
Preoperative Evaluation and Stress Testing
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Mclaren Bay Region
December 6, 2019
Preoperative Evaluation
Stress Testing

DISCLOSURE:

- No Conflicts of Interest

Preoperative Evaluation

The patient is the swimmer and the river is the surgical procedure.

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Can this patient safely cross the river?

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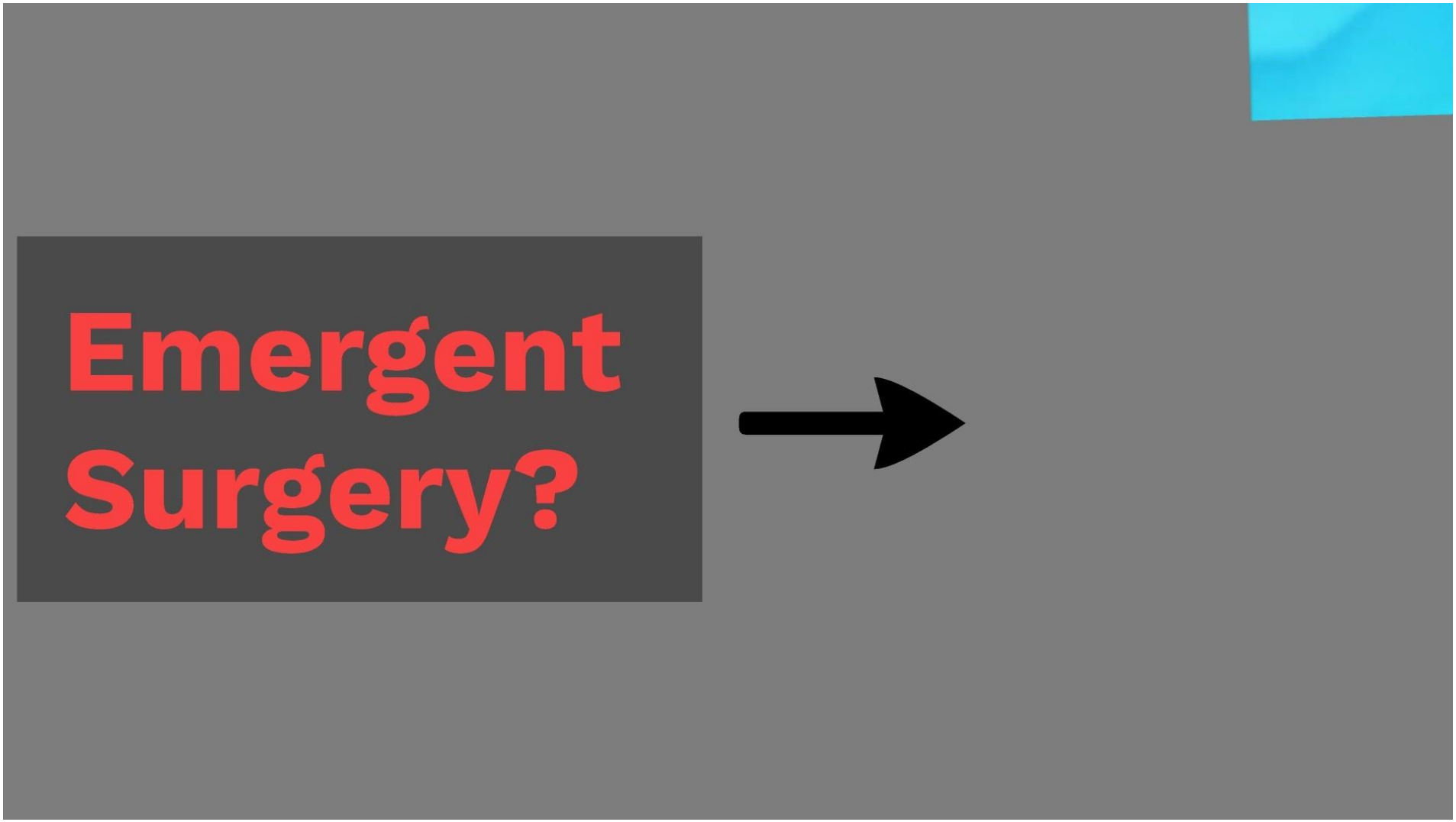
Emergent Surgery?


Emergent
Surgery?


Emergent
Surgery?

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- Proceed to surgery with no further testing
- Optimize the patient on the way to OR

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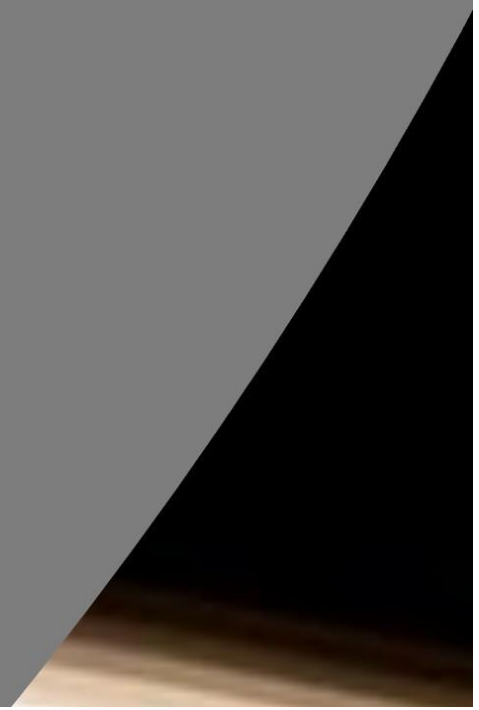
Non-emergent Surgery

Patient Risk Factors

Exceptionally High risk

Need Risk Assessment



Exceptionally High Risk Features

- High grade valvular disease:
  - Severe symptomatic Aortic stenosis
- Hemodynamic instability
- Unstable angina or recent MI within 60 days
- Acute decompensated CHF
- Ventricular arrhythmias

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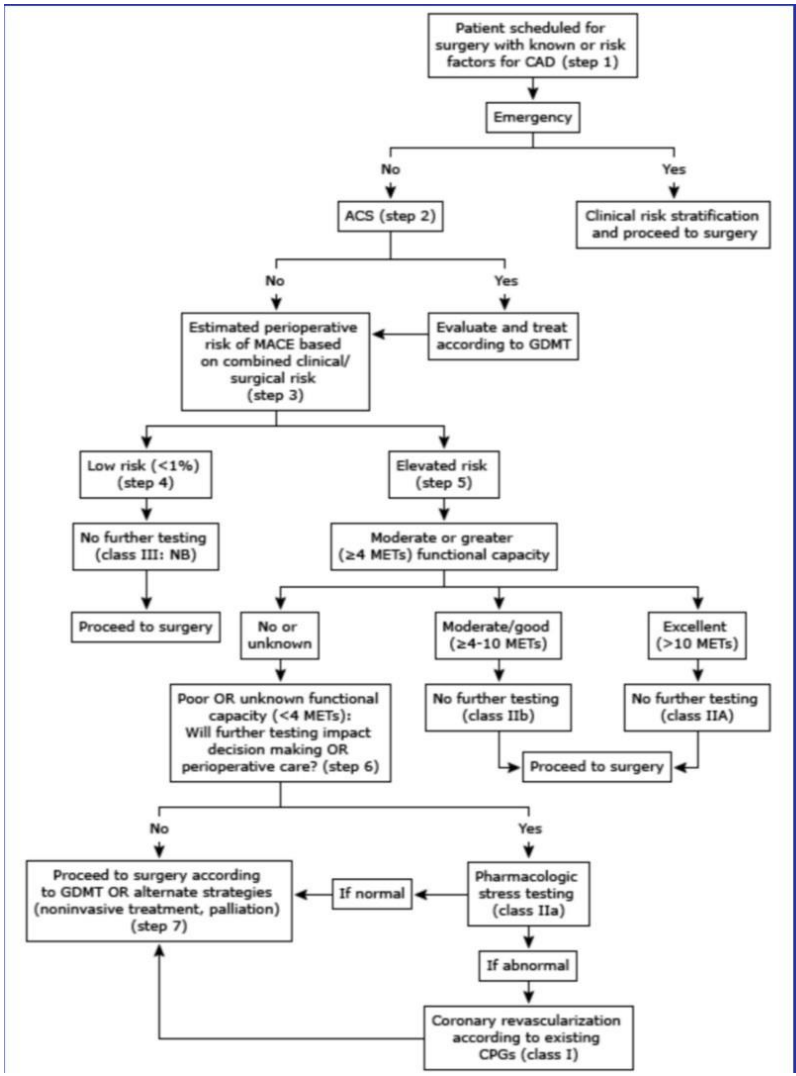
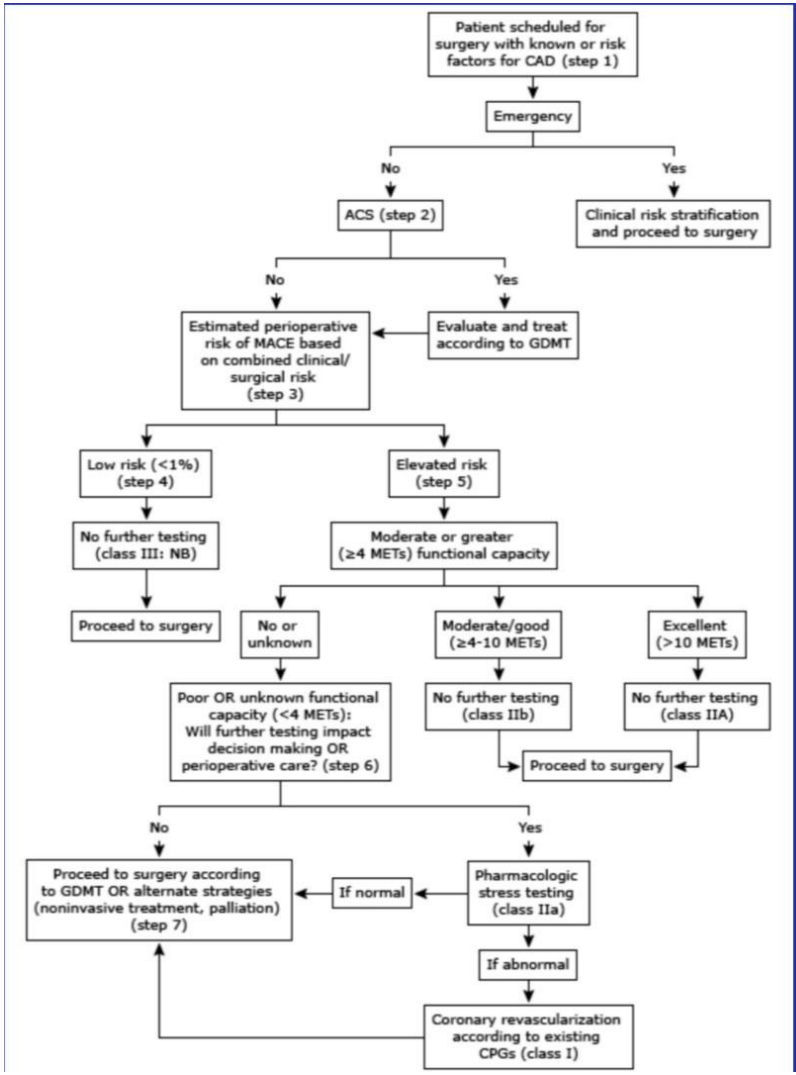
These patients should probably be evaluated by a cardiologist.


