FC máx. = 214 - 0,8 * idade	Mulheres	Univer. de Ball State

Frequência cardíaca máxima e VO2 max

Relação entre % FC máx e VO2 máx	
%VO² máx	%FC máx
28	50
42	60
56	70
70	80
83	90
100	100

80%

85%

Tabela 2 – Relação do percentual da freqüência cardíaca e percentual do consumo máximo de oxigênio, proposta por Marion et al. (1994).

Frequência cardíaca máxima e VO2 max

Classificação de atividades aeróbias baseadas em atividades de 60 min			
	%VO² máx	%FC máx	PSE
Muito Leve	<20	<35	<10
Leve	20-30	35-54	10-11
Moderada	40-59	55-69	12-13
Intensa	80% 60-84	70-89 85%	14-16
Muito Intensa	> ou igual a 85	> ou igual a 90	17-19
Máximo	100	100	20

Fonte:
McArdle, Katch, Katch, 1986
ACMS, 1998
Pini, M.C. Fisiologia Esportiva - 1983

PROVA DE ESFORÇO

- IMPORTÂNCIA NA ESTRATIFICAÇÃO PROGNÓSTICA DA DOENÇA CORONÁRIA
- DECISÃO NA REALIZAÇÃO DE EXAME MAIS INVASIVO (CORONARIOGRAFIA)

Table 16. Prognostic Studies of Exercise Testing

Study	Years of Enrollment	N	Length of Follow-up (y)	Independent Prognostic Factors
CASS[102]	1974–1979	4083	5	1. CHF 2. TM stage 3. Exercise-induced ST depression
Duke[103]	1969–1981	2842	5	1. Exercise-induced ST deviation 2. Exercise-induced angina 3. Exercise duration
Long Beach VA[104]	1984–1990	2546	5	1. CHF/digoxin use 2. METs 3. Max SBP 4. Exercise-induced ST depression
Italian CNR[105]	1976–1979	1083	5.5	1. Q wave 2. Prior MI 3. Effort ischemia 4. Exercise capacity
Belgian[106]	1978–1985	470	5	1. Age 2. Score of maximum HR, ST depression, angina, watts, ST slope
German[107]	1975–1978	1238	4.5	1. Exercise tolerance (watts) 2. Maximum HR
Seattle Heart Watch[108]	1971–1974	733	3.3	1. CHF 2. Maximum double product 3. Max SBP 4. Angina 5. Resting ST depression

CASS indicates Coronary Artery Surgery Study; CHF, congestive heart failure; TM, treadmill; VA, Veterans Administration; METs, metabolic equivalents; Max, maximum; SBP, systolic blood pressure; CNR, Consiglio Nazionale Ricerche; MI, myocardial infarction; and HR, heart rate.

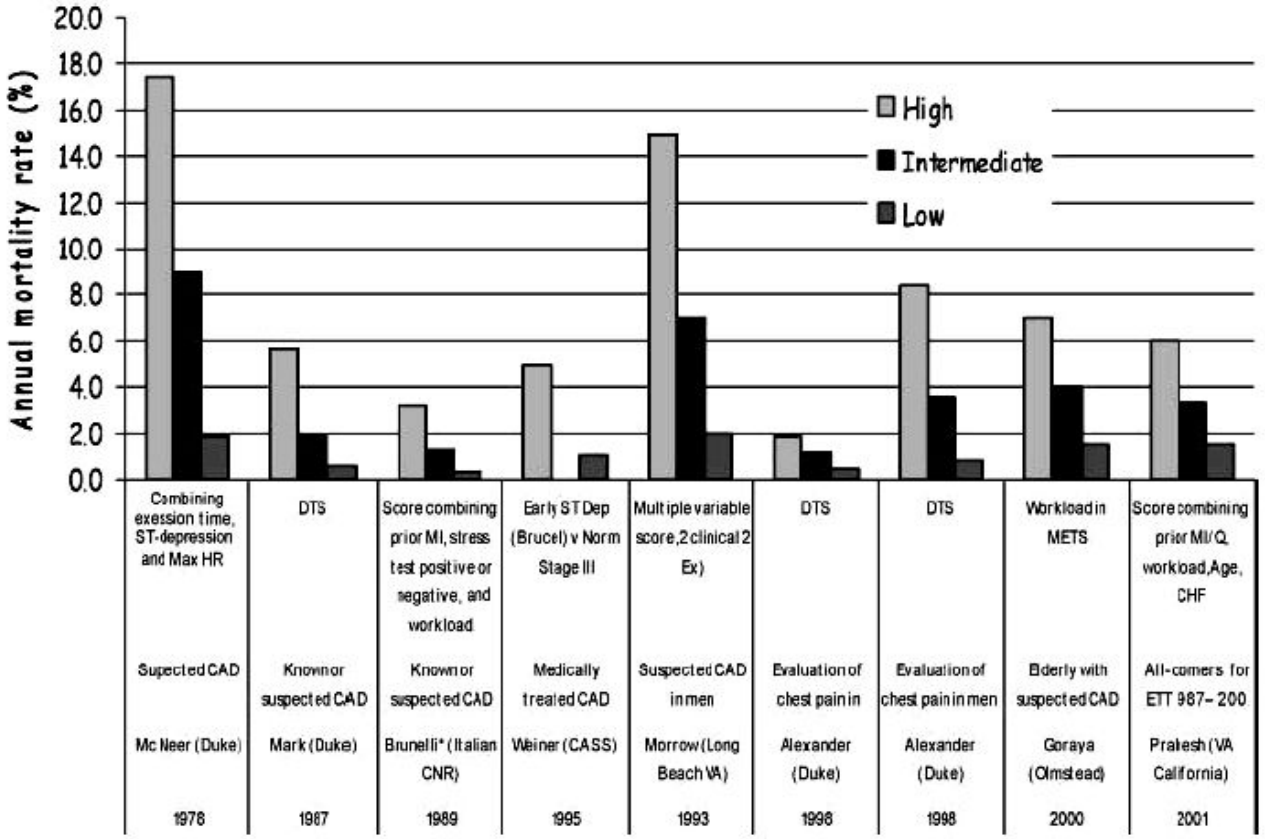


Figure 5 Prognostic stratification according to combined clinical and exercise variables.[52,270–273,681–683]

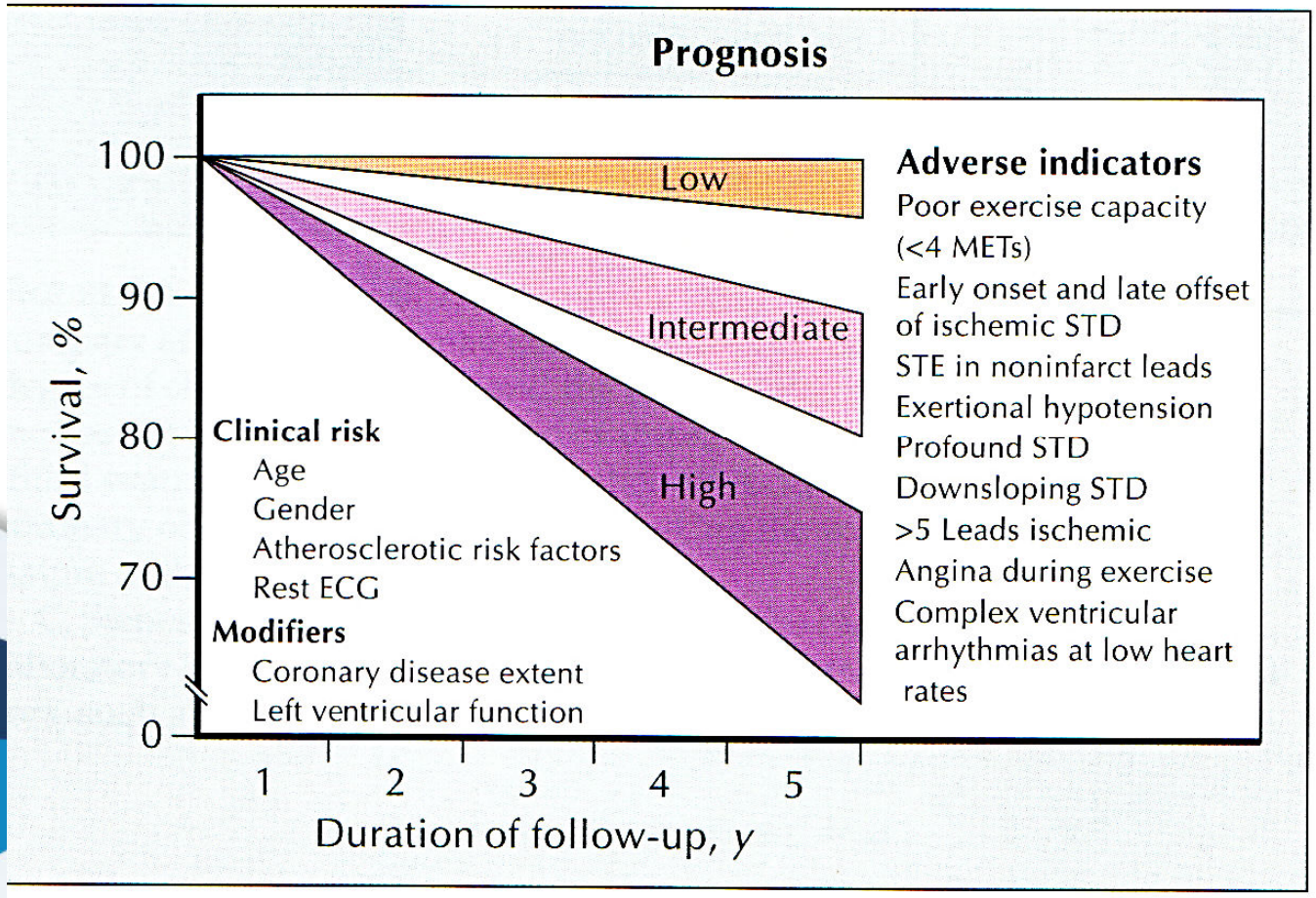

Prognosis
100
90
80
70
0
Survival, %
Low
Intermediate
High
Clinical risk
Age
Gender
Atherosclerotic risk factors
Rest ECG
Modifiers
Coronary disease extent
Left ventricular function
Adverse indicators
Poor exercise capacity (<4 METs)
Early onset and late offset of ischemic STD
STE in noninfarct leads
Exertional hypotension
Profound STD
Downsloping STD
>5 Leads ischemic
Angina during exercise
Complex ventricular arrhythmias at low heart rates
1
2
3
4
5
Duration of follow-up, y

Table 2. High-risk features of noninvasive modalities

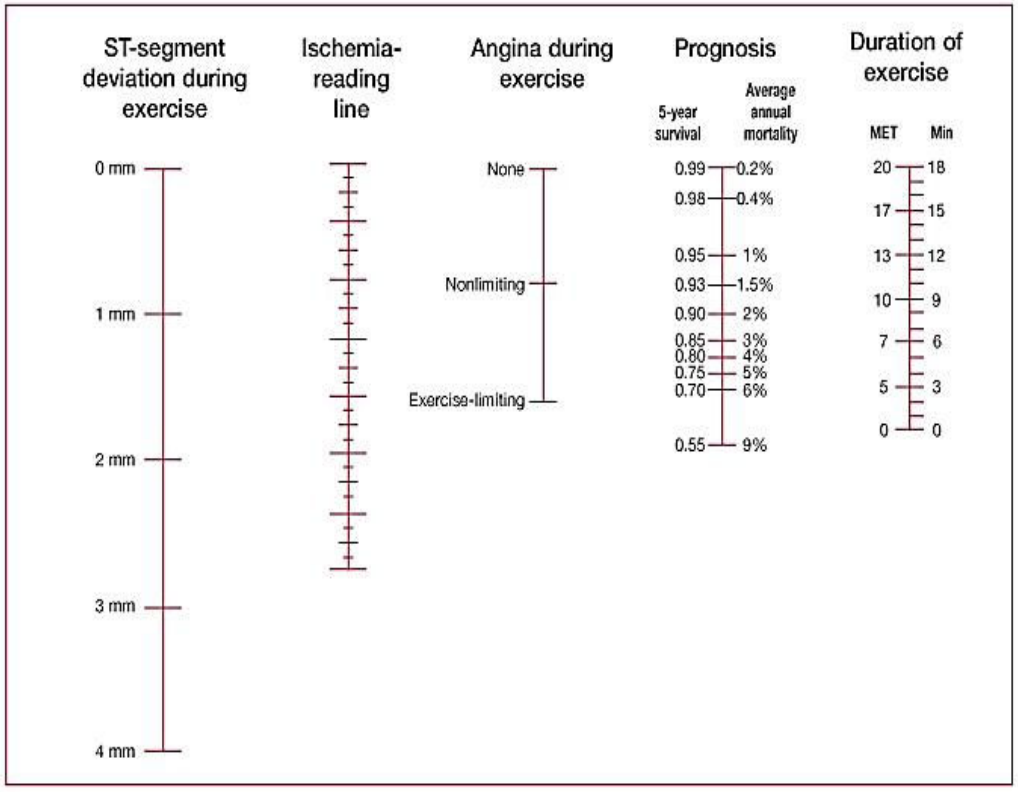
MPI
Large reversible perfusion defect
Multiple perfusion defects
SDS ≥13
Poststress TID
Poststress RV uptake
Poststress lung uptake
Abnormal poststress LVEF
Stress ECHO
Poststress global LV impairment
Diastolic dysfunction
Poststress LV cavity dilatation
Mitral regurgitation
Cardiac CT
Left main stenosis ≥ 50%
3 vessel disease
2 vessel disease including proximal LAD
Cardiac MR
SDS ≥7
Presence of late gadolinium enhancement and reversible perfusion defects
Exercise Treadmill Testing (ETT)
Duke score < -11 (ST-segment depression, exercise time and symptoms)
Time to onset of ST-segment depression
ST-segment elevation
Time to resolution of ST-segment depression
Exercise induced ventricular arrhythmias

CAD= coronary artery disease, MPI= myocardial perfusion imaging, SDS= sum difference score (sum stress score-sum rest score), TID= transient ischemic dilatation, RV= right ventricle, LVEF= left ventricular ejection fraction, ECHO= echocardiography, LAD= left anterior descending artery

Score de Duke

- DTS= exercise time-(5 x ST deviation)-(4 x exercise angina), 0=none
- 1=nonlimiting
- 2=exercise-limiting.