Patient scheduled for surgery with known or risk factors for CAD (step 1)
Emergency
No
Yes
ACS (step 2)
Clinical risk stratification and proceed to surgery
No
Yes
Estimated perioperative risk of MACE based on combined clinical/ surgical risk (step 3)
Evaluate and treat according to GDMT
Low risk (<1%) (step 4)
Elevated risk (step 5)
No further testing (class III: NB)
Moderate or greater (≥4 METs) functional capacity
Proceed to surgery
No or unknown
Moderate/good (≥4-10 METs)
Excellent (>10 METs)
Poor OR unknown functional capacity (<4 METs): Will further testing impact decision making OR perioperative care? (step 6)
No further testing (class IIb)
No further testing (class IIA)
Proceed to surgery
No
Yes
Proceed to surgery according to GDMT OR alternate strategies (noninvasive treatment, palliation) (step 7)
If normal
Pharmacologic stress testing (class IIa)
If abnormal
Coronary revascularization according to existing CPGs (class I)



Recommendations:

- Obtain an electrocardiogram (ECG) in patients with cardiac disease. This will provide a baseline should a postoperative test be abnormal

Additional testing:
- Echo
- Stress test
- Holters

These should be done only if there is an indication for them irrespective of the planned procedure

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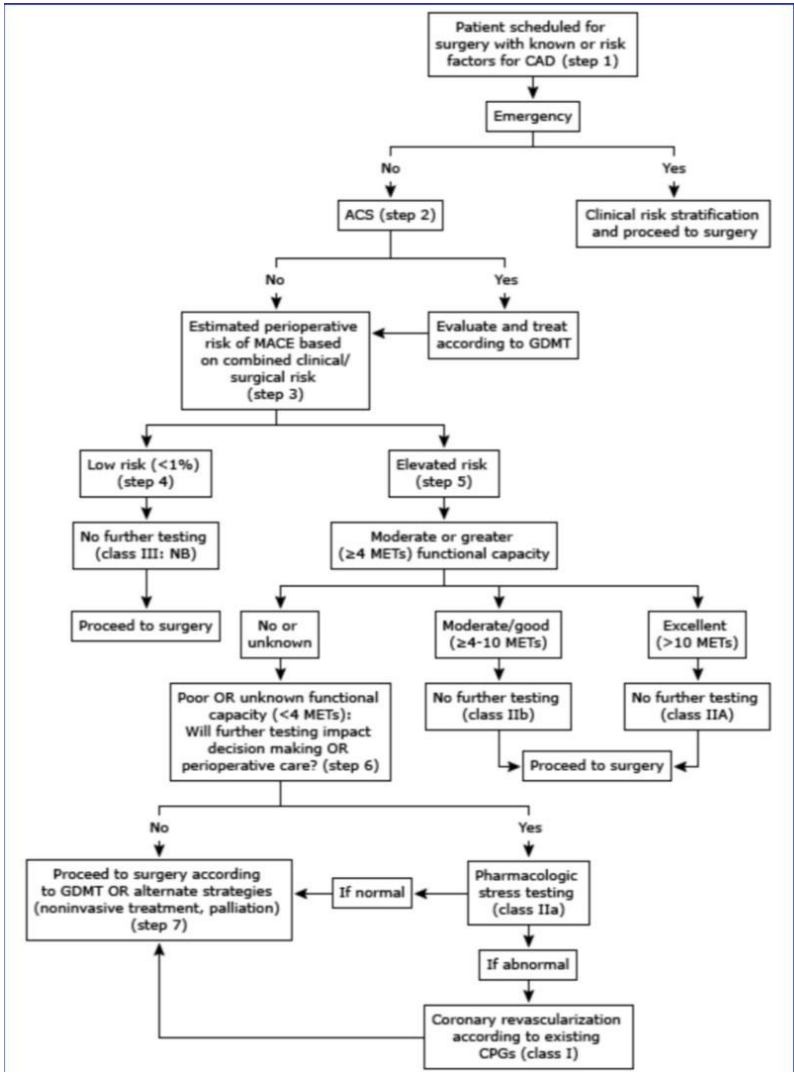

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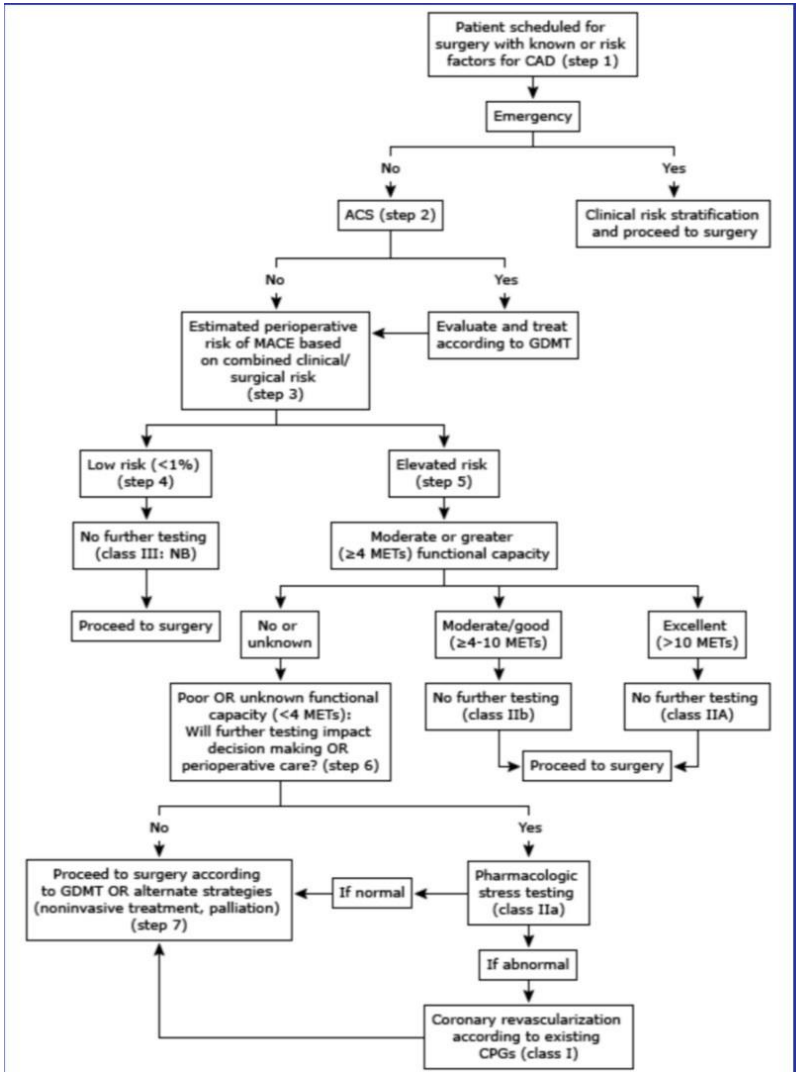

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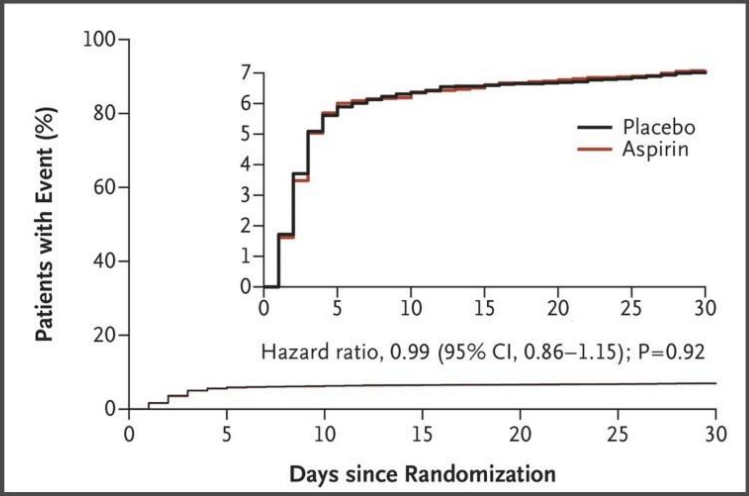

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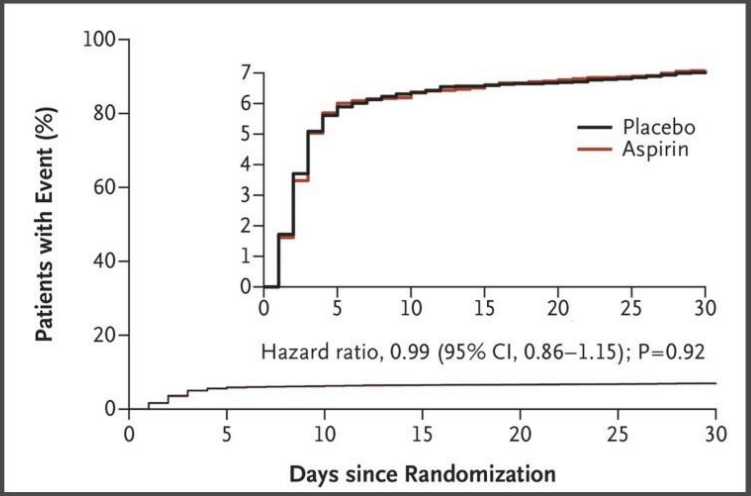
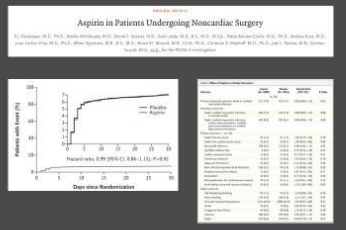


Table 2. **Effects of Aspirin on 30-Day Outcomes.***

Outcome	Aspirin (N=4998)	Placebo (N=5012)	Hazard Ratio (95% CI)†	P Value
	no. (%)			
Primary composite outcome: death or nonfatal myocardial infarction	351 (7.0)	355 (7.1)	0.99 (0.86–1.15)	0.92
Secondary outcomes				
Death, nonfatal myocardial infarction, or nonfatal stroke	362 (7.2)	370 (7.4)	0.98 (0.85–1.13)	0.80
Death, nonfatal myocardial infarction, cardiac revascularization, nonfatal pulmonary embolism, or nonfatal deep venous thrombosis	402 (8.0)	407 (8.1)	0.99 (0.86–1.14)	0.90
Tertiary outcomes — no. (%)				
Death from any cause	65 (1.3)	62 (1.2)	1.05 (0.74–1.49)	0.78
Death from cardiovascular cause	35 (0.7)	35 (0.7)	1.00 (0.63–1.60)	0.99
Myocardial infarction	309 (6.2)	315 (6.3)	0.98 (0.84–1.15)	0.85
Nonfatal cardiac arrest	9 (0.2)	12 (0.2)	0.75 (0.32–1.79)	0.52
Cardiac revascularization	13 (0.3)	17 (0.3)	0.77 (0.37–1.58)	0.47
Pulmonary embolism	33 (0.7)	31 (0.6)	1.07 (0.65–1.74)	0.79
Deep-vein thrombosis	25 (0.5)	35 (0.7)	0.72 (0.43–1.20)	0.20
New clinically important atrial fibrillation	109 (2.2)	94 (1.9)	1.16 (0.88–1.53)	0.28
Peripheral arterial thrombosis	13 (0.3)	15 (0.3)	0.87 (0.41–1.83)	0.71
Amputation	10 (0.2)	13 (0.3)	0.77 (0.34–1.76)	0.54
Rehospitalization for cardiovascular reasons	70 (1.4)	54 (1.1)	1.30 (0.91–1.86)	0.15
Acute kidney injury with receipt of dialysis‡	33 (0.7)	19 (0.4)	1.75 (1.00–3.09)	0.05
Safety outcomes				
Life-threatening bleeding	87 (1.7)	73 (1.5)	1.19 (0.88–1.63)	0.26
Major bleeding	230 (4.6)	188 (3.8)	1.23 (1.01–1.49)	0.04
Clinically important hypotension	2143 (42.9)	2096 (41.8)	1.03 (0.97–1.09)	0.37
Stroke	16 (0.3)	19 (0.4)	0.84 (0.43–1.64)	0.62
Congestive heart failure	44 (0.9)	38 (0.8)	1.16 (0.75–1.79)	0.50
Infection	488 (9.8)	495 (9.9)	0.99 (0.87–1.12)	0.86
Sepsis	243 (4.9)	258 (5.2)	0.94 (0.79–1.13)	0.52

Periprocedural Management: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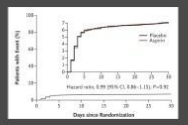

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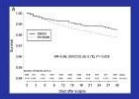
- Continue statin periop? 
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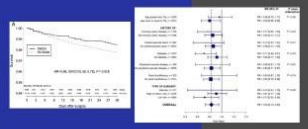
- Continue statin periop? 
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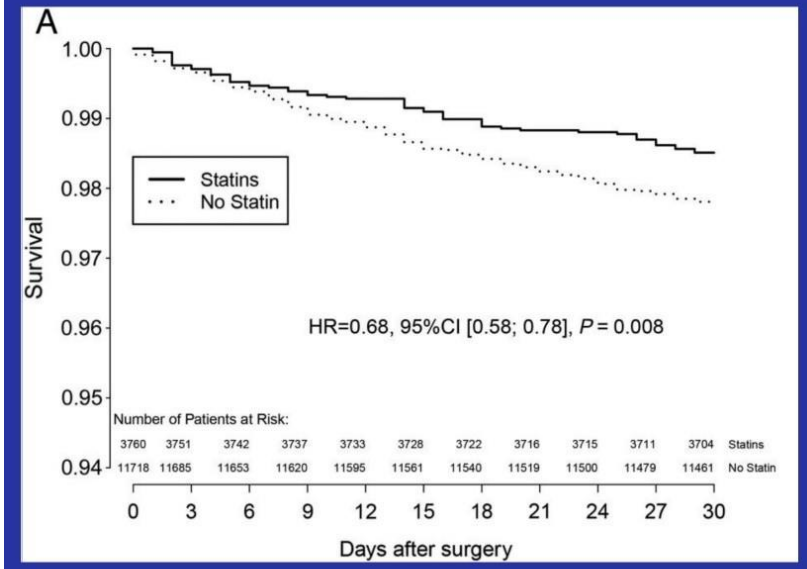
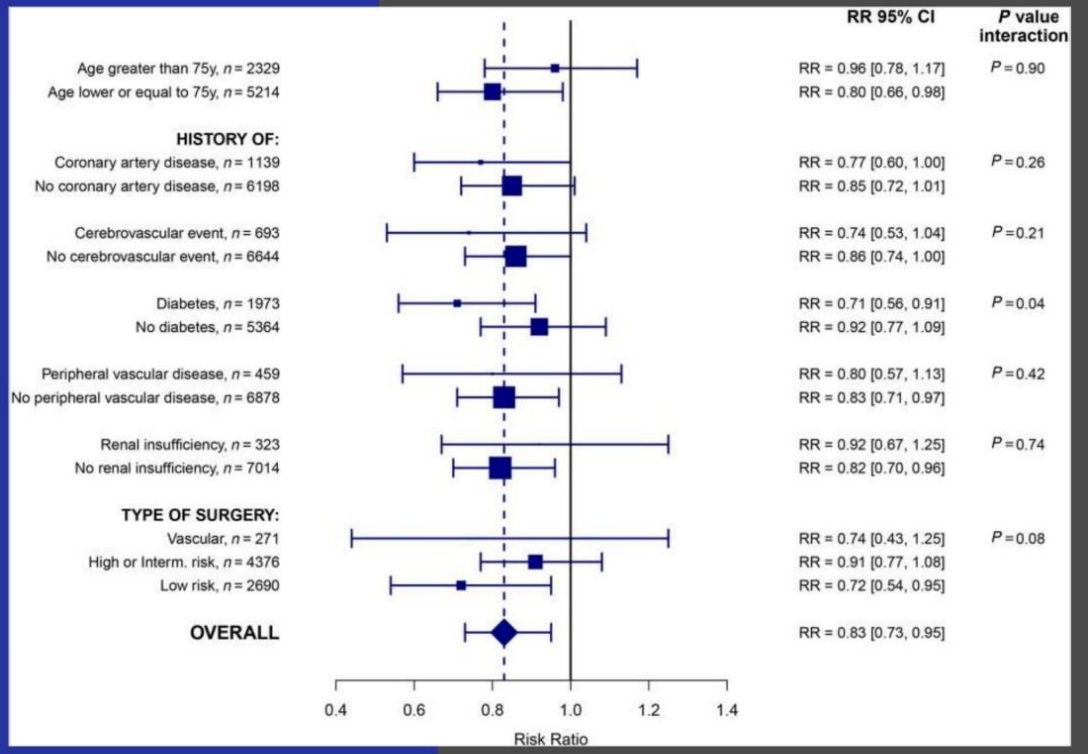

A
1.00
0.99
0.98
0.97
0.96
0.95
0.94
Survival
Statins
No Statin
HR=0.68, 95%CI [0.58; 0.78], P = 0.008
Number of Patients at Risk:
3760 3751 3742 3737 3733 3728 3722 3716 3715 3711 3704 Statins
11718 11685 11653 11620 11595 11561 11540 11519 11500 11479 11461 No Statin
0 3 6 9 12 15 18 21 24 27 30
Days after surgery


RR 95% CI
P value interaction
Age greater than 75y, n = 2329
RR = 0.96 [0.78, 1.17]
P = 0.90
Age lower or equal to 75y, n = 5214
RR = 0.80 [0.66, 0.98]
HISTORY OF:
Coronary artery disease, n = 1139
RR = 0.77 [0.60, 1.00]
P = 0.26
No coronary artery disease, n = 6198
RR = 0.85 [0.72, 1.01]
Cerebrovascular event, n = 693
RR = 0.74 [0.53, 1.04]
P = 0.21
No cerebrovascular event, n = 6644
RR = 0.86 [0.74, 1.00]
Diabetes, n = 1973
RR = 0.71 [0.56, 0.91]
P = 0.04
No diabetes, n = 5364
RR = 0.92 [0.77, 1.09]
Peripheral vascular disease, n = 459
RR = 0.80 [0.57, 1.13]
P = 0.42
No peripheral vascular disease, n = 6878
RR = 0.83 [0.71, 0.97]
Renal insufficiency, n = 323
RR = 0.92 [0.67, 1.25]
P = 0.74
No renal insufficiency, n = 7014
RR = 0.82 [0.70, 0.96]
TYPE OF SURGERY:
Vascular, n = 271
RR = 0.74 [0.43, 1.25]
P = 0.08
High or Interm. risk, n = 4376
RR = 0.91 [0.77, 1.08]
Low risk, n = 2690
RR = 0.72 [0.54, 0.95]
OVERALL
RR = 0.83 [0.73, 0.95]
0.4 0.6 0.8 1.0 1.2 1.4
Risk Ratio