- Low risk: 5+15
- Moderate Risk: -10+4
- High Risk: -11-25



Duke treadmill score	
Exercise time in minutes	n
mm ST-depression × 5	$-n$
Angina, not limiting × 4	$-n$
Angina, limiting × 8	$-n$

Risk		1-year mortality
Low risk	≥5	0.25%
Intermediate	4 to −10	1.25%
High	≤−11	5.25%

Figure 4 Duke treadmill score.[272]

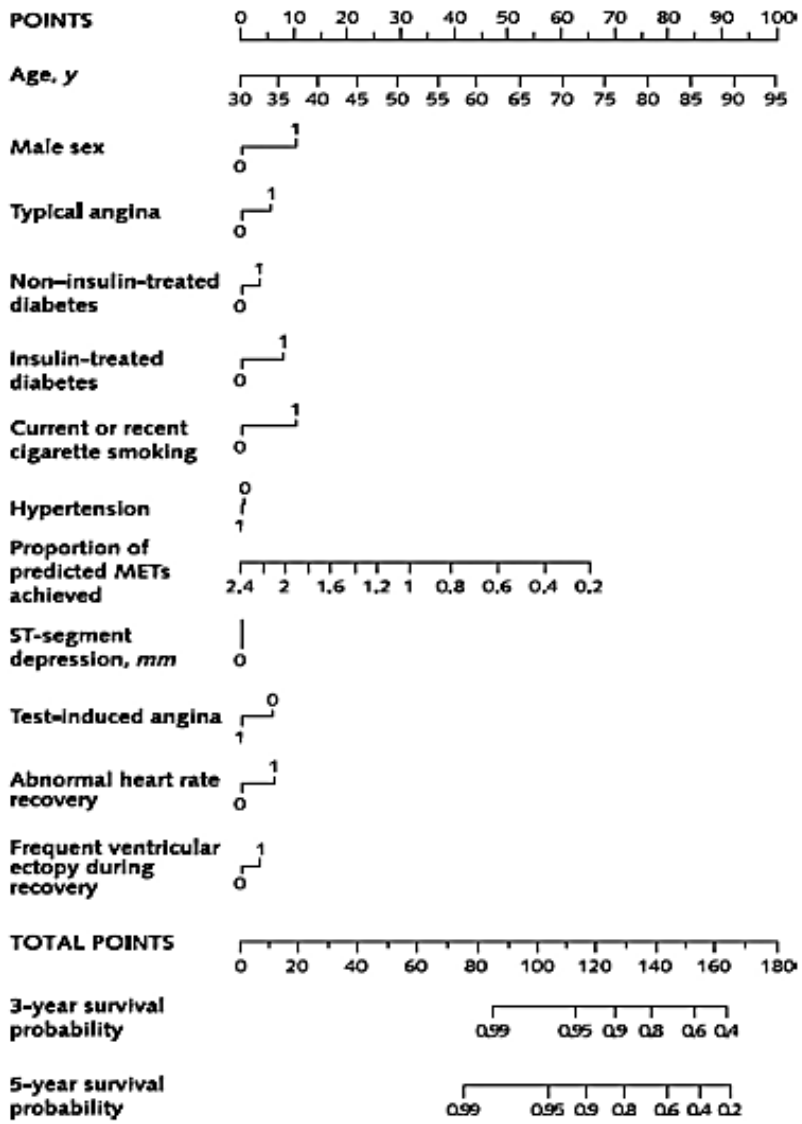


Figure 8. Nomogram to predict risk of death based on clinical data and results of exercise testing. To determine risk, draw a vertical line from each risk marker to the top line, labeled 'POINTS,' to calculate points for each risk marker. The sum of all these points is then marked on the line labeled 'TOTAL POINTS.' Drop vertical lines from there to yield the 3- and 5-year survival probabilities. For binary variables, 1 means yes and 0 means no. MET indicates metabolic equivalent. Reproduced from Lauer et al.[44]

Risk Factor	Score Contribution	Individual's Score
Comorbidity		
No	0	
Yes	86	
Diabetes		
No	0	
Yes	57	
Angina score		
Class I	0	
Class II	54	
Class III	91	
Duration of symptoms		
≥6 months	0	
<6 months	80	
Abnormal ventricular function		
No	0	
Yes	114	
ST depression or T wave inversion on resting electrocardiogram		
No	0	
Yes	34	
		Total =

Figure 9. Euro heart score sheet to calculate risk score for patients presenting with stable angina (derived from 3779 patients with newly diagnosed SIHD). *≥1 of previous cerebrovascular event; hepatic disease defined as chronic hepatitis or cirrhosis, or other hepatic disease causing elevation of transaminases ≥3 times upper limit of normal; PVD defined as claudication either at rest or on exertion, amputation for arterial vascular insufficiency, vascular surgery (reconstruction or bypass) or angioplasty to the extremities, documented aortic aneurysm, or noninvasive evidence of impaired arterial flow; chronic renal failure defined as chronic dialysis or renal transplantation or serum creatinine >200 mmol/L; chronic respiratory disease defined as a diagnosis previously made by physician or patient receiving bronchodilators or FEV_1 <75%, arterial Po_2 <60%, or arterial Pco_2 >50% predicted in previous studies; chronic inflammatory conditions defined as a diagnosis of rheumatoid arthritis, systemic lupus erythematosus or other connective tissue disease, polymyalgia rheumatica, and so on; malignancy defined as a diagnosis of malignancy within a year of active malignancy. FEV_1 indicates forced expiratory volume; Po_2, partial pressure of oxygen; Pco_2, partial pressure of carbon dioxide; and PVD, peripheral vascular disease. Reproduced from Daly et al.[57]

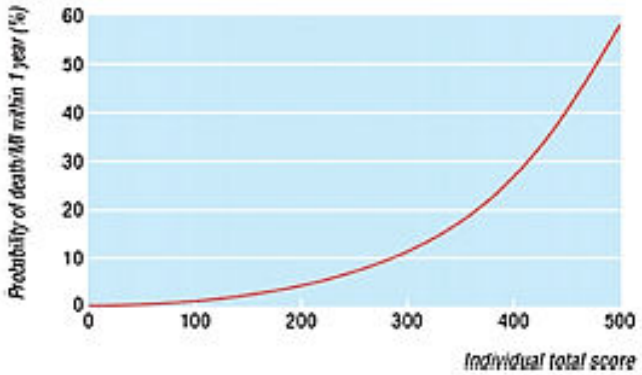


Figure 10. Risk of death or MI over 1 year after diagnosis of SIHD according to Euro heart score. Plot to assign estimated probability of death or nonfatal MI within 1 year of presentation according to combination of clinical and investigative features in patients with stable angina. MI indicates myocardial infarction. Reproduced from Daly et al.[57]

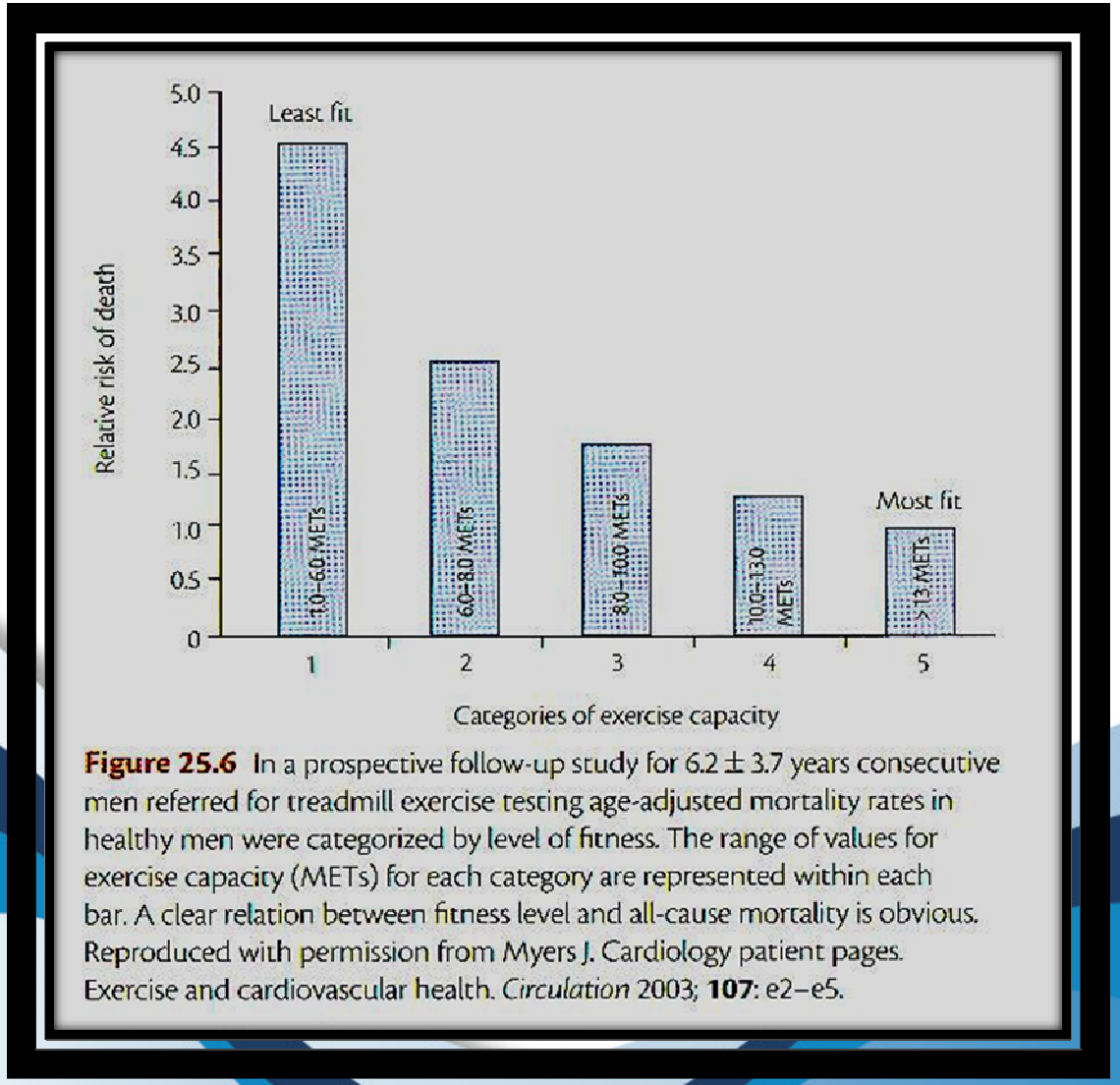


Figure 25.6 In a prospective follow-up study for 6.2 ± 3.7 years consecutive men referred for treadmill exercise testing age-adjusted mortality rates in healthy men were categorized by level of fitness. The range of values for exercise capacity (METs) for each category are represented within each bar. A clear relation between fitness level and all-cause mortality is obvious. Reproduced with permission from Myers J. Cardiology patient pages. Exercise and cardiovascular health. *Circulation* 2003; **107**: e2–e5.

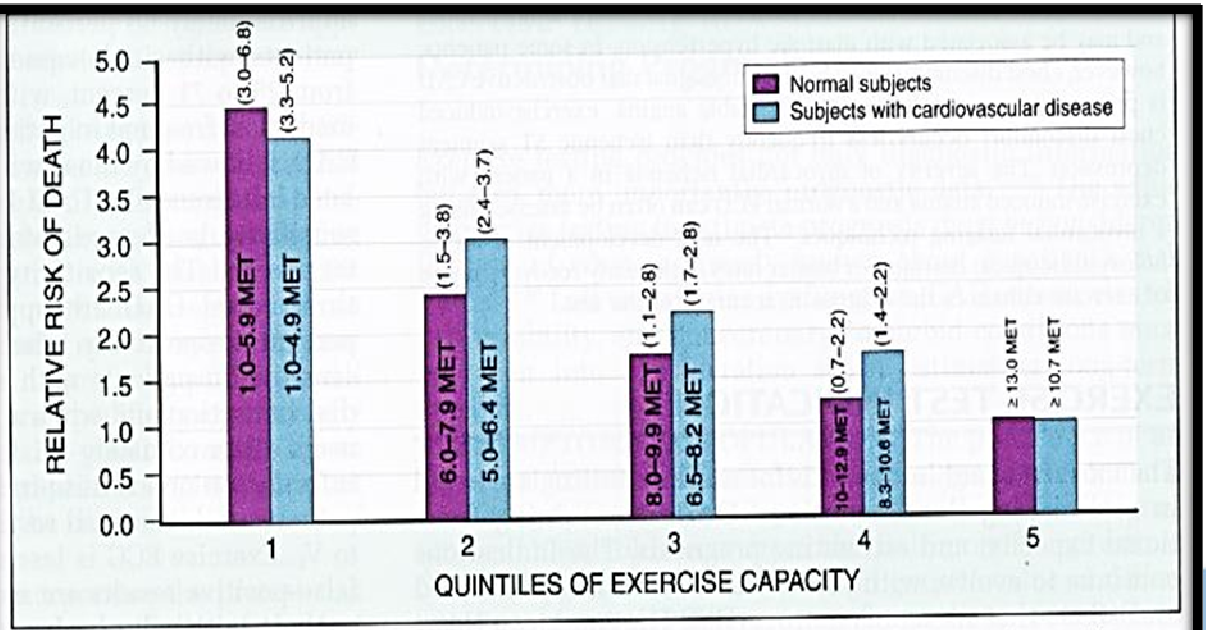


FIGURE 13–11 Age-adjusted relative risks of all-cause mortality by quintile of exercise capacity in 2534 subjects with a normal exercise test result and no history of cardiovascular disease and in 3679 subjects with an abnormal exercise test result or history of cardiovascular disease. The mean duration of follow-up was 6.2 ± 3.7 years. Quintile 5 was used as the reference category. For each 1-MET increase in exercise capacity, survival improved by 12 percent. *(From Myers J, Prakash M, Froelicher V, et al: Exercise capacity and mortality among men referred for exercise testing. N Engl J Med 346:793, 2002.)*

CASCATA ISQUÉMICA

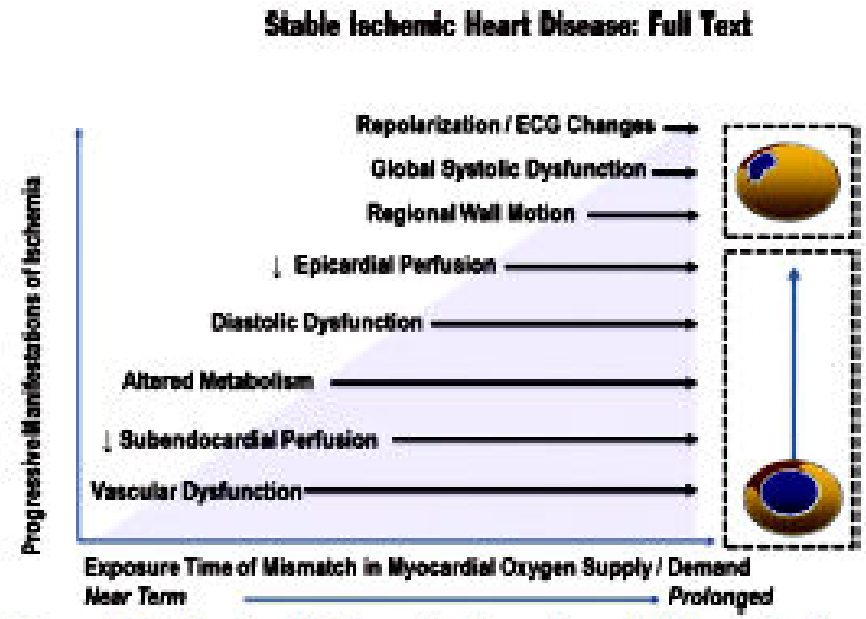


Figure 7. The Ischemic Cascade. Reproduced with permission from Shaw et al.[75]

Congresso
Novas Fronteiras em Cardiologia
8 a 10 fevereiro.2013
Hotel Vila Galé Ericeira

TESTES DIAGNÓSTICOS NÃO INVASIVOS

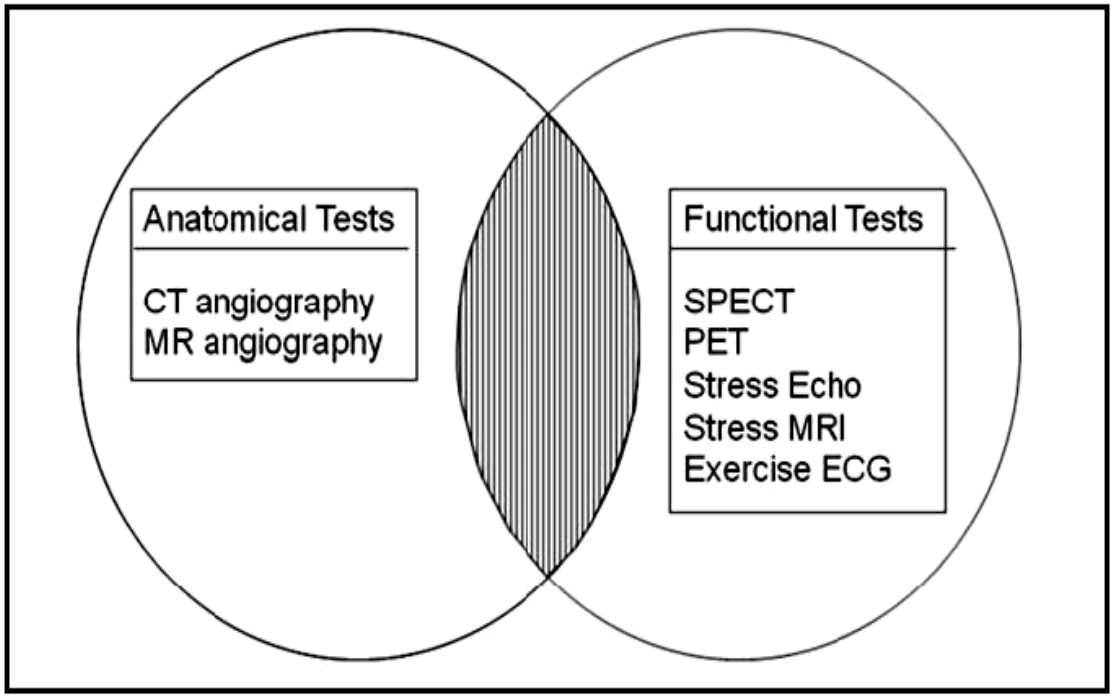


FIGURE 1. *Anatomical and functional noninvasive modalities available for evaluating coronary artery disease.*

Congresso
Novas Fronteiras em Cardiologia
8 a 10 fevereiro.2013
Hotel Vila Galé Ericeira

TESTES DIAGNÓSTICOS NÃO INVASIVOS

- DIAGNOSTICAR ANATOMIA?
- ABORDAGEM FUNCIONAL? – DEMONSTRAÇÃO DE ISQUEMIA?

OUTROS TESTES DIAGNÓSTICOS NÃO INVASIVOS

- NEM SEMPRE DIAGNÓSTICO ANATÓMICO DE DOENÇA CORONÁRIA É SINÓNIMO DE REVASCULARIZAÇÃO.

- Angina de peito estável, habitualmente bom prognóstico, com baixa incidência de eventos. Importante delimitar grupos de maior risco (prognóstico).

ESC 2006

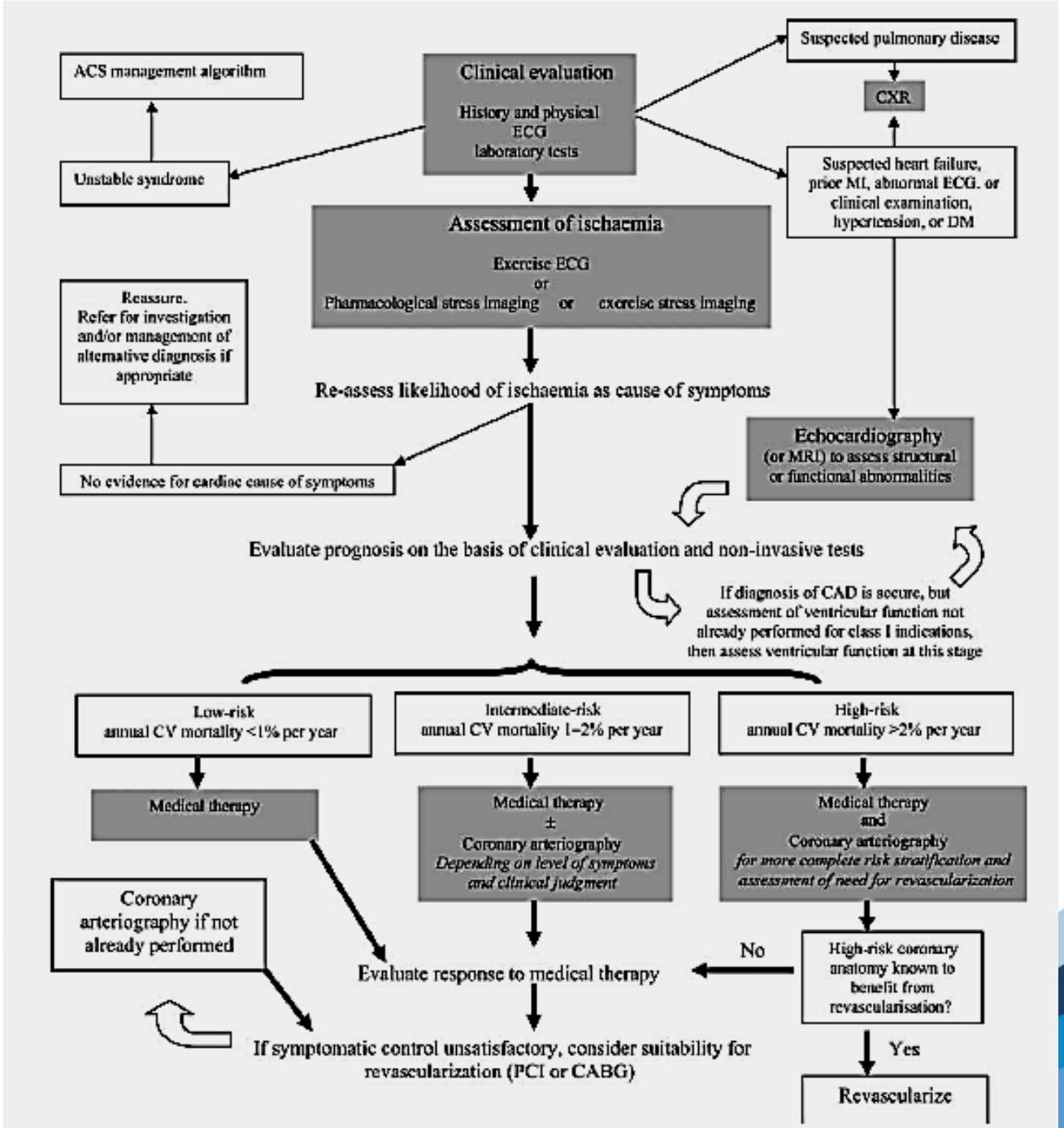


Figure 2 Algorithm for the initial evaluation of patients with clinical symptoms of angina.

ESC 2006

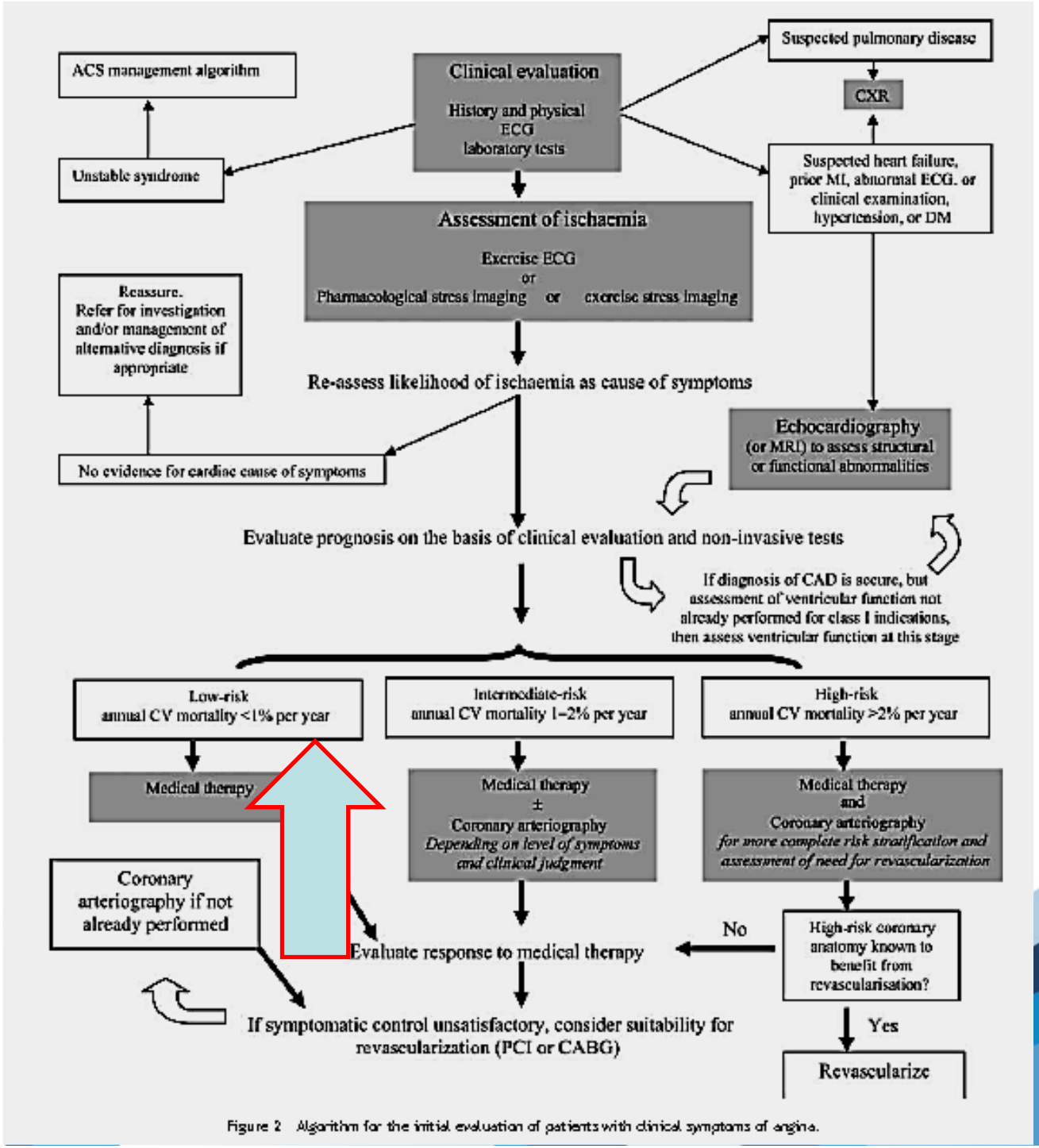


Figure 2 Algorithm for the initial evaluation of patients with clinical symptoms of angina.

OUTROS TESTES DIAGNÓSTICOS NÃO INVASIVOS

- NEM SEMPRE DIAGNÓSTICO ANATÓMICO DE DOENÇA CORONÁRIA É SINÓNIMO DE REVASCULARIZAÇÃO.

- Estudo COURAGE
- Nem sempre estenose é sinal de ser funcionalmente significativa (utilização do FFR no CATH)

Congresso
Novas Fronteiras em Cardiologia
8 a 10 fevereiro.2013
Hotel Vila Galé Ericeira

Optimal Medical Therapy with or without PCI for Stable Coronary Disease

William E. Boden, M.D., Robert A. O'Rourke, M.D., Koon K. Teo, M.B., B.Ch., Ph.D., Pamela M. Hartigan, Ph.D., David J. Maron, M.D., William J. Kostuk, M.D., Merril Knudtson, M.D., Marcin Dada, M.D., Paul Casperson, Ph.D., Crystal L. Harris, Pharm.D., Bernard R. Chaitman, M.D., Leslee Shaw, Ph.D., Gilbert Gosselin, M.D., Shah Nawaz, M.D., Lawrence M. Title, M.D., Gerald Gau, M.D., Alvin S. Blaustein, M.D., David C. Booth, M.D., Eric R. Bates, M.D., John A. Spertus, M.D., M.P.H., Daniel S. Berman, M.D., G.B. John Mancini, M.D., and William S. Weintraub, M.D., for the COURAGE Trial Research Group*

ABSTRACT

BACKGROUND

In patients with stable coronary artery disease, it remains unclear whether an initial management strategy of percutaneous coronary intervention (PCI) with intensive pharmacologic therapy and lifestyle intervention (optimal medical therapy) is superior to optimal medical therapy alone in reducing the risk of cardiovascular events.

METHODS

We conducted a randomized trial involving 2287 patients who had objective evidence of myocardial ischemia and significant coronary artery disease at 50 U.S. and Canadian centers. Between 1999 and 2004, we assigned 1149 patients to undergo PCI with optimal medical therapy (PCI group) and 1138 to receive optimal medical therapy alone (medical-therapy group). The primary outcome was death from any cause and nonfatal myocardial infarction during a follow-up period of 2.5 to 7.0 years (median, 4.6).

RESULTS

There were 211 primary events in the PCI group and 202 events in the medical-therapy group. The 4.6-year cumulative primary-event rates were 19.0% in the PCI group and 18.5% in the medical-therapy group (hazard ratio for the PCI group, 1.05; 95% confidence interval [CI], 0.87 to 1.27; P=0.62). There were no significant differences between the PCI group and the medical-therapy group in the composite of death, myocardial infarction, and stroke (20.0% vs. 19.5%; hazard ratio, 1.05; 95% CI, 0.87 to 1.27; P=0.62); hospitalization for acute coronary syndrome (12.4% vs. 11.8%; hazard ratio, 1.07; 95% CI, 0.84 to 1.37; P=0.56); or myocardial infarction (13.2% vs. 12.3%; hazard ratio, 1.13; 95% CI, 0.89 to 1.43; P=0.33).

CONCLUSIONS

As an initial management strategy in patients with stable coronary artery disease, PCI did not reduce the risk of death, myocardial infarction, or other major cardiovascular events when added to optimal medical therapy. (ClinicalTrials.gov number, NCT00007657.)

Affiliations for all authors are listed in the Appendix. Address reprint requests to Dr. Boden at the Division of Cardiology, Buffalo General Hospital, 100 High St., Buffalo, NY 14203, or at wboden@kaleidahealth.org.

*Members of the Clinical Outcomes Utilizing Revascularization and Aggressive Drug Evaluation (COURAGE) trial are listed in the Appendix and in the Supplementary Appendix, available with the full text of this article at www.nejm.org.

This article (10.1056/NEJMoa070829) was published at www.nejm.org on March 26, 2007.

N Engl J Med 2007;356:1503-16.

Optimal Medical Therapy With or Without Percutaneous Coronary Intervention to Reduce Ischemic Burden

Results From the Clinical Outcomes Utilizing Revascularization and Aggressive Drug Evaluation (COURAGE) Trial Nuclear Substudy

Leslee J. Shaw, PhD; Daniel S. Berman, MD; David J. Maron, MD; G.B. John Mancini, MD; Sean W. Hayes, MD; Pamela M. Hartigan, PhD; William S. Weintraub, MD; Robert A. O'Rourke, MD; Marcin Dada, MD; John A. Spertus, MD, MPH; Bernard R. Chaitman, MD; John Friedman, MD; Piotr Slomka, PhD; Gary V. Heller, MD, PhD; Guido Germano, PhD; Gilbert Gosselin, MD; Peter Berger, MD; William J. Kostuk, MD; Ronald G. Schwartz, MD; Merill Knudtson, MD; Emir Veledar, PhD; Eric R. Bates, MD; Benjamin McCallister, MD; Koon K. Teo, MD; William E. Boden, MD; for the COURAGE Investigators

Background—Extent and severity of myocardial ischemia are determinants of risk for patients with coronary artery disease, and ischemia reduction is an important therapeutic goal. The Clinical Outcomes Utilizing Revascularization and Aggressive Drug Evaluation (COURAGE) nuclear substudy compared the effectiveness of percutaneous coronary intervention (PCI) for ischemia reduction added to optimal medical therapy (OMT) with the use of myocardial perfusion single photon emission computed tomography (MPS).

Methods and Results—Of the 2287 COURAGE patients, 314 were enrolled in this substudy of serial rest/stress MPS performed before treatment and 6 to 18 months (mean−374±50 days) after randomization using paired exercise (n−84) or vasodilator stress (n−230). A blinded core laboratory analyzed quantitative MPS measures of percent ischemic myocardium. Moderate to severe ischemia encumbered ≥10% myocardium. The primary end point was ≥5% reduction in ischemic myocardium at follow-up. Treatment groups had similar baseline characteristics. At follow-up, the reduction in ischemic myocardium was greater with PCI+OMT (−2.7%; 95% confidence interval, −1.7%, −3.8%) than with OMT (−0.5%; 95% confidence interval, −1.6%, 0.6%; $P<0.0001$). More PCI+OMT patients exhibited significant ischemia reduction (33% versus 19%; $P=0.0004$), especially patients with moderate to severe pretreatment ischemia (78% versus 52%; $P=0.007$). Patients with ischemia reduction had lower unadjusted risk for death or myocardial infarction ($P=0.037$ [risk-adjusted $P=0.26$]), particularly if baseline ischemia was moderate to severe ($P=0.001$ [risk-adjusted $P=0.08$]). Death or myocardial infarction rates ranged from 0% to 39% for patients with no residual ischemia to ≥10% residual ischemia on follow-up MPS ($P=0.002$ [risk-adjusted $P=0.09$]).