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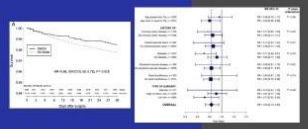
- Continue statin periop? 
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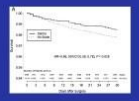
- Continue statin periop? 
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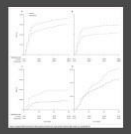

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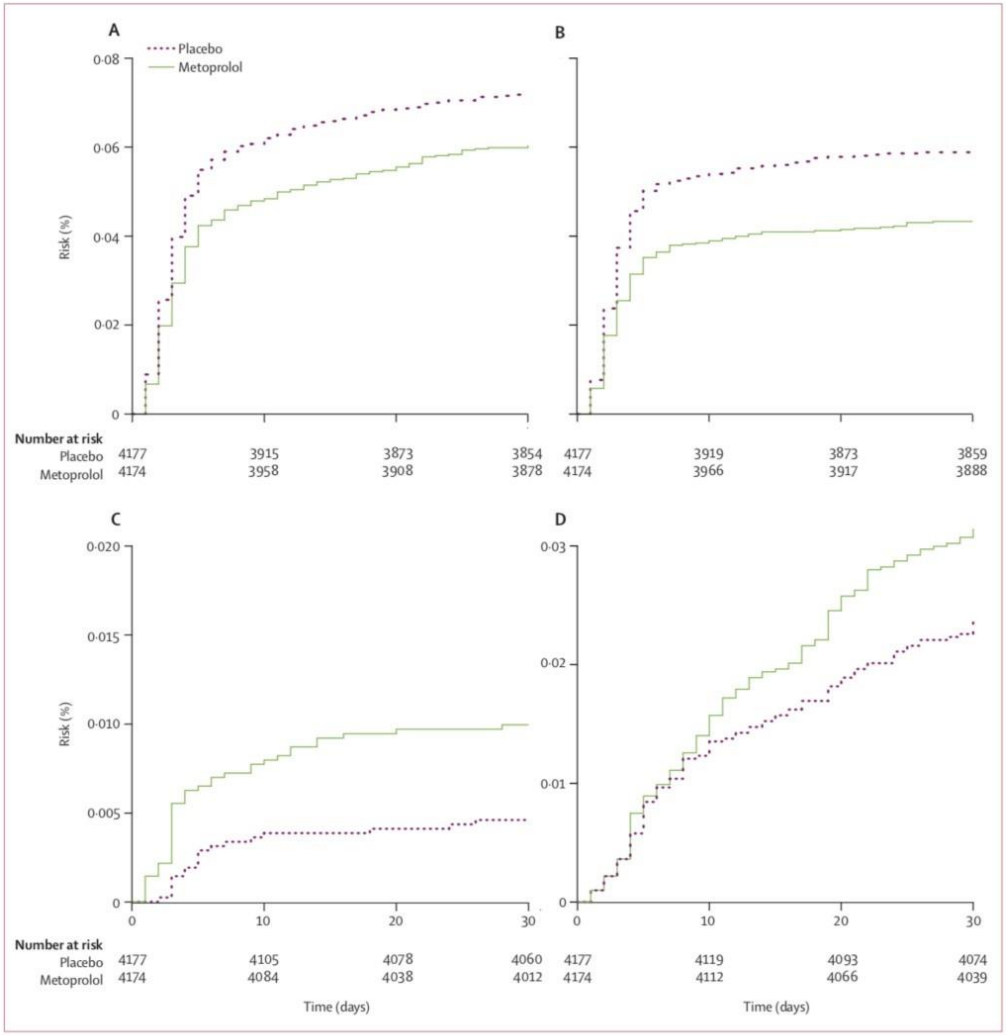
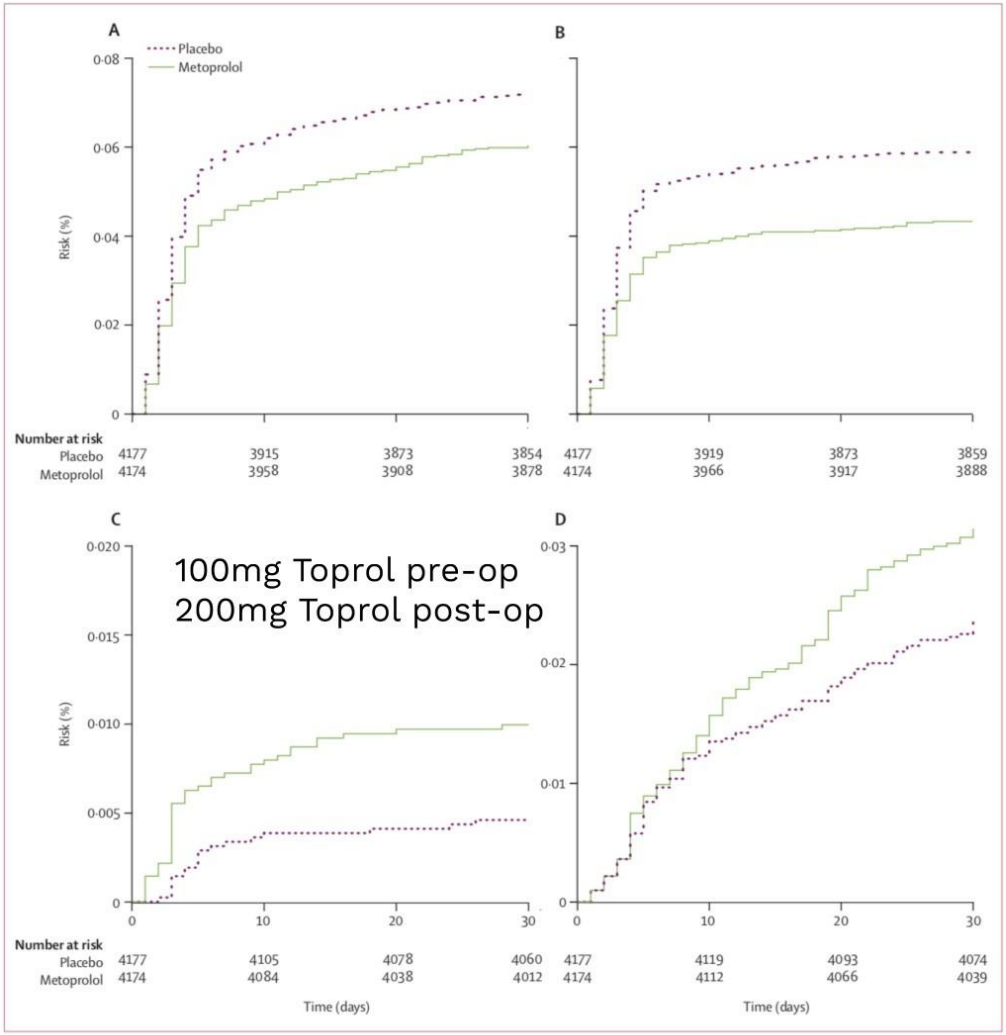


Figure 2: Kaplan-Meier estimates of the primary outcome (A), myocardial infarction (B), stroke (C), and death (D)



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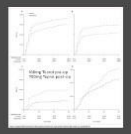

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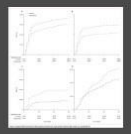

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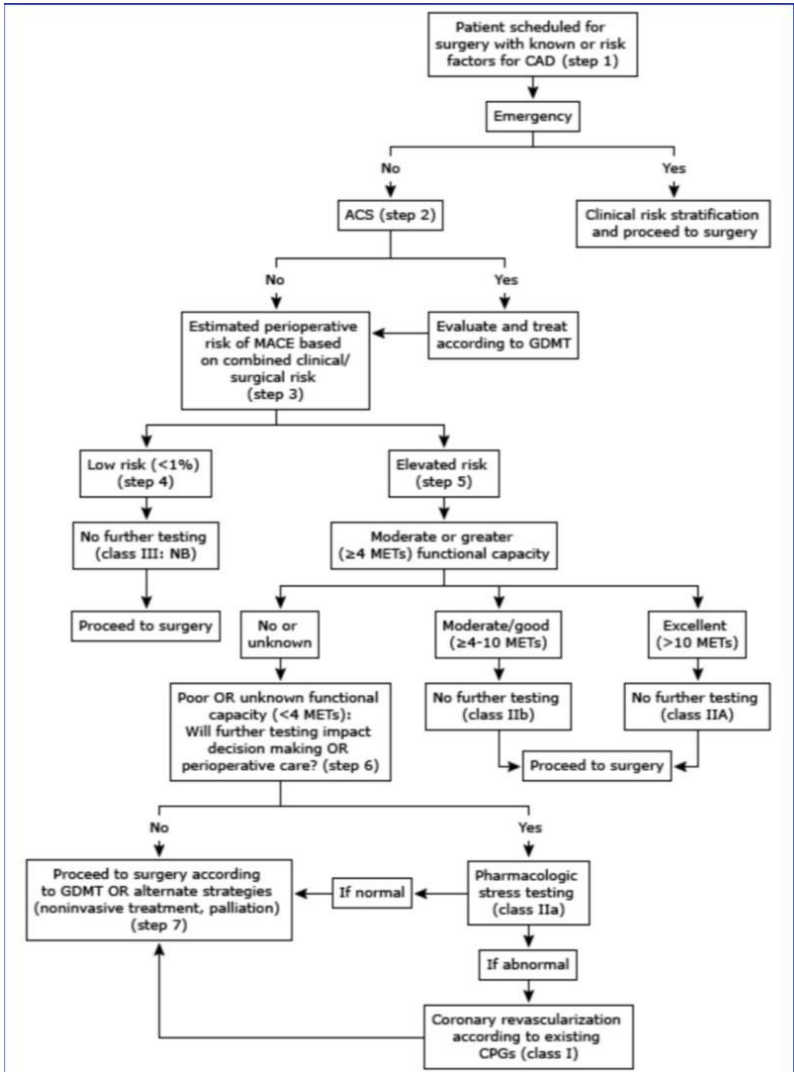