Conclusions—In COURAGE patients who underwent serial MPS, adding PCI to OMT resulted in greater reduction in ischemia compared with OMT alone. Our findings suggest a treatment target of ≥5% ischemia reduction with OMT with or without coronary revascularization. (***Circulation.*** **2008;117:1283-1291.**)

Congresso
Novas Fronteiras em Cardiologia
8 a 10 fevereiro.2013
Hotel Vila Galé Ericeira

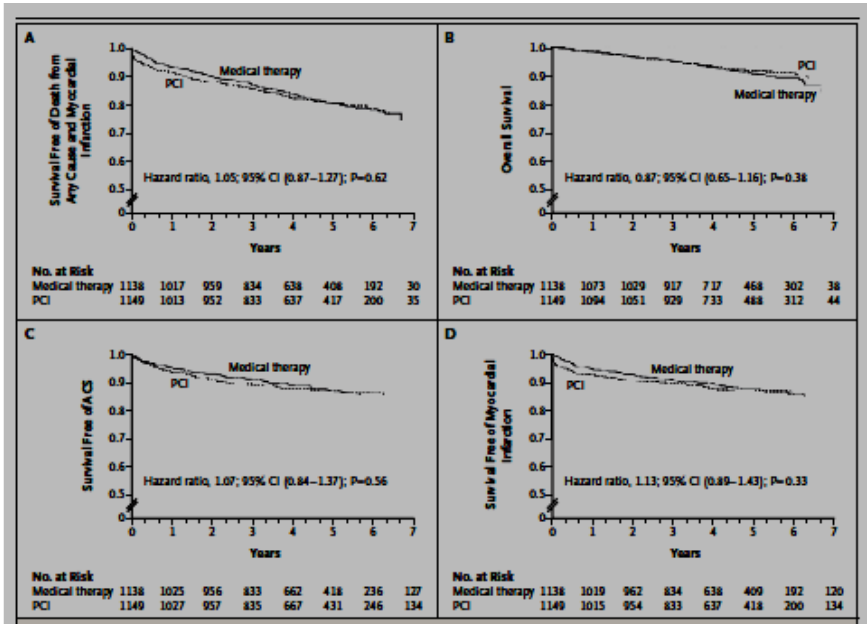


Figure 2. Kaplan–Meier Survival Curves.

In Panel A, the estimated 4.6-year rate of the composite primary outcome of death from any cause and nonfatal myocardial infarction was 19.0% in the PCI group and 18.5% in the medical-therapy group. In Panel B, the estimated 4.6-year rate of death from any cause was 7.6% in the PCI group and 8.3% in the medical-therapy group. In Panel C, the estimated 4.6-year rate of hospitalization for acute coronary syndrome (ACS) was 12.4% in the PCI group and 11.8% in the medical-therapy group. In Panel D, the estimated 4.6-year rate of acute myocardial infarction was 13.2% in the PCI group and 12.3% in the medical-therapy group.

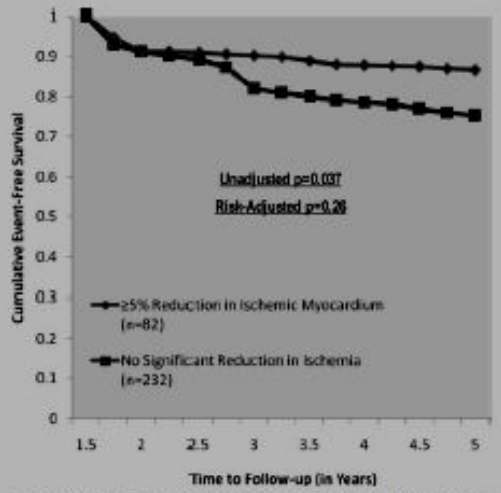


Figure 2. Kaplan–Meier survival for patients with ≥5% reduction in ischemic myocardium and for those without significant reduction in ischemia after 6 to 18 months of PCI+OMT or OMT. Overall event-free survival was 86.6% vs 75.3% for patients with vs without significant ischemia reduction ($P=0.037$). In a risk-adjusted Cox model (controlling for randomized treatment), this difference was not significant ($P=0.26$).

Follow-Up Anginal Status at 6 to 18 Months

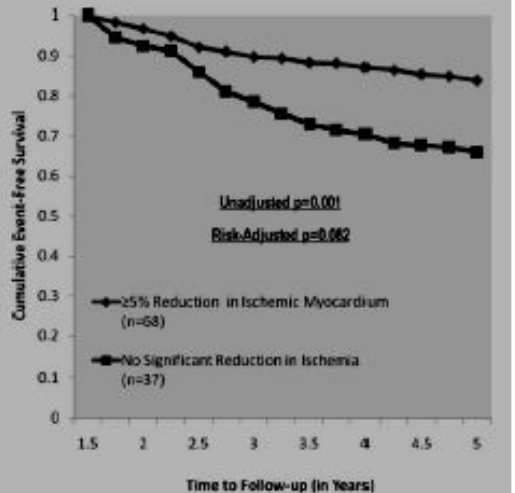
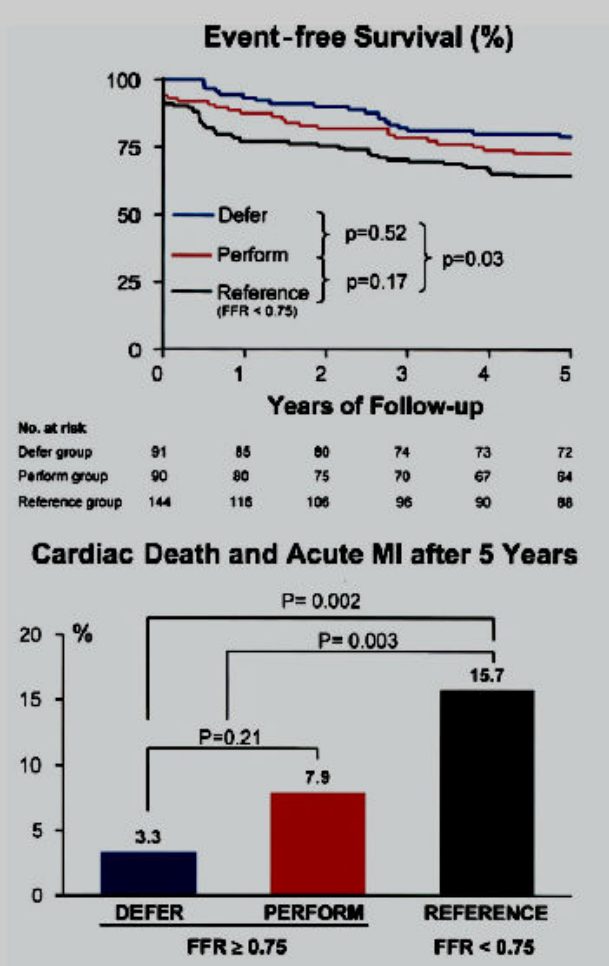


Figure 3. Kaplan–Meier survival for the subset of 105 patients with moderate to severe pretreatment ischemia including a comparison of patients with ≥5% reduction in ischemic myocardium compared with those without a significant reduction in ischemia after 6 to 18 months of PCI+OMT or OMT. Overall event-free survival was 83.8% vs 66.0% for patients with vs without significant ischemia reduction ($P=0.001$). In a risk-adjusted Cox model (controlling for randomized treatment), this difference was not significant ($P=0.082$).

Courage

Courage sub-study

Congresso
Novas Fronteiras em Cardiologia
8 a 10 de Fevereiro.2013
Hotel Vila Galé Ericeira



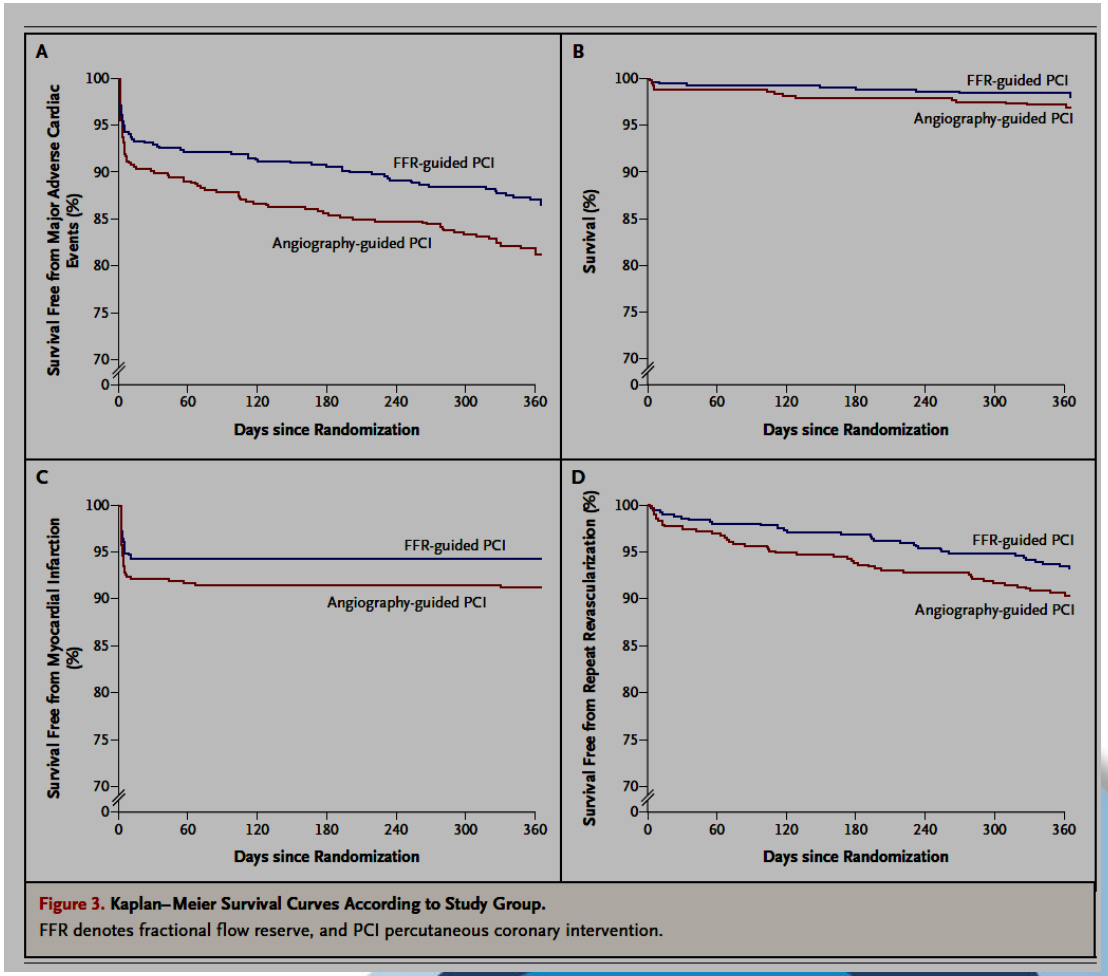


Figure 3. Kaplan–Meier Survival Curves According to Study Group.
FFR denotes fractional flow reserve, and PCI percutaneous coronary intervention.

DEFER

FAME

TESTES DIAGNÓSTICOS NÃO INVASIVOS FUNCIONAIS

- Prova de esforço
  - Acessibilidade
  - Inocuidade
  - Barata, custo/benefício, facilmente repetível

  Diagnóstico: Risco pré-teste intermédio, ECG interpretável e consegue fazer esforço

  Baixo risco >>>> Alta probabilidade de Falso+ (VPN elevado)

  Alto risco >>>>>Maior probabilidade de Falso –

  (especialmente para ver prognóstico)

TESTES DIAGNÓSTICOS NÃO INVASIVOS FUNCIONAIS

- Cintigrafia de perfusão miocárdica (SPECT)
  - Menor Acessibilidade
  - Radiação (especialmente quando teste duplo, depende do radioisótopo) 11 mSev
  - Mais cara. Limitações nos obesos

  PET melhor resolução com aumento da sensibilidade
- Eco de sobrecarga e de esforço
  - Melhor acessibilidade
  - Sem radiação
  - Depende da janela transtorácica e do tipo morfologico (obeso, DPOC)
  - Observador- dependente (expertise)
- RMN de stress
  - Menor acessibilidade. Custos do aparelho e do exame
  - Claustrofobia
  - Poucos estudos

TESTES DIAGNÓSTICOS NÃO INVASIVOS ANATÓMICOS

- CCTA
  - Radiação
  - Uso de contraste
  - Coronárias calcificadas
- RMN (angio)
  - Menor acessibilidade. Custos do aparelho e do exame
  - Claustrofobia

TESTES DIAGNÓSTICOS NÃO INVASIVOS
RADIAÇÃO

Units of Absorbed Dose

Units not normalized by w_R	mGy	0.01	0.1	1	10	100	1,000	10,000
	rad=cGy	0.001	0.01	0.1	1	10	100	1,000
	Gy	0.00001	0.0001	0.001	0.01	0.1	1	10

Units of Effective Dose, Equivalent Dose, and Weighted Equivalent Dose

Units normalized by w_R	mSv	0.01	0.1	1	10	100	1,000	10,000
	rem =cSv	0.001	0.01	0.1	1	10	100	1,000
	Sv	0.00001	0.0001	0.001	0.01	0.1	1	10
# of Chest x-rays (PA)		0.5	5	50	500	5,000	50,000	500,000

LD50: 5 Sv

Average dose, atomic bomb survivors (RERF): 200 mSv

Annual limit to radiation workers (10 CFR 20.1201): 50 mSv

Dual isotope stress test: 29 mSv

Sestamibi stress test or CTA with tube current modulation: 11 mSv

Average US annual background radiation: 3 mSv

Annual limit to general public from a licensed radiation operation (10 CFR 20.1301): 1 mSv

Chest x-ray (lateral) or Dental x-rays (4 bitewing films): 0.04 mSv

Roundtrip flight, New York-Los Angeles: 0.03 mSv

Chest x-ray (single view, posteroanterior): 0.02 mSv

Einstein A J et al. Circulation 2007;116:1290-1305

Congresso
Novas Fronteiras em Cardiologia
8 a 10 fevereiro.2013
Hotel Vila Galé Ericeira

TESTES DIAGNÓSTICOS NÃO INVASIVOS
RADIAÇÃO E RISCO DE CANCRO

	Age at Exposure (years)										
	0	5	10	15	20	30	40	50	60	70	80
Males	2563	1816	1445	1182	977	686	648	591	489	343	174
Females	4777	3377	2611	2064	1646	1065	886	740	586	409	214

- **Figure 6. Lifetime attributable risk estimates of all-cancer incidence per 100 000 persons exposed to a single 100-mGv dose to all organs. Cancer risk estimates in this table are for the general US population**
- **Einstein A J et al. Circulation 2007;116:1290-1305**

Radiation Dose Chart

This is a chart of the ionizing radiation dose a person can absorb from various sources. The unit for absorbed dose is "sievert" (Sv), and measures the effect a dose of radiation will have on the cells of the body. One sievert (all at once) will make you sick, and too many more will kill you, but we safely absorb small amounts of natural radiation daily. Note: The same number of sieverts absorbed in a shorter time will generally cause more damage, but your cumulative long-term dose plays a big role in things like cancer risk.

- Sleeping next to someone (0.05 µSv)
- Living within 50 miles of a nuclear power plant for a year (0.09 µSv)
- Eating one banana (0.1 µSv)
- Living within 50 miles of a coal power plant for a year (0.3 µSv)
- Arm x-ray (1 µSv)
- Using a CRT monitor for a year (1 µSv)
- Extra dose from spending one day in an area with higher-than-average natural background radiation, such as the Colorado plateau (1.2 µSv)
- Dental x-ray (5 µSv)
- Background dose received by an average person over one normal day (10 µSv)
- Airplane flight from New York to LA (40 µSv)
- Using a cell phone (0 µSv)—a cell phone's transmitter does not produce ionizing radiation* and does not cause cancer.

* Unless it's a bananaphone.

- Chest x-ray (20 µSv)
- All the doses in the blue chart combined (~60 µSv)
- Extra dose to Tokyo in weeks following Fukushima accident (40 mSv)
- Living in a stone, brick, or concrete building for a year (70 µSv)
- Average total dose from the Three Mile Island accident to someone living within 10 miles (80 µSv)
- Approximate total dose received at Fukushima Town Hall over two weeks following accident (100 µSv)
- EPA yearly release limit for a nuclear power plant (250 µSv)
- Yearly dose from natural potassium in the body (390 µSv)
- Mammogram (400 µSv)
- EPA yearly limit on radiation exposure to a single member of the public (1 mSv=1,000 µSv)
- Maximum external dose from Three Mile Island accident (1 mSv)
- Typical dose over two weeks in Fukushima Exclusion Zone (1 mSv, but areas northwest saw far higher doses)
- Head CT Scan (2 mSv)
- Normal yearly background dose. About 85% is from natural sources. Nearly all of the rest is from medical scans (~4 mSv)

- EPA yearly release target for a nuclear power plant (30 µSv)
- Dose from spending an hour on the grounds at the Chernobyl plant in 2010 (6 mSv in one spot, but varies wildly)
- Chest CT scan (7 mSv)
- Maximum yearly dose permitted for US radiation workers (50 mSv)

■ = (0.05 µSv)

■ = (20 µSv)

■ = (10 mSv)

■ = (1 Sv)

Ten minutes next to the Chernobyl reactor core after explosion and meltdown (50 Sv)

- Approximate total dose at one station at the northwest edge of the Fukushima exclusion zone (40 mSv)
- All doses in green chart combined (~75 mSv)
- Radiation worker one-year dose limit (50 mSv)
- Lowest one-year dose clearly linked to increased cancer risk (100 mSv)
- Dose received by two Fukushima plant workers (~180 mSv)
- Dose causing symptoms of radiation poisoning if received in a short time (400 mSv, but varies)

EPA guidelines for emergency situations, provided to ensure quick decision-making:

- Dose limit for emergency workers protecting valuable property (100 mSv)
- Dose limit for emergency workers in lifesaving operations (250 mSv)

- Severe radiation poisoning, in some cases fatal (2000 mSv, 2 Sv)
- Usually fatal radiation poisoning. Survival occasionally possible with prompt treatment (4 Sv)
- Fatal dose, even with treatment (8 Sv)

Sources:

http://www.nrc.gov/reading-rm/doc-collections/cfr/part020/
www.nema.ne.gov/technological/dose-limits.html
http://www.deq.idaho.gov/inl_oversight/radiation/dose_calculator.cfm
http://www.deq.idaho.gov/inl_oversight/radiation/radiation_guide.cfm
http://mitnse.com/
http://www.bnl.gov/bnlweb/PDF/03SEB/Chapter_8.pdf
http://dels-old.nas.edu/dels/rpt_briefs/rerf_final.pdf
http://people.reed.edu/~emcmanis/radiation.html
http://en.wikipedia.org/wiki/Sievert
http://blog.vornaskotti.com/2010/07/15/into-the-zone-chernobyl-pripyat/
http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/tritium-radiation-fs.html
http://www.mext.go.jp/component/a_menu/other/detail/__icsFiles/afieldfile/2011/03/18/1303727_1716.pdf
http://radiology.rsna.org/content/248/1/254

Chart by Randall Munroe, with help from Ellen, Senior Reactor Operator at the Reed Research Reactor, who suggested the idea and provided a lot of the sources. I'm sure I've added in lots of mistakes; it's for general education only. If you're basing radiation safety procedures on an internet PNG image and things go wrong, you have no one to blame but yourself.

Congresso
Novas Fronteiras em Cardiologia
8 a 10 de Fevereiro 2013
Hotel Vila Galé Ericeira

Units of Measurement (Radiation)

1 rad = 0.01 gray (Gy)
1 rem = 0.01 sievert (Sv)
1 gray (Gy) = 100 rad
1 sievert (Sv) = 100 rem

radiation doses normally encountered are expressed in milliSievert (mSv)

Radiation dose for increase cancer risk of 1 in a 1,000
1,250 milliRem (mRem)
12.5 milliSievert (mSv)

TESTES DIAGNÓSTICOS NÃO INVASIVOS
CINTIGRAFIA PERFUSÃO MIOCÁRDICA E RADIAÇÃO

TABLE 2. Estimates of Effective Doses of Standard Myocardial Perfusion Imaging Protocols

	Injected Activity (mCi)		Effective Doses, mSv			
			From ICRP Tables		From Manufacturers' PIs	
Protocol	Rest	Stress	E_1	E_2	E_1	E_2
^{99m}Tc sestamibi rest-stress	10.0	27.5	11.3	11.4	14.6	NR
^{99m}Tc sestamibi stress only	0.0	27.5	7.9	8.0	10.0	NR
^{99m}Tc sestamibi 2-day	25.0	25.0	15.7	15.6	20.6	NR
^{99m}Tc tetrofosmin rest-stress	10.0	27.5	9.3	9.9	9.7	12.9
^{99m}Tc tetrofosmin stress only	0.0	27.5	6.6	7.1	6.7	8.8
^{99m}Tc tetrofosmin 2-day	25.0	25.0	12.8	13.5	13.7	18.3
^{201}Tl stress-redistribution	0.0	3.5	22.0	22.0	28.7 (PI 1) 9.3 (PI 2) 28.4 (PI 3)	46.6 (PI 1) NR (PI 2) 46.6 (PI 3)
^{201}Tl stress-reinjection	1.5	3.0	31.4	31.5	43.0 (PI 1) 14.0 (PI 2) 42.6 (PI 3)	69.9 (PI 1) NR (PI 2) 69.9 (PI 3)
Dual isotope ^{201}Tl-^{99m}Tc sestamibi	3.5	25.0	29.2	29.3	37.8 (PI 1) 18.4 (PI 2) 37.5 (PI 3)	NR (PI 1) NR (PI 2) NR (PI 3)
^{99m}Tc-labeled erythrocytes	22.5	0.0	5.7	5.8	2.3	NR
^{82}Rb	50.0	50.0	13.5	12.6	3.0	NR
^{13}N-ammonia	15.0	15.0	2.4	2.2	NA	NA
^{15}O-water*	29.7	29.7	2.5	2.4	NA	NA
^{18}F-FDG	10.0	0.0	7.0	7.0	NA	NA

Radiation Dose to Patients From Cardiac Diagnostic Imaging
Andrew J. Einstein, Kevin W. Moser, Randall C. Thompson, Manuel D. Cerqueira and Milena J. Henzlova

Circulation. 2007;116:1290-1305
doi: 10.1161/CIRCULATIONAHA.107.688101
Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231

Print ISSN: 0009-7322. Online ISSN: 1524-4539

Congresso
Novas Fronteiras em Cardiologia
8 a 10 fevereiro.2013
Hotel Vila Galé Ericeira

TESTES DIAGNÓSTICOS NÃO INVASIVOS
CCTA E RADIAÇÃO

TABLE 7. Studies Reporting Effective Dose in CTCA

				Mean Effective Dose Estimates, mSv					
				CTCA			Calcium Scoring		
Study	Slices	Vendor	Method	Without ECTCM	Mixed	With ECTCM	Without ECTCM	With ECTCM	Prospective Gating
Hunold et al[33]	4	Siemens	TLD-ARP (low)	6.7♂ 8.1♀	...	...	3.0♂ 3.6♀	...	1.5♂ 1.8♀
	4	Siemens	TLD-ARP (high)	10.9♂ 13.0♀	...	...	5.2♂ 6.2♀	...	...
McCollough[75]	4	... (1st)	Multiple	9.0	...	...	2.5	...	0.9
	4	... (2nd)	Multiple	12.0	...	...	4.5	...	1.1
Poll et al[34]	4	Siemens	DLP	8.3♂ 11.0♀	...	4.0♂ 5.4♀	1.9♂ 2.5♀	1.2♂ 1.6♀	...
	4	Siemens	TLD-ARP	10.3♂ 12.7♀	...	4.6♂ 5.6♀	2.4♂ 2.9♀	1.5♂ 1.8♀	...
Hacker et al[35]	12	Siemens	...	...	...	4.3	...	...	...
Coles et al[36]	12	Siemens	CTDosimetry.xls	14.2	...	...	4.1	2.6	...
	16	Siemens	CTDosimetry.xls	15.3	...	...	...	...	...
Flohr et al[37]	16	Siemens	WinDose	7.1♂ 10.5♀	...	4.3♂ 6.4♀	2.2♂ 3.1♀	...	0.45♂ 0.65♀
Garcia et al[38]	16	Philips	DLP	...	8	...	...	...	...
Gerber et al[39]	16	Siemens	Modified DLP	11.3	...	8.1	...	...	...
Hoffmann et al[40]	16	Philips	...	4.9	...	8.1	...	...	...
Nawfel and Yoshizumi[41]	16	GE	MOSFET-CIRS	20.6	...	...	...	...	...
	16	Siemens	MOSFET-CIRS	18.8	...	...	...	...	...
Sato et al[42]	4	Siemens	...	4-5	...	...	...	...	...
	16	Toshiba	...	7-8	...	...	...	...	...
Trabold et al[43]	16	Siemens	TLD-ARP	8.1♂ 10.9♀	...	4.3♂ 5.6♀	2.9♂ 3.6♀	1.6♂ 2.0♀	...
Gaspar et al[44]	40	Philips	Modified DLP	9.9	...	...	...	...	...
Caussin et al[45]	64	Siemens	...	...	8.4	...	...	...	...
Hausleiter et al[46]	16	Siemens	DLP	10.6	...	6.4	...	...	...
	64	Siemens	DLP	14.8	...	9.4	...	...	...
Ghostine et al[47]	64	Siemens	DLP	...	...	7	...	...	...
Leber et al[48]	64	Siemens	...	...	...	10-14	...	...	...
Mollet et al[49]	64	Siemens	WinDose	15.2♂ 21.4♀	...	...	...	1.3♂ 1.7♀	...
Muhlenbruch et al[50]	64	Siemens	...	13.6♂ 17.2♀	...	...	...	...	...
Nikolaou et al[51]	64	Siemens	WinDose	8-10	...	...	...	...	...
Pugliese et al[52]	64	Siemens	...	15♂ 20♀	...	...	...	...	...
Raff et al[53]	64	Siemens	...	13♂ 18♀	...	...	...	...	...

Ellipses (. . .) indicate not specified; TLD-ARP, thermoluminescent dosimeters in an Alderson-Rando phantom; DLP, derived from dose-length product on scanner console; ♂, male; ♀, female; and MOSFET-CIRS, metal oxide semiconductor field effect transistors in a CIRS Phantom.

Radiation Dose to Patients From Cardiac Diagnostic Imaging
Andrew J. Einstein, Kevin W. Moser, Randall C. Thompson, Manuel D. Cerqueira and Milena J. Henzlova

Circulation. 2007;116:1290-1305
doi: 10.1161/CIRCULATIONAHA.107.688101
Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231

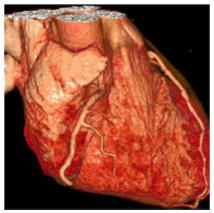
Print ISSN: 0009-7322. Online ISSN: 1524-4539

Congresso
Novas Fronteiras em Cardiologia
8 a 10 fevereiro.2013
Hotel Vila Galé Ericeira

TESTES DIAGNÓSTICOS NÃO INVASIVOS
RADIAÇÃO E CCTA

HealthImaging
ECONOMICS · PRACTICE · INFORMATICS
Published on *Health Imaging* (http://www.healthimaging.com)

JAMA: Potential CCTA radiation risks should serve as wake-up call



Study cautions cardiac CT labs to be cautious. Image Source: NYU Internal Medical Blog

Use of cardiac CT angiography (CCTA) has the potential to expose patients to high doses of radiation, and methods available to reduce radiation dose are not frequently used, according to a study in today's issue of the *Journal of the American Medical Association* .

"With the constantly increasing number of CCTA-capable scanners worldwide, the volume of CCTA scans performed is likely to show substantial further increase," the authors wrote. They added that the clinical usefulness of CCTA for the assessment of coronary artery disease has to be weighed against the radiation exposure of CCTA and the small but potential risk of cancer. Many clinicians may still be unfamiliar with the magnitude of radiation exposure that is received during CCTA in daily practice and with the factors that contribute to radiation dose, according to the researchers.

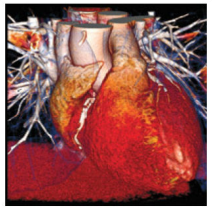
Jörg Hausleiter, MD, of the Klinik an der Technischen Universität München in Munich, Germany, and colleagues investigated the magnitude of radiation dose of CCTA in daily practice, factors contributing to radiation dose and the use of currently available strategies to reduce radiation dose.

The PROTECTION I trial (Prospective Multicenter Study On Radiation Dose Estimates Of Cardiac CT Angiography In Daily Practice I), an international, multi-center study (21 university hospitals and 29 community hospitals) includes 1,965 patients undergoing CCTA between February and December 2007. They identified independent predictors associated with radiation dose, which was measured as dose-length product (DLP), which best mirrors the radiation a patient is exposed to by the entire CT scan, according to the authors.

Hausleiter and colleagues found that the median DLP of the patients in the study was 885 mGy cm, which corresponds to an estimated radiation dose of 600 chest x-rays. They observed a high variability in DLP between study sites (range of median DLPs per site, 331-2,146 mGy cm).

Cardiovascular Business
Published on *Cardiovascular Business* (http://www.cardiovascularbusiness.com)

AJR: Rad dose may be underestimated in CCTA studies



Source: U. Joseph Schoepf, MD

Published effective radiation dose values may be underestimated and current methods of dose assessment may not be suitable for cardiac CT angiography (CCTA) acquisitions, according to a multicenter trial published in the May issue of the *American Journal of Roentgenol* ogy. The researchers also found that the use of protocols and newer technologies can help reduce dose.

"Dose assessment is particularly relevant for cardiac CT because it is increasingly used in patient groups with various risk profiles," wrote Jacob Geleijns, MD, of the Leiden University Medical Center in Leiden, Netherlands, and colleagues.

During the CORE 64 study (Coronary Artery Evaluation Using 64-Row Multidetector Computed Tomography Angiography Study), researchers assessed the diagnostic accuracy of a 64-slice CT to identify coronary artery stenosis (CAS). Different acquisition protocols were used to take into account CT scanner (Aquilion 64, Toshiba Medical Systems) characteristics and patient size and sex. The researchers also reported patient dose exposure.

The cardiac CT protocol and organ and effective radiation doses were reported for six patient models. The average dose for CCTA was calculated by Report 103 of the International Commission on Radiological Protection (ICRP) and was 19 mSv with a range from 16-26 mSv, Geleijns and colleagues reported.

The average effective dose for whole cardiac CT protocol—CT scanograms, bolus tracking and calcium scoring—was reported to be 22 mSv with a range of 18 to 30 mSv. Sex-averaged effective dose was 16 mSv and size-averaged dose was 18 mSv using ICRP definitions.

Average normalized weighted $CTDI_{100}$ for CCTA was 0.086 mGy/mAs with a range of 0.080-0.094 mGy/mAs across the nine participating centers. "The good agreement between sites confirms that variation in radiation output was only minimal between the nine different CT scanners that were installed at the centers participating in the CORE 64 study."

For women, the average volume $CTDI_{100}$ was reported to be 41 mGy and for small, normal-sized and obese men these numbers were 52, 59 and 62 mGy, respectively.

TESTES DIAGNÓSTICOS NÃO INVASIVOS

The highest proportion of the collective dose of non-therapeutic medical radiation (49 percent) in 2006 was related to CT
Use increased by 10 - 11 percent per year from 1993 (18.3 million studies) to 2006 (62 million).
Nuclear medicine studies represented 26 percent of the collective dose in 2006. The use of nuclear medicine studies increased over fourfold from 7.6 million in 1982 to an estimated 18.1 million in 2006. The highest increase in utilization was related to cardiac imaging.
In 2005, 57% nuclear medicine visits (increased from 1 percent in 1973) and 85 % of the collective dose received from nuclear medicine studies

Health Phys. 2008;95(5):502

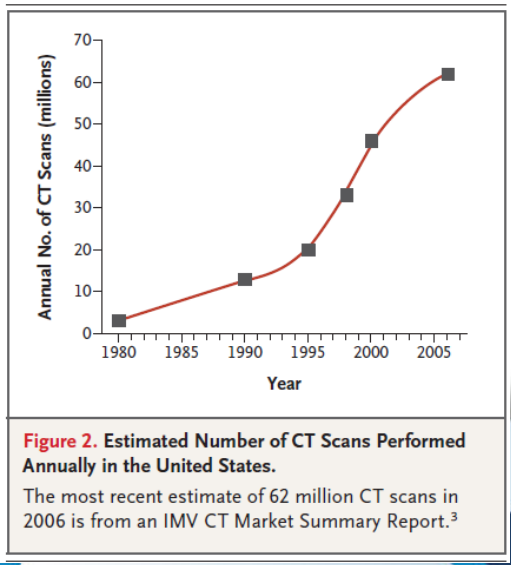


Figure 2. Estimated Number of CT Scans Performed Annually in the United States.
The most recent estimate of 62 million CT scans in 2006 is from an IMV CT Market Summary Report.[3]

Congresso
Novas Fronteiras em Cardiologia
8 a 10 fevereiro.2013
Hotel Vila Galé Ericeira

TESTES DIAGNÓSTICOS NÃO INVASIVOS

CURRENT CONCEPTS

Computed Tomography — An Increasing Source of Radiation Exposure

David J. Brenner, Ph.D., D.Sc., and Eric J. Hall, D.Phil., D.Sc.

N Engl J Med 2007;357:2277-84.

Table 1. Typical Organ Radiation Doses from Various Radiologic Studies.