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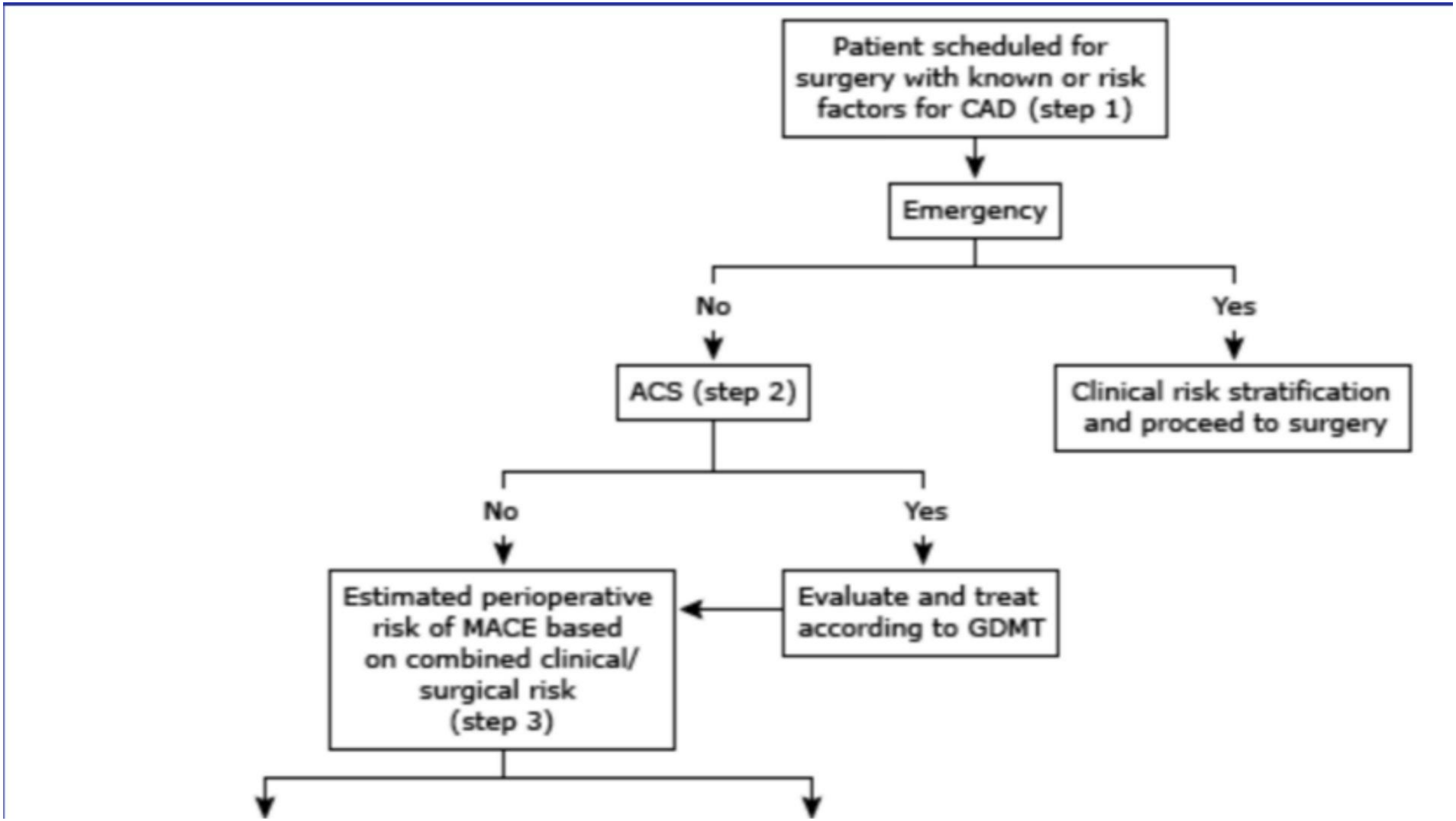
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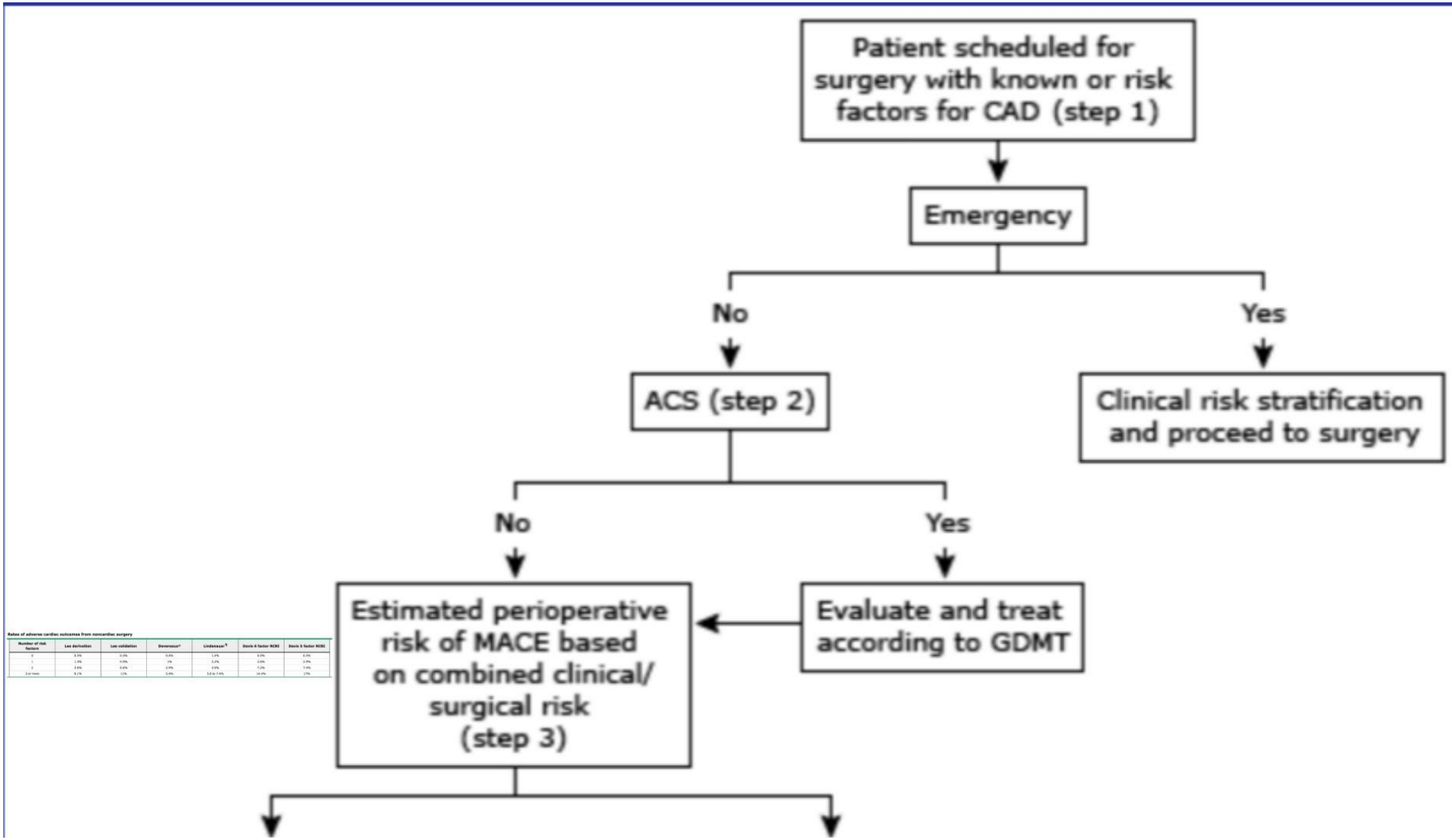
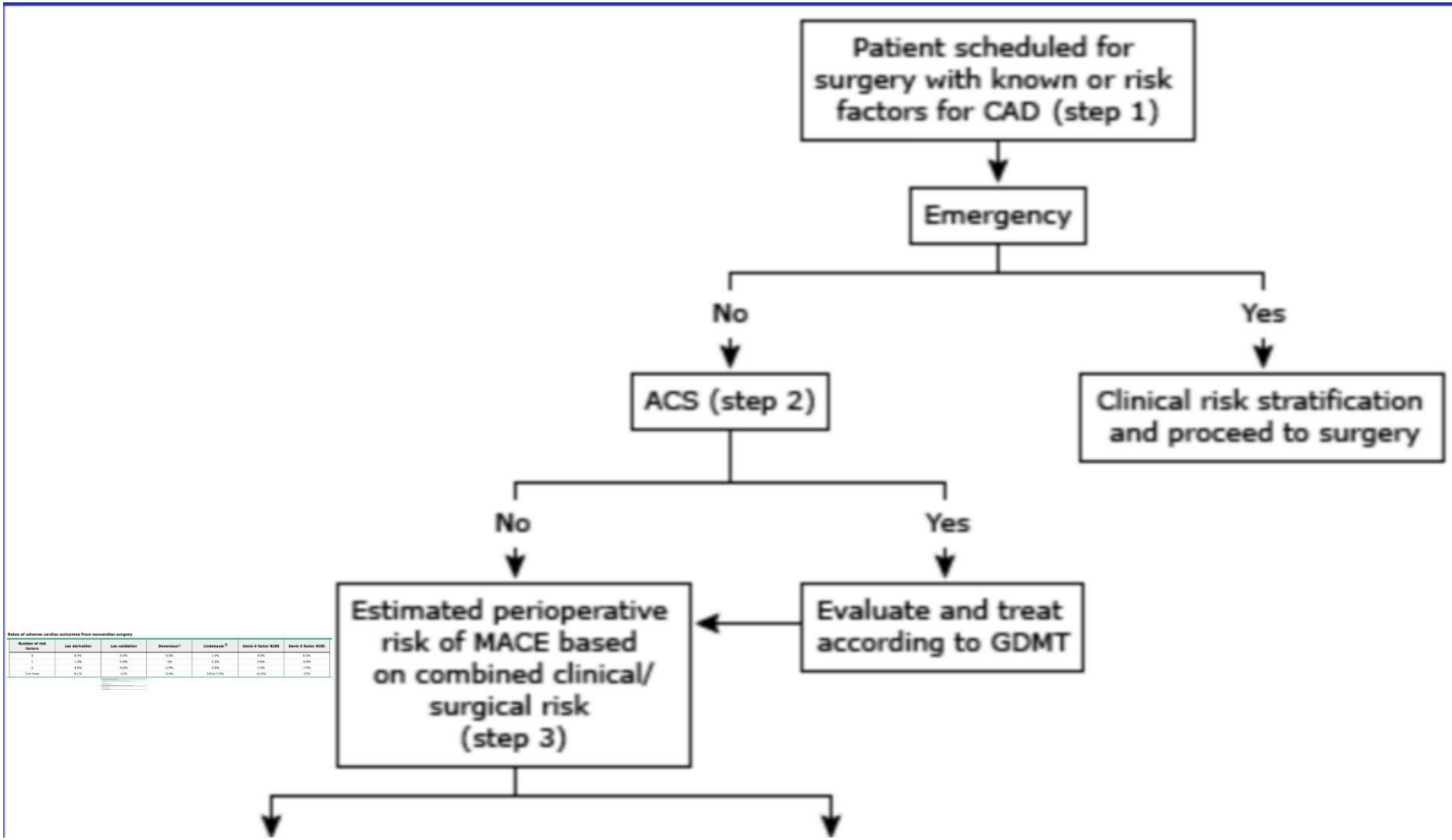