Study Type	Relevant Organ	Relevant Organ Dose* (mGy or mSv)
Dental radiography	Brain	0.005
Posterior–anterior chest radiography	Lung	0.01
Lateral chest radiography	Lung	0.15
Screening mammography	Breast	3
Adult abdominal CT	Stomach	10
Barium enema	Colon	15
Neonatal abdominal CT	Stomach	20

Cancer Risks from CT Scans: Now We Have Data, What Next?[1]

Radiology: Volume 265: Number 2—November 2012

results. The new risk estimates clearly enable us to confirm that for every clinically justified CT scan, the benefit by far outweighs the risk. That being said, far too many clinically unnecessary CT scans are still being performed—these number in the tens of millions each year in the United States (18,19)—and here the ben-

From an individual standpoint, when a CT scan is justified by medical need, the associated risk is small relative to the diagnostic information obtained. However, if it is true that about one third of all CT scans are not justified by medical need, and it appears to be likely,[35] perhaps 20 million adults and, crucially, more than 1 million children per year in the United States are being irradiated unnecessarily.

Congresso
Novas Fronteiras em Cardiologia
8 a 10 fevereiro.2013
Hotel Vila Galé Ericeira

TESTES DIAGNÓSTICOS NÃO INVASIVOS

Coronary computed tomography angiography in a single cardiac cycle with a mean radiation dose of approximately 1 mSv: initial experience

Quadro I - Dose de radiação efectiva

	*DLP médio (mGy*cm)*	*Dose Radição (mSv)*
Pacientes ≤ 80 kg 100 KV	*61±7*	*0,86 ± 0,10*
Pacientes> 80 kg 120 KV	*124±3*	*1,74± 0,05*
Total	*71±25*	*0,99 ± 0,34*

DLP, dose-lenght product

RICARDO DUARTE[1,3], NUNO BETTENCOURT[2], JOÃO C. COSTA[3], GABRIEL FERNANDEZ[4]

[1]Serviço de Imagiologia, Centro Hospitalar de Gaia/ Espinho, Vila Nova de Gaia, Portugal
[2]Serviço de Cardiologia, Centro Hospitalar de Gaia/ Espinho, Vila Nova de Gaia, Portugal
[3]João Carlos Costa – Diagnóstico por Imagem;
[4]Serviço de Radiologia, Hospital POVISA, Vigo, Espanha

Rev Port Cardiol 2010; 29 (11): 1667-1676

Table 1. Cardiac stress test cost, performance, advantages and disadvantages[1,2,5,6]

Stress test	MBS rebate $	Sensitivity %	Specificity %	Advantages	Disadvantages
Electrocardiography (EST)	149	68	70–77	• Assessment of exercise capacity • Cost effective • First line test in absence of contraindications	• Lowest sensitivity of all stress tests: risk of false negative test • Lower diagnostic accuracy in women
Echocardiography (exercise)	310	80–85	84–86	• Assessment of exercise capacity, cardiac structure/function • No radiation • High specificity	• False negatives in single vessel/circumflex territory ischaemia (increased sensitivity with cycle ergometry)
Nuclear perfusion study	449–834	85–90	70–75	• Exercise capacity can be assessed • High sensitivity	• Radiation • False positives due to higher sensitivity/ diaphragmatic attenuation
CT coronary angiogram	700 (Requires referral from specialist or consultant physician)	95–99	64–90	• High negative predictive value (especially in low to intermediate risk subjects)	• Radiation • Functional effect of stenosis not usually assessed, nor exercise capacity
Coronary angiogram	522–900	~100	~100	• Gold standard	• Invasive • Radiation • Functional effect of stenosis not routinely assessed

MBS = Medicare Benefits Schedule

ACC/AHA 2012

	stress	Sensibil. (%)	Especi.(%)	
PE		68	77	
Eco	esforço	70-85	77-89	
	farmacológico	85-90	79-90	
SPECT	esforço	82-88	70-88	
	farmacológico	88-91	75-90	
PET		>sens		
RMN	dobutamina	83	86	
	vasodilatador	91	81	
CCT		93-97	80-95	VPN+++
CAC scoring		85	75	
RMN angio		87-88	56-70	VPN: 81

Congresso
Novas Fronteiras em Cardiologia
8 a 10 de Fevereiro.2013
Hotel Vila Galé Ericeira

Practice Guideline

2012 ACCF/AHA/ACP/AATS/PCNA/SCAI/STS Guideline for the Diagnosis and Management of Patients With Stable Ischemic Heart Disease

A Report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines, and the American College of Physicians, American Association for Thoracic Surgery, Preventive Cardiovascular Nurses Association, Society for Cardiovascular Angiography and Interventions, and Society of Thoracic Surgeons

WRITING COMMITTEE MEMBERS*
Stephan D. Fihn, MD, MPH, Chair†; Julius M. Gardin, MD, Vice Chair*‡; Jonathan Abrams, MD‡; Kathleen Berra, MSN, ANP*§; James C. Blankenship, MD¶; Apostolos P. Dallas, MD*†; Pamela S. Douglas, MD*‡; JoAnne M. Foody, MD*‡; Thomas C. Gerber, MD, PhD‡; Alan L. Hinderliter, MD‡; Spencer B. King III, MD*‡; Paul D. Kligfield, MD‡; Harlan M. Krumholz, MD‡; Raymond Y.K. Kwong, MD‡; Michael J. Lim, MD*¶‖; Jane A. Linderbaum, MS, CNP-BC¶‖; Michael J. Mack, MD*#; Mark A. Munger, PharmD*‡; Richard L. Prager, MD#; Joseph F. Sabik, MD**‡; Leslee J. Shaw, PhD*‡; Joanna D. Sikkema, MSN, ANP-BC*§; Craig R. Smith, Jr, MD**; Sidney C. Smith, Jr, MD*††; John A. Spertus, MD, MPH*‡‡; Sankey V. Williams, MD*†

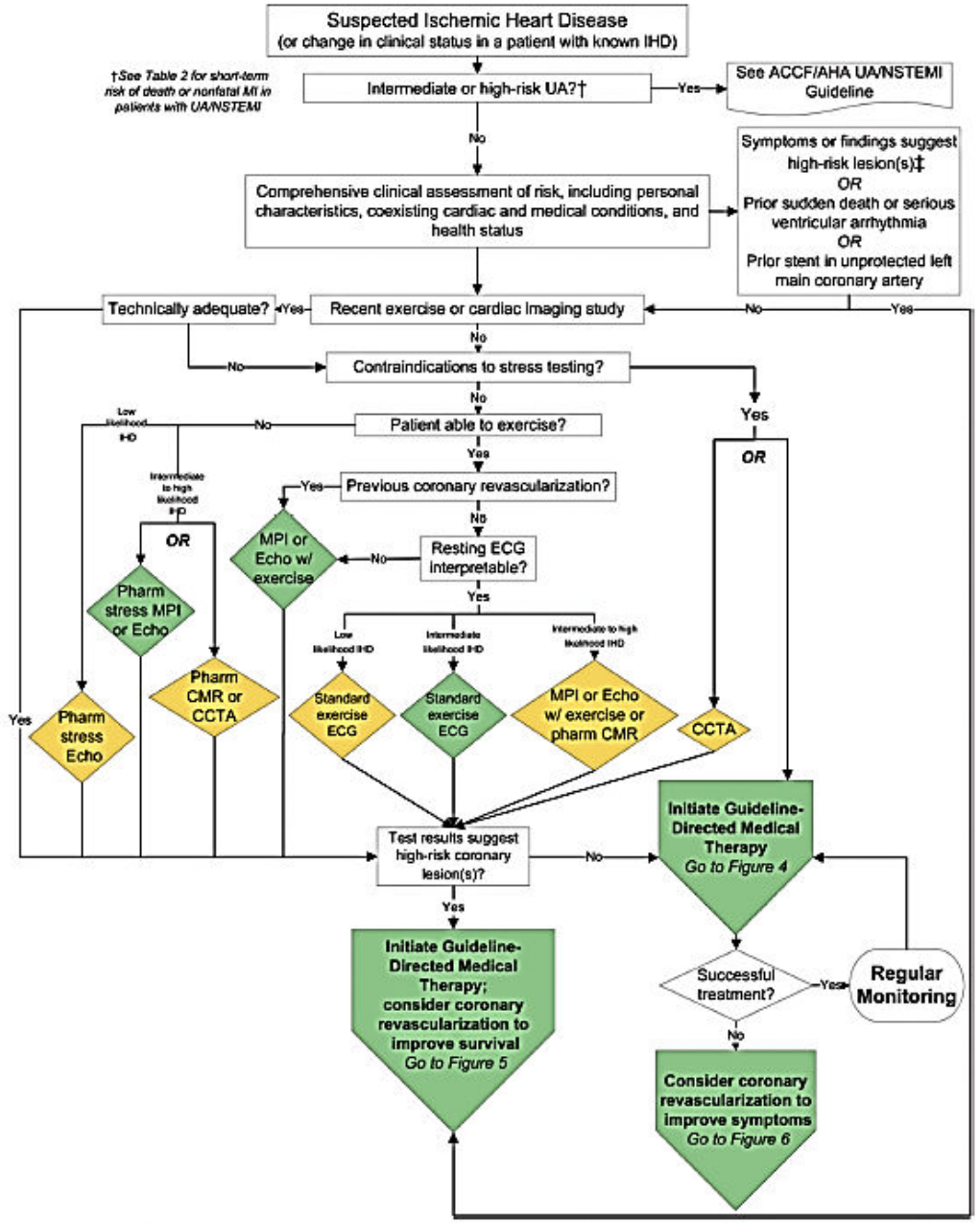


Figure 2. Diagnosis of patients with suspected ischemic heart disease.* *Colors correspond to the class of recommendations in the ACCF/AHA Table 1. The algorithms do not represent a comprehensive list of recommendations (see text for all recommendations). †See Table 2 for short-term risk of death or nonfatal MI in patients with UA/NSTEMI. ‡CCTA is reasonable only for patients with intermediate probability of IHD. CCTA indicates computed coronary tomography angiography; CMR, cardiac magnetic resonance; EOG, electrocardiogram; Echo, echocardiography; IHD, ischemic heart disease; MI, myocardial infarction; MPI, myocardial perfusion imaging; Pharm, pharmacological; UA, unstable angina; and UA/NSTEMI, unstable angina/non-ST-elevation myocardial infarction.

Congresso
Novas Fronteiras em Cardiologia
8 a 10 fevereiro.2013
Hotel Vila Galé Ericeira

Congresso
Novas Fronteiras em Cardiologia
8 a 10 de Fevereiro.2013
Hotel Vila Galé Ericeira

•RESERVAS

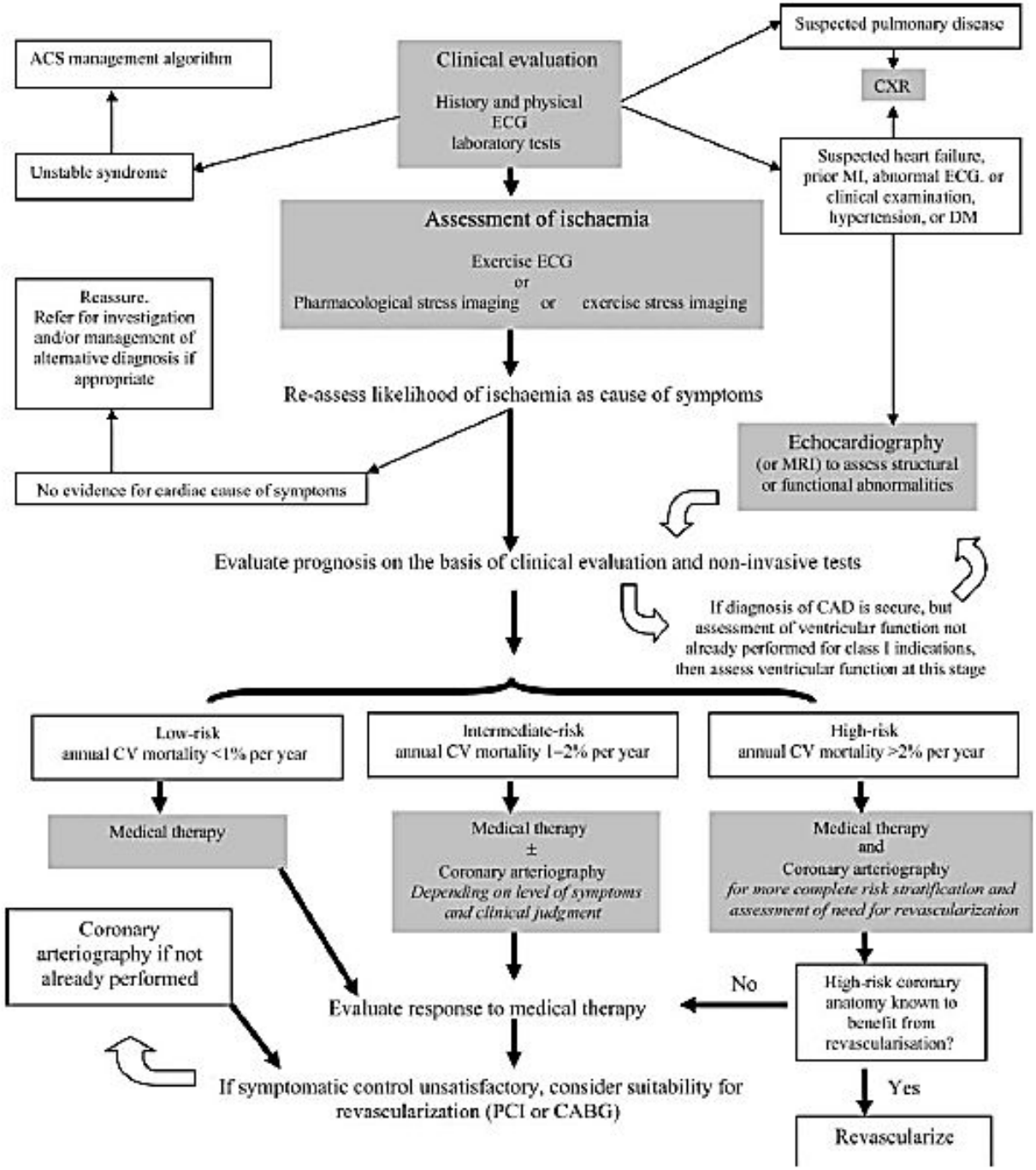


Figure 2 Algorithm for the initial evaluation of patients with clinical symptoms of angina.

META-ANÁLISES: SENSIBILIDADE E ESPECIFICIDADE

68%

77%

Table 7. Meta-Analyses of Exercise Testing[25,26]

Grouping	Number of Studies	Total Number of Patients	Sens (%)	Spec (%)	Predictive Accuracy (%)
Meta-analysis of standard exercise test	147	24,047	68	77	73
Meta-analysis without MI	58	11,691	67	72	69
Meta-analysis without workup bias	3	>1000	50	90	69
Meta-analysis with ST depression	22	9153	69	70	69
Meta-analysis without ST depression	3	840	67	84	75
Meta-analysis with digoxin	15	6338	68	74	71
Meta-analysis without digoxin	9	3548	72	69	70
Meta-analysis with LVH	15	8016	68	69	68
Meta-analysis without LVH	10	1977	72	77	74

Sens indicates sensitivity; Spec, specificity; MI, myocardial infarction; and LVH, left ventricular hypertrophy.

73%

Congresso
Novas Fronteiras em Cardiologia
8 a 10 de Fevereiro.2013
Hotel Vila Galé Ericeira

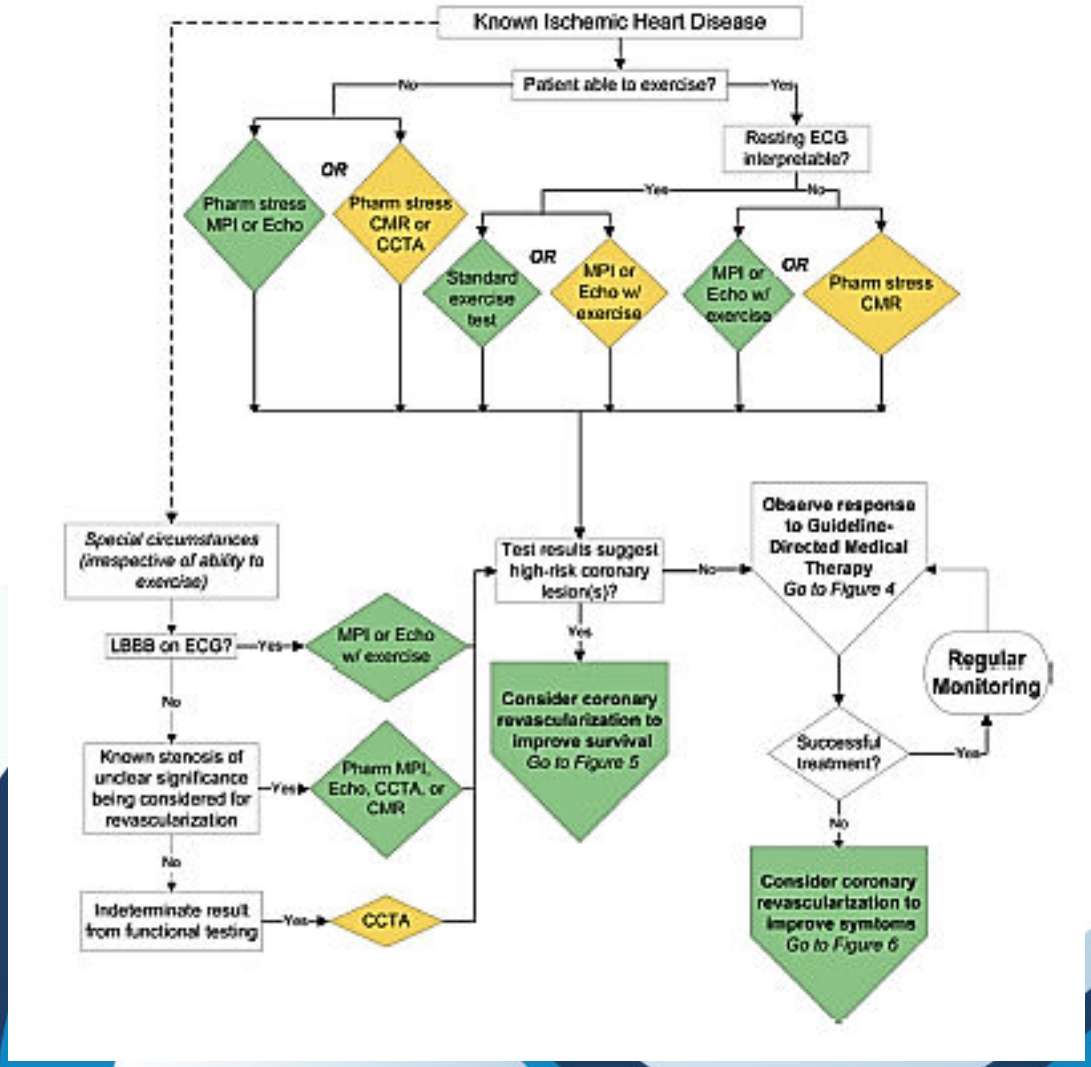
Table 3. Diagnostic accuracy of noninvasive modalities for detection of CAD

Imaging modality	Sensitivity (%)	Specificity (%)
CT angiography	91	93
Stress echocardiography	79	87
MPI-SPECT	86	74
MPI-PET	89	90
Stress MR perfusion	91	81
Stress MR wall motion	83	86
MR coronary angiography	73	86
Exercise electrocardiogram	68	77

Congresso
Novas Fronteiras em Cardiologia
8 a 10 de Fevereiro.2013
Hotel Vila Galé Ericeira

Table 6 Summary of test characteristics for investigations used in the diagnosis of stable angina

	Diagnosis of CAD	
	Sensitivity (%)	Specificity (%)
Exercise ECG	68	77
Exercise echo	80–85	84–86
Exercise myocardial perfusion	85–90	70–75
Dobutamine stress echo	40–100	62–100
Vasodilator stress echo	56–92	87–100
Vasodilator stress myocardial perfusion	83–94	64–90


Known Ischemic Heart Disease
Patient able to exercise?
No
Yes
Pharm stress MPI or Echo
OR
Pharm stress CMR or CCTA
Resting ECG interpretable?
Yes
No
Standard exercise test
OR
MPI or Echo w/ exercise
MPI or Echo w/ exercise
OR
Pharm stress CMR
Special circumstances (irrespective of ability to exercise)
LBBB on ECG?
Yes
MPI or Echo w/ exercise
No
Known stenosis of unclear significance being considered for revascularization
Yes
Pharm MPI, Echo, CCTA, or CMR
No
Indeterminate result from functional testing
Yes
CCTA
Test results suggest high-risk coronary lesion(s)?
No
Yes
Consider coronary revascularization to improve survival
Go to Figure 5
Observe response to Guideline-Directed Medical Therapy
Go to Figure 4
Regular Monitoring
Successful treatment?
Yes
No
Consider coronary revascularization to improve symtoms
Go to Figure 6

Appendix Table 2. **Short-Term Risk for Death or Nonfatal Myocardial Infarction in Patients With Unstable Angina***

High Risk	Intermediate Risk	Low Risk
At least one of the following features must be present:	No high-risk features but must have any of the following:	No high- or intermediate-risk feature but may have any of the following:
Prolonged, ongoing (>20 min) pain at rest	Prolonged (>20 min) rest angina, now resolved, with moderate or high likelihood of CAD	Increased angina frequency, severity, or duration
Pulmonary edema, most likely related to ischemia	Rest angina (>20 min or relieved with sublingual nitroglycerin)	Angina provoked at a lower threshold
Angina at rest with dynamic ST-segment changes ≥1 mm	Nocturnal angina	New-onset angina with onset 2 wk–2 mo before presentation
Angina with new or worsening mitral regurgitation murmur	Angina with dynamic T-wave changes	Normal or unchanged ECG
Angina with S_3 or new/worsening rales	New-onset CCSC III or IV angina in the past 2 wk with moderate or high likelihood of CAD†	
Angina with hypotension	Pathologic Q waves or resting ST-segment depression ≤1 mm in multiple lead groups (anterior, inferior, lateral)	
	Age >65 y	

CAD = coronary artery disease; CCSC = Canadian Cardiovascular Society Classification; ECG = electrocardiogram.
* Estimation of the short-term risks for death and nonfatal myocardial infarction in unstable angina is a complex multivariable problem that cannot be fully specified in a table such as this. Therefore, it is meant to offer general guidance and illustration rather than rigid algorithms. Modified from Braunwald et al (9) with permission.
† CCSC III angina is defined by marked limitation of ordinary physical activity. CCSC IV angina is defined by the inability to carry out any physical activity without discomfort (10).

Congresso
Novas Fronteiras em Cardiologia
8 a 10 de Fevereiro.2013
Hotel Vila Galé Ericeira

European Heart Journal
doi:10.1093/eurheartj/ehl001

ESC Guidelines

Guidelines on the management of stable angina pectoris: full text†

The Task Force on the Management of Stable Angina Pectoris of the European Society of Cardiology

Authors/Task Force Members, Kim Fox, Chairperson, London (UK)*, Maria Angeles Alonso Garcia, Madrid (Spain), Diegia Ardissino, Parma (Italy), Pawel Buszman, Katowice (Poland), Paola G. Camici, London (UK), Filippo Crea, Roma (Italy), Caroline Daly, London (UK), Guy De Backer, Ghent (Belgium), Paul Hjemdahl, Stockholm (Sweden), José Lopez-Sendon, Madrid (Spain), Jean Marco, Toulouse (France), João Morais, Leiria (Portugal), John Pepper, London (UK), Udo Sechtem, Stuttgart (Germany), Maarten Simoons, Rotterdam (The Netherlands), Kristian Thygesen, Aarhus (Denmark)

ESC Committee for Practice Guidelines (CPG), Silvia G. Priori (Chairperson) (Italy), Jean-Jacques Blanc (France), Andrzej Budaj (Poland), John Camm (UK), Veronica Dean (France), Jaap Deckers (The Netherlands), Kenneth Dickstein (Norway), John Lekakis (Greece), Keith McGregor (France), Marco Metra (Italy), João Morais (Portugal), Ady Osterspey (Germany), Juan Tamargo (Spain), José L. Zamorano (Spain)

Document Reviewers, José L. Zamorano (CPG Review Coordinator) (Spain), Felicita Andreotti (Italy), Harald Becher (UK), Rainer Dietz (Germany), Alan Fraser (UK), Huon Gray (UK), Rosa Ana Hernández Antolín (Spain), Kurt Huber (Austria), Dimitris T. Kremastinos (Greece), Attilio Maseri (Italy), Hans-Joachim Nesser (Austria), Tomasz Pasierski (Poland), Ulrich Sigwart (Switzerland), Marco Tubaro (Italy), Michael Weis (Germany)

Table 7 Summary of recommendations for routine non-invasive investigations in evaluation of stable angina

Test	For Diagnosis		For Prognosis	
	Class of recommendation	Level of evidence	Class of recommendation	Level of evidence
Laboratory tests				
Full blood count, creatinine	I	C	I	B
Fasting glucose	I	B	I	B
Fasting lipid profile	I	B	I	B
Hs-C-reactive protein, homocysteine, lp(a), apoA, and apoB	IIb	B	IIb	B
ECG				
Initial evaluation	I	C	I	B
During episode of angina	I	B		
Routine periodic ECG on successive visits	IIb	C	IIb	C
Ambulatory ECG monitoring				
Suspected arrhythmia	I	B		
Suspected vasospastic angina	IIa	C		
In suspected angina with normal exercise test	IIa	C		
CXR				
Suspected heart failure or abnormal cardiac auscultation	I	B	I	B
Suspected significant pulmonary disease	I	B		
Echocardiogram				
Suspected heart failure, abnormal auscultation, abnormal ECG, Qwaves, BBB, and marked ST changes	I	B	I	B
Previous MI			I	B
Hypertension or diabetes mellitus	I	C	I	B/C
Intermediate or low-risk patient not due to have alternative assessment of LV function			IIa	C
Exercise ECG				
First line for initial evaluation, unless unable to exercise/ECG not evaluable	I	B	I	B
Patients with known CAD and significant deterioration in symptoms			I	B
Routine periodic testing once angina controlled	IIb	C	IIb	C
Exercise imaging technique (echo or radionuclectide)				
Initial evaluation in patients with uninterpretable ECG	I	B	I	B
Patients with non-conclusive exercise test (but adequate exercise tolerance)	I	B	I	B
Angina post-revascularization	IIa	B	IIa	B
To identify location of ischaemia in planning revascularization	IIa	B		
Assessment of functional severity of intermediate lesions on arteriography	IIa	C		
Pharmacological stress imaging technique				
Patients unable to exercise	I	B	I	B
Patients with non-conclusive exercise test due to poor exercise tolerance	I	B	I	B
To evaluate myocardial viability	IIa	B		
Other indications as for exercise imaging where local facilities favour pharmacological rather than exercise stress	IIa	B	IIa	B
Non-invasive CT arteriography				
Patients with low probability of disease and non-conclusive or positive stress test	IIb	C		

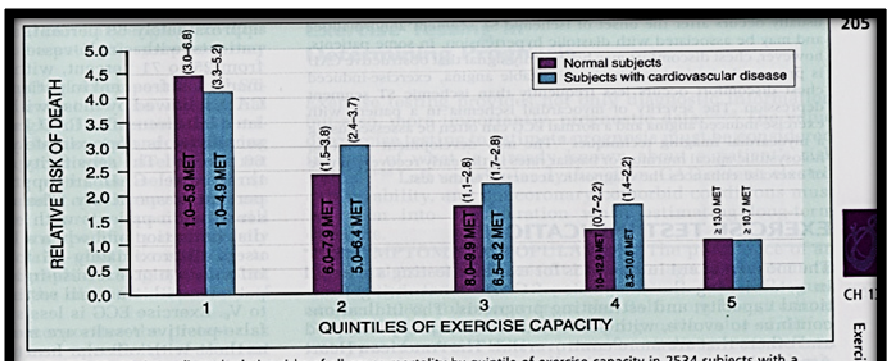
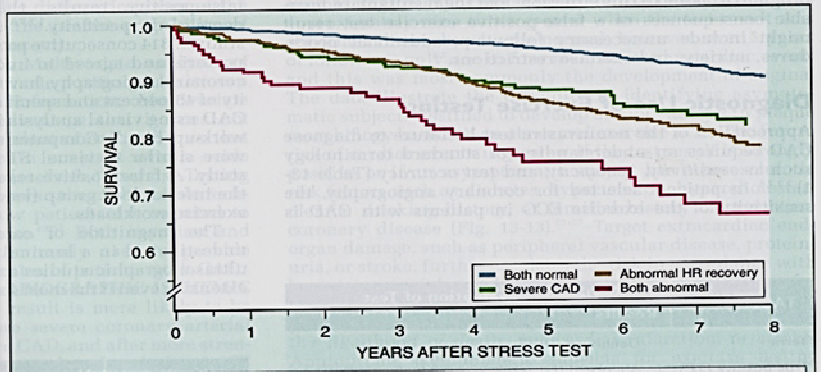


FIGURE 13–11 Age-adjusted relative risks of all-cause mortality by quintile of exercise capacity in 2534 subjects with a normal exercise test result and no history of cardiovascular disease and in 3679 subjects with an abnormal exercise test result or history of cardiovascular disease. The mean duration of follow-up was 6.2 ± 3.7 years. Quintile 5 was used as the reference category. For each 1-MET increase in exercise capacity, survival improved by 12 percent. *(From Myers J, Prakash M, Froelicher V, et al: Exercise capacity and mortality among men referred for exercise testing. N Engl J Med 346:793, 2002.)*



No. at risk									
Both normal	1817	1802	1784	1666	1415	1170	868	706	475
Severe CAD	280	273	264	251	210	161	127	90	79
Abnl HR rec	697	678	665	614	508	395	299	243	143
Both abnormal	141	129	125	117	84	51	49	40	29

FIGURE 13–12 Six-year follow-up in 2935 patients who underwent an exercise test and coronary angiography. After adjustment for age, gender, standard risk factors, medications, exercise capacity, coronary disease extent, and left ventricular function, abnormal heart rate recovery (Abnl HR rec) was an independent predictor of mortality. The survival plot illustrates a mortality gradient, with the worst prognosis in patients with abnormal heart rate recovery and severe coronary artery disease (CAD). *(From Vivekananthan DP, Blackstone EH, Pothier CE, et al: Heart rate recovery after exercise is a predictor of mortality, independent of the angiographic severity of coronary disease. J Am Coll Cardiol 42:831, 2003.)*

DECLIVE (slope) ST/FC

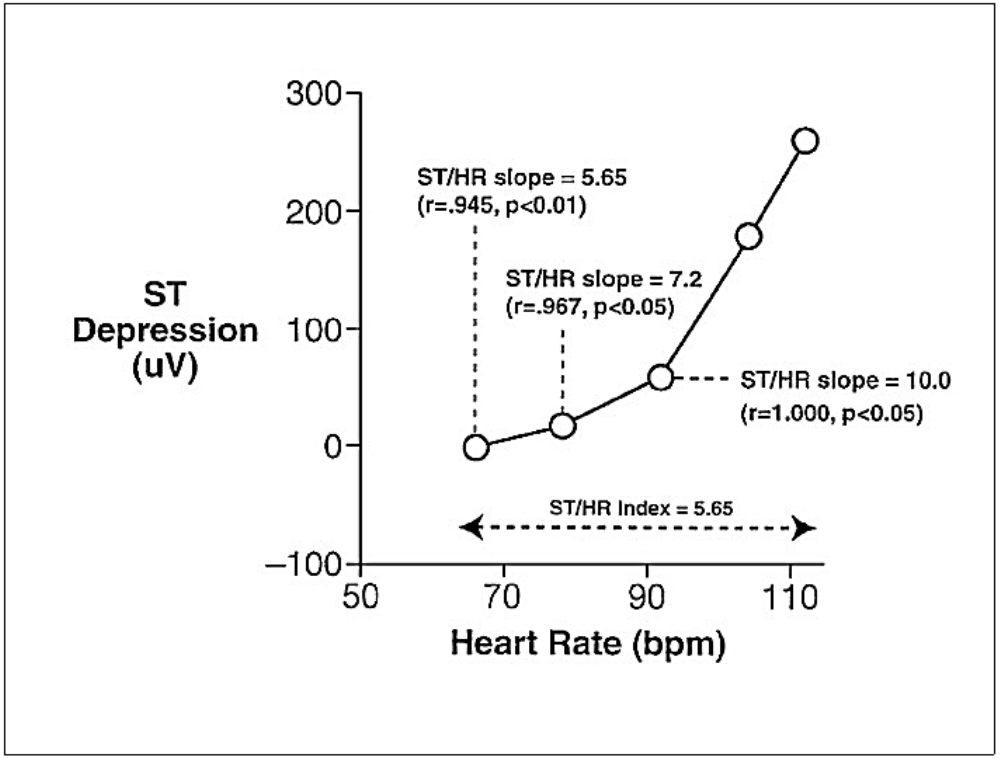


FIGURE 48.3. Calculation of the ST/HR slope. Progressive STsegment depression in lead CM_5 (shown as a positive magnitude on the vertical axis) is plotted against exercise heart rate in a patient with three-vessel coronary artery disease. This cases illustrates the linear relation of ST-segment depression to heart rate as peak exercise is approached. As a result, the slope of the line relating the final three data points by linear regression is higher than the slope of lines incorporating earlier data points. When more than one linear correlation is statistically significant, the greatest value (in this case, 10.0) is taken as the test result for that patient. The value obtained by simply dividing the total change in ST-segment depression by the total change in heart rate (the ST/HR index) markedly underestimates the true ST/HR slope. (From Okin PM, Kligfield P. Heart rate adjustment of ST depression and performance of the exercise electrocardiogram: a critical evaluation. *J Am Coll Cardiol* 1995;25:1726, with permission of Elsevier Science, Inc.)