Rates of adverse cardiac outcomes from noncardiac surgery

Number of risk factors	Lee derivation	Lee validation	Devereaux[4]	Lindenauer[5]	Davis 6 factor RCRI	Davis 5 factor RCRI
0	0.5%	0.4%	0.4%	1.4%	0.3%	0.3%
1	1.3%	0.9%	1%	3.1%	3.0%	2.9%
2	3.9%	6.6%	2.4%	3.9%	7.2%	7.4%
3 or more	9.1%	11%	5.4%	5.8 to 7.4%	14.4%	17%


Patient scheduled for surgery with known or risk factors for CAD (step 1)
Emergency
No
Yes
ACS (step 2)
Clinical risk stratification and proceed to surgery
No
Yes
Estimated perioperative risk of MACE based on combined clinical/ surgical risk (step 3)
Evaluate and treat according to GDMT

Rates of adverse cardiac outcomes from noncardiac surgery

Number of risk factors	Lee derivation	Lee validation	Devereaux*	Lindenauer¶	Davis 6 factor RCRI	Davis 5 factor RCRI
0	0.5%	0.4%	0.4%	1.4%	0.5%	0.5%
1	1.3%	0.9%	1%	2.2%	2.6%	2.9%
2	3.6%	6.6%	2.4%	3.9%	7.2%	7.4%
3 or more	9.1%	11%	5.4%	5.8 to 7.4%	14.4%	17%

ion	Lee validation	Deverea
	0.4%	0.4%
	0.9%	1%
	6.6%	2.4%
	11%	5.4%

Six independent predictors of major cardiac complications[1]
High-risk type of surgery (examples include vascular surgery and any open intraperitoneal or intrathoracic procedures)
History of ischemic heart disease (history of myocardial infarction or a positive exercise test, current complaint of chest pain considered to be secondary to myocardial ischemia, use of nitrate therapy, or ECG with pathological Q waves; do not count prior coronary revascularization procedure unless one of the other criteria for ischemic heart disease is present)
History of heart failure
History of cerebrovascular disease
Diabetes mellitus requiring treatment with insulin
Preoperative serum creatinine >2.0 mg/dL (177 micromol/L)
Rate of cardiac death, nonfatal myocardial infarction, and nonfatal cardiac arrest according to the number of predictors[2]
No risk factors – 0.4% (95% CI: 0.1-0.8)
One risk factor – 1.0% (95% CI: 0.5-1.4)
Two risk factors – 2.4% (95% CI: 1.3-3.5)
Three or more risk factors – 5.4% (95% CI: 2.8-7.9)

11%

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High-risk type of surgery (examples include vascular surgery and any open intraperitoneal or intrathoracic procedures)
History of ischemic heart disease (history of myocardial infarction or a positive exercise test, current complaint of chest pain considered to be secondary to myocardial ischemia, use of nitrate therapy, or ECG with pathological Q waves; do not count prior coronary revascularization procedure unless one of the other criteria for ischemic heart disease is present)
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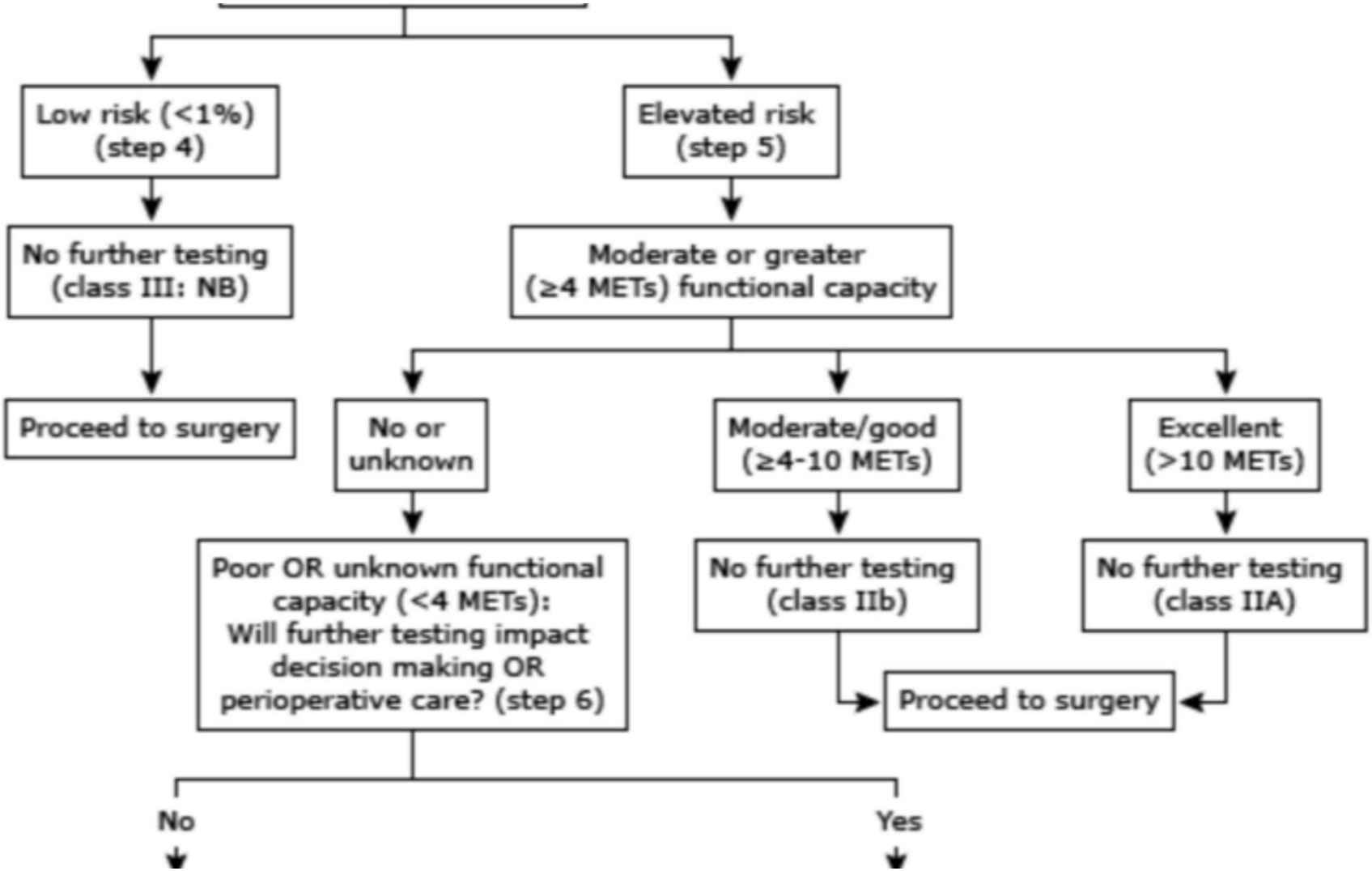
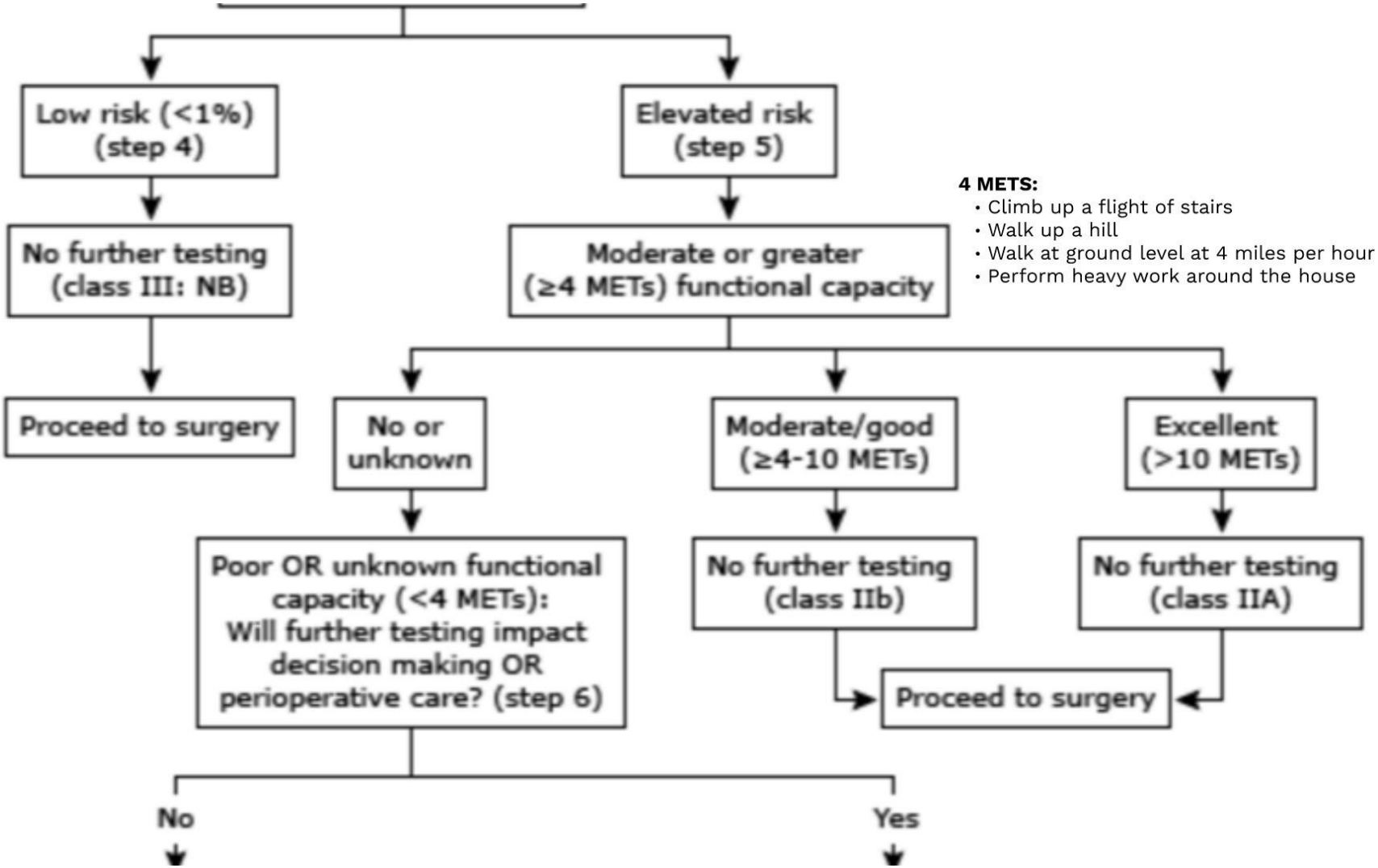