RATIO var ST/ varFC

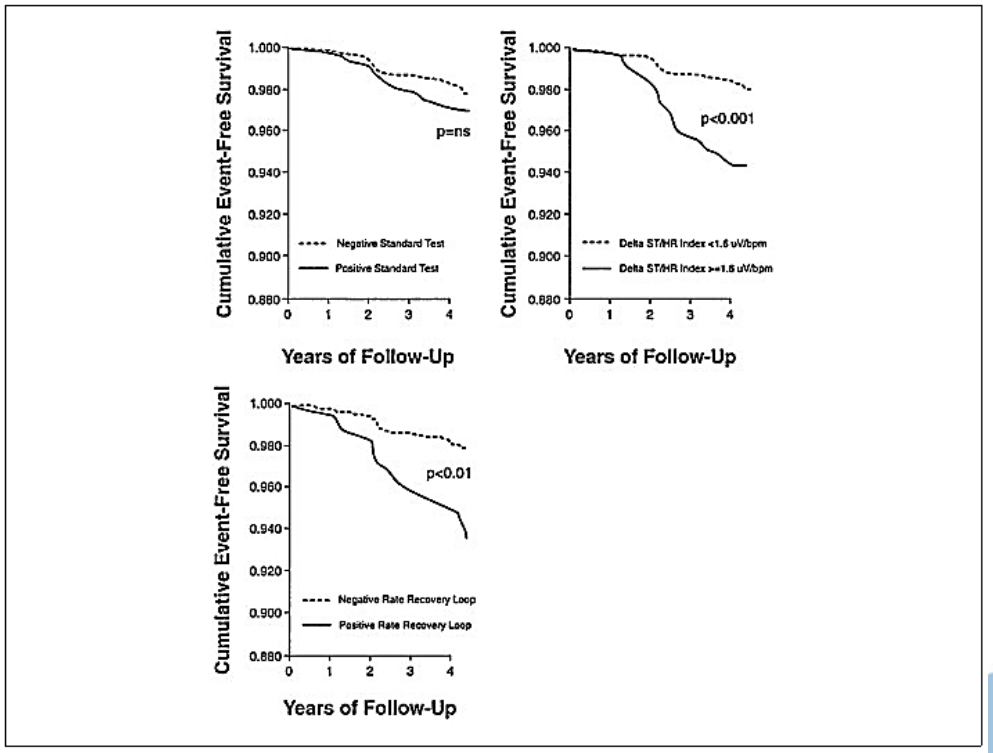


FIGURE 48.5. Kaplan-Meier plots of survival free of angina, nonfatal myocardial infarction, or coronary heart disease death according to exercise test criteria in the Framingham Offspring Study. Both the ST/HR index and the rate-recovery loop were predictive of outcome, with significantly lower event-free survival rates among subjects with positive than those with negative test outcomes. In contrast, there was no significant difference in event-free survival between subjects with positive and negative standard exercise tests defined according to traditional electrocardiographic criteria. (From Okin PM, Anderson KM, Levy D, Kligfield P. Heart rate adjustment of exercise-induced ST segment depression: Improved risk stratification in the Framingham Offspring Study. *Circulation* 1991;83:866, with the permission of the American Heart Association.)

AUMENTO DA SENSIBILIDADE

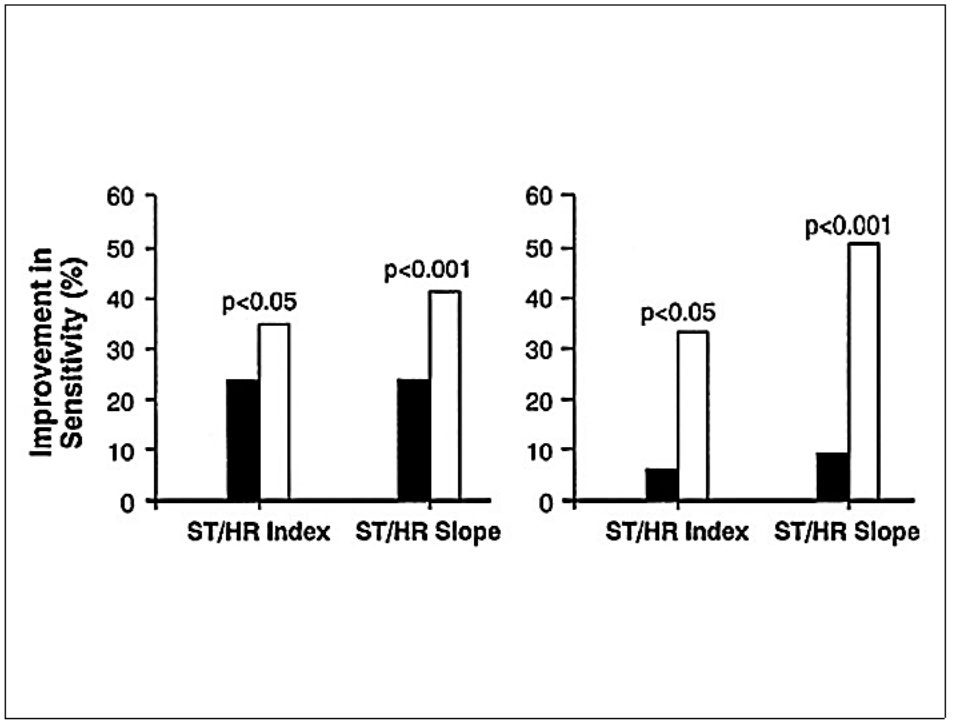


FIGURE 48.7. Bar graphs showing sex differences in the improvement in sensitivity obtained using the ST/HR index and ST/HR slope compared with standard test criteria for the identification of coronary artery disease (*left*) and for the identification of three-vessel coronary disease (*right*). Solid bars represent men; white bars, women. (Reprinted from Okin PM, Kligfield P. Gender-specific criteria and performance of the exercise electrocardiogram. *Circulation* 1995;92:1209, with the permission of the American Heart Association).

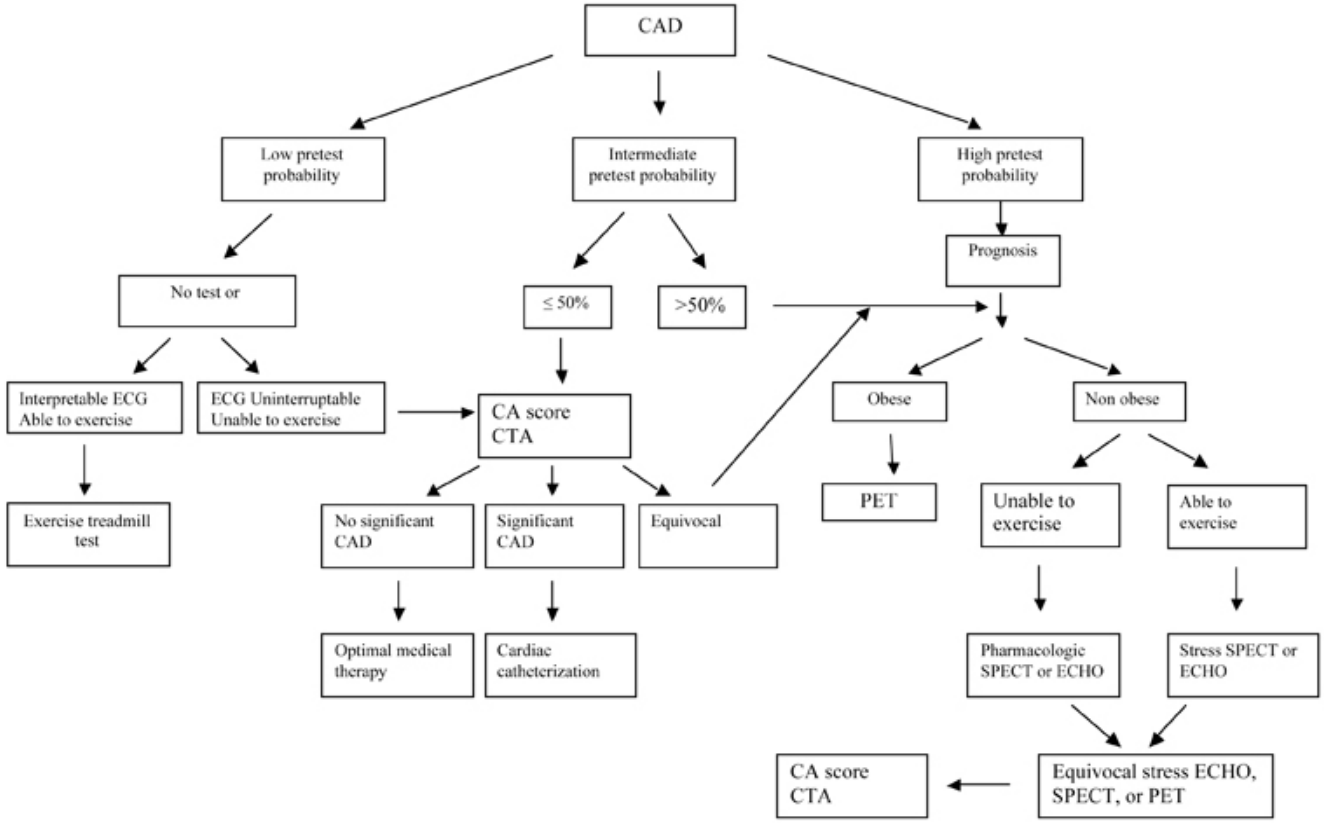
Table 4 Probability of coronary disease in symptomatic patients based on (a) age, gender, and symptom classification and (b) modified by exercise test results

(a) Pretest likelihood of CAD in symptomatic patients according to age and sex

Age (years)	Typical angina		Atypical angina		Non-anginal chest pain	
	Male	Female	Male	Female	Male	Female
30–39	69.7 + 3.2	25.8 + 6.6	21.8 + 2.4	4.2 + 1.3	5.2 + 0.8	0.8 + 0.3
40–49	87.3 + 1.0	55.2 + 6.5	46.1 + 1.8	13.3 + 2.9	14.1 + 1.3	2.8 + 0.7
50–59	92.0 + 0.6	79.4 + 2.4	58.9 + 1.5	32.4 + 3.0	21.5 + 1.7	8.4 + 1.2
60–69	94.3 + 0.4	90.1 + 1.0	67.1 + 1.3	54.4 + 2.4	28.1 + 1.9	18.6 + 1.9

(b) CAD post-test likelihood (%) based on age, sex, symptom classification and exercise-induced electrocardiographic ST-segment depression

Age (years)	ST-depression (mV)	Typical angina		Atypical angina		Non-anginal chest pain		Asymptomatic	
		Male	Female	Male	Female	Male	Female	Male	Female
30–39	0.00–0.04	25	7	6	1	1	<1	<1	<1
	0.05–0.09	68	24	21	4	5	1	2	4
	0.00–0.14	83	42	38	9	10	2	4	<1
	0.00–0.19	91	59	55	15	19	3	7	1
	0.00–0.24	96	79	76	33	39	8	18	3
	>0.25	99	93	92	63	68	24	43	11
40–49	0.00–0.04	61	22	16	3	4	1	1	<1
	0.00–0.09	86	53	44	12	13	3	5	1
	0.00–0.14	94	72	64	25	26	6	11	2
	0.00–0.19	97	84	78	39	41	11	20	4
	0.00–0.24	99	93	91	63	65	24	39	10
	>0.25	>99	98	97	86	87	53	69	28
50–59	0.00–0.04	73	47	25	10	6	2	2	1
	0.00–0.09	91	78	57	31	20	8	9	3
	0.00–0.14	96	89	75	50	37	16	19	7
	0.00–0.19	98	94	86	67	53	28	31	12
	0.00–0.24	99	98	94	84	75	50	54	27
	>0.25	>99	99	98	95	91	78	81	56
60–69	0.00–0.04	79	69	32	21	8	5	3	2
	0.00–0.09	94	90	65	52	26	17	11	7
	0.00–0.14	97	95	81	72	45	33	23	15
	0.00–0.19	99	98	89	83	62	49	37	25
	0.00–0.24	99	99	96	93	81	72	61	47
	>0.25	>99	99	99	98	94	90	85	76


CAD
Low pretest probability
Intermediate pretest probability
High pretest probability
No test or
≤ 50%
>50%
Prognosis
Interpretable ECG Able to exercise
ECG Uninterruptable Unable to exercise
CA score CTA
Obese
Non obese
Exercise treadmill test
No significant CAD
Significant CAD
Equivocal
PET
Unable to exercise
Able to exercise
Optimal medical therapy
Cardiac catheterization
Pharmacologic SPECT or ECHO
Stress SPECT or ECHO
CA score CTA
Equivocal stress ECHO, SPECT, or PET

TESTES DIAGNÓSTICOS NÃO INVASIVOS
ANGIOGRAFIA E RADIAÇÃO

TABLE 8. Studies Reporting Effective Dose of Conventional Coronary Angiography in Nonpediatric Populations

			Mean Effective Dose Estimate, mSv					
Study	Year	Group	CA	CA±PTCA	PTCA	CA+PTCA	ICS	CA+ICS
Karppinen et al[66]	1995	...	...	10.6	...	...	...	...
Leung and Martin[67]	1996	...	3.1	...	...	...	...	...
Broadhead et al[68]	1997	Room A	9.4	...	14.2	...	...	...
		Room B	4.6	...	10.2	...	...	...
Betsou et al[69]	1998	...	5.6	...	6.9	9.3	9	13
Harrison et al[70]	1998	...	3.4	...	...	...	...	...
Neofotistou et al[71]	1998	...	4.6-15.8	...	...	5.4–41.0	...	...
Katritsis et al[72]	2000	...	5	...	6.6	13.6	10.2	16.7
Lobotesi et al[62]	2001	...	13.2	...	...	...	...	...
Delichas et al[73]	2003	Hospital A	22.7	...	30.5	...	...	...
		Hospital B	17.9	...	14.7	...	...	...
Efstathopoulos et al[74]	2003	...	5	...	...	14.8	...	...
Hunold et al[63]	2003	...	2.3	...	...	...	...	...
Sandborg et al[64]	2004	Femoral	6.8	...	...	8.6	...	...
		Radial	9.2	...	...	13.5	...	...
Stisova[75]	2004	Workplace A1	8.8	...	...	...	...	...
		Workplace A2	3.6	...	...	9.7	...	...
		Workplace B	7.9	...	...	15.3	...	...
		Workplace C	2.7	...	...	5.7	...	...
Coles et al[76]	2006	...	5.6	...	...	...	...	...
Vijayalakshmi et al[77]	2007	...	4.4	...	...	...	...	...

CA indicates coronary angiography; PTCA, percutaneous transluminal coronary angioplasty; ICS, intracoronary stenting; and ellipses (. . .), not specified.

Radiation Dose to Patients From Cardiac Diagnostic Imaging
Andrew J. Einstein, Kevin W. Moser, Randall C. Thompson, Manuel D. Cerqueira and Milena J. Henzlova

Circulation. 2007;116:1290-1305
doi: 10.1161/CIRCULATIONAHA.107.688101
Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231

Print ISSN: 0009-7322. Online ISSN: 1524-4539