Low risk (<1%) (step 4)
Elevated risk (step 5)
No further testing (class III: NB)
Moderate or greater (≥4 METs) functional capacity
Proceed to surgery
No or unknown
Moderate/good (≥4-10 METs)
Excellent (>10 METs)
Poor OR unknown functional capacity (<4 METs): Will further testing impact decision making OR perioperative care? (step 6)
No further testing (class IIb)
No further testing (class IIA)
Proceed to surgery
No
Yes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No or unknown
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No further testing (class IIb)
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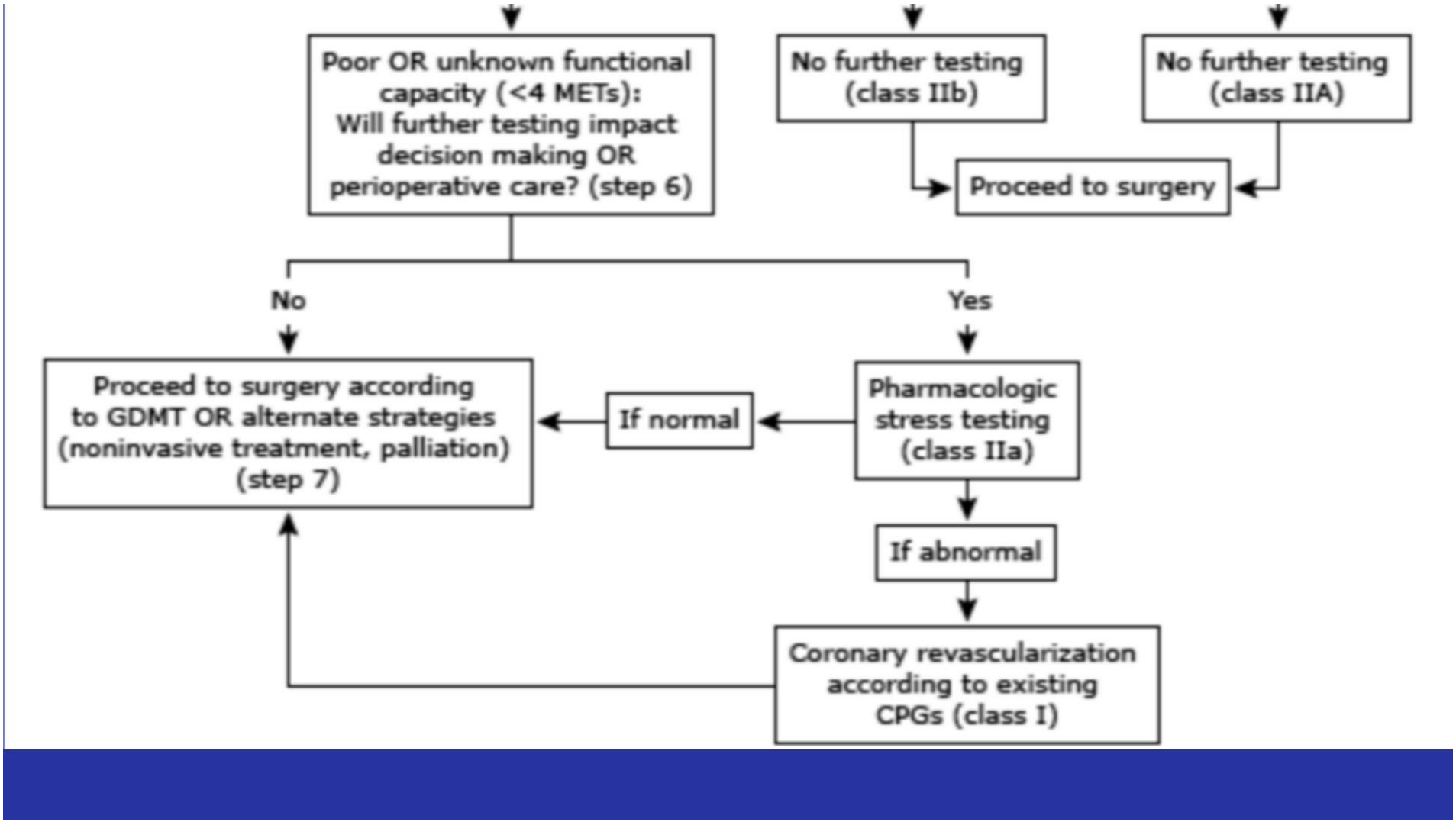
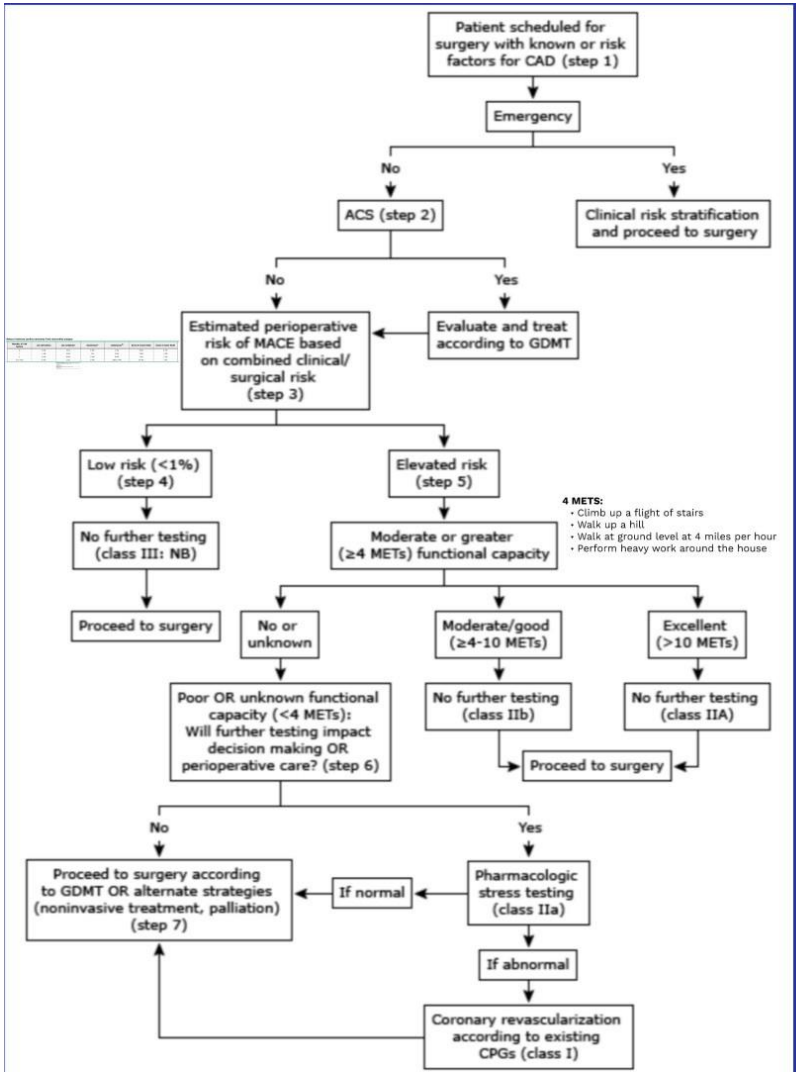
Proceed to surgery
No
Yes
4 METS:
• Climb up a flight of stairs
• Walk up a hill
• Walk at ground level at 4 miles per hour
• Perform heavy work around the house


Poor OR unknown functional capacity (<4 METs): Will further testing impact decision making OR perioperative care? (step 6)
No further testing (class IIb)
No further testing (class IIA)
Proceed to surgery
No
Yes
Proceed to surgery according to GDMT OR alternate strategies (noninvasive treatment, palliation) (step 7)
If normal
Pharmacologic stress testing (class IIa)
If abnormal
Coronary revascularization according to existing CPGs (class I)



Recommendations:

- Obtain an electrocardiogram (ECG) in patients with cardiac disease. This will provide a baseline should a postoperative test be abnormal

Additional testing:
- Echo
- Stress test
- Holters

These should be done only if there is an indication for them irrespective of the planned procedure

Periprocedural Management:

- Should aspirin be given prior to surgery?
- Continue statin periop?
- Continue beta blocker periop?
- Don't start beta blocker unless known ischemic heart disease or strong indication for it.
- ACE inhibitors should be stopped due to risk of hypotension.

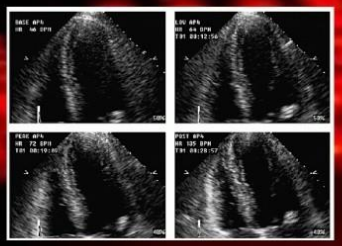

Preoperative Evaluation and Stress Testing
Yousef Bader MD
Mclaren Bay Region
December 6, 2019
Preoperative Evaluation
Stress Testing

Stress Testing

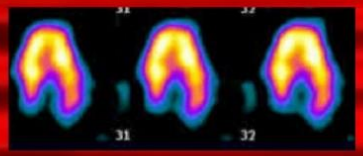
- Exercise treadmill test
- Stress echo
- Myocardial SPECT
- PET scan
- CT Angiography
- Coronary MR Angiography

ETT

Stress Echo



Nuclear Stress



Stress Testing

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- Stress echo
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Stress Testing

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	Sensitivity	Specificity
Exercise EKG	68%	77%
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rnit test

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rnit test

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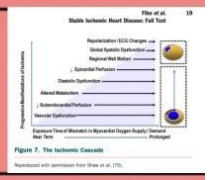

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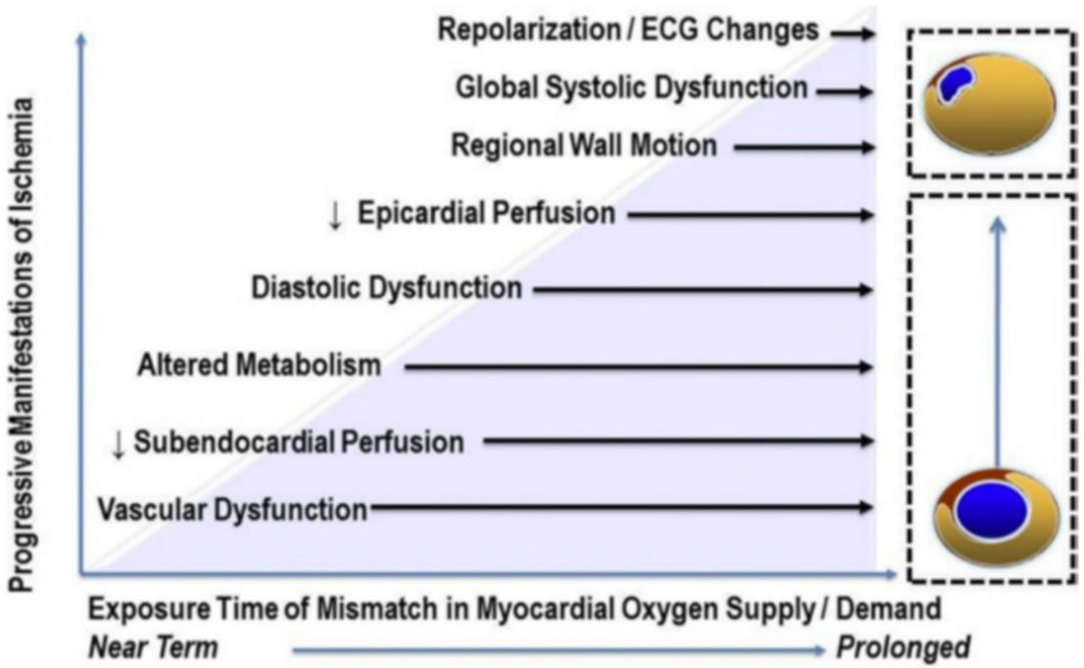
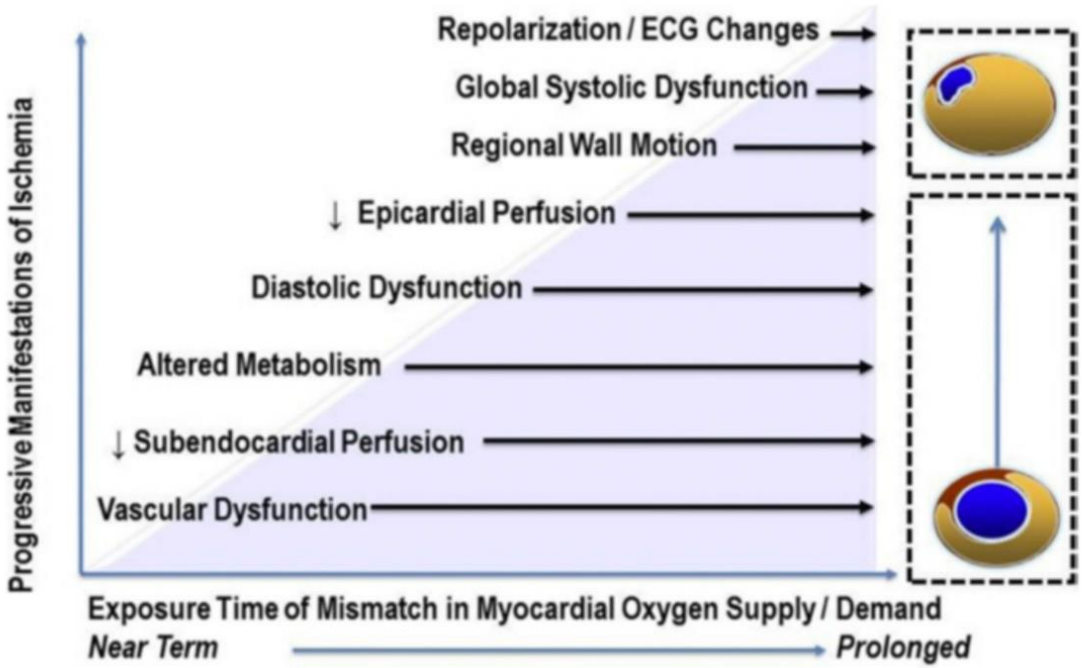


Figure 7. The Ischemic Cascade

Reproduced with permission from Shaw et al. (75).

ETT



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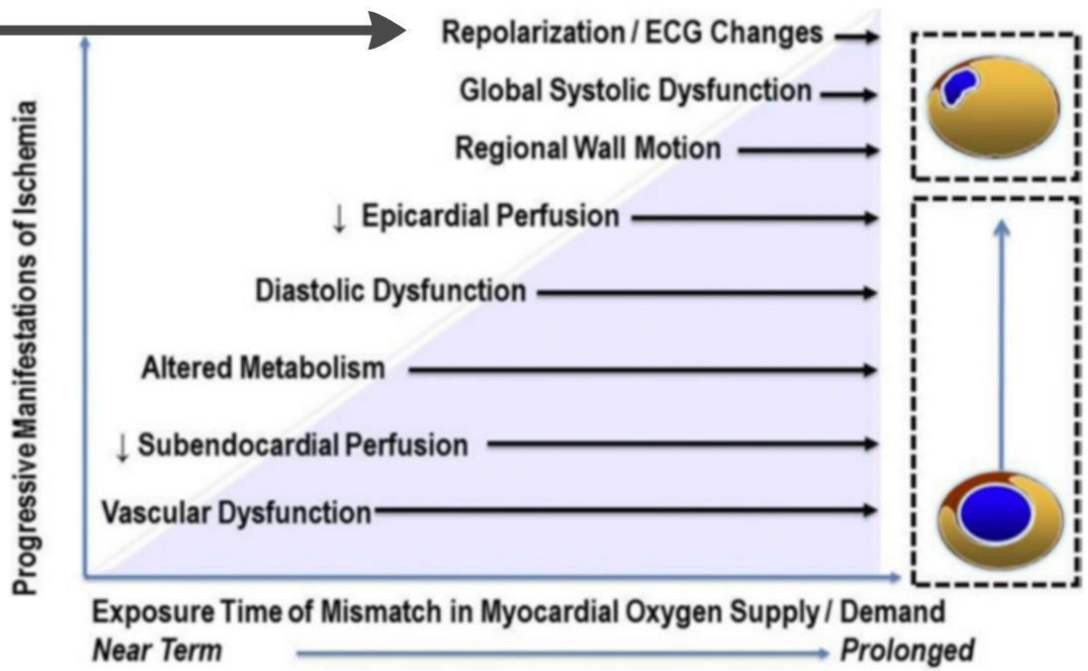

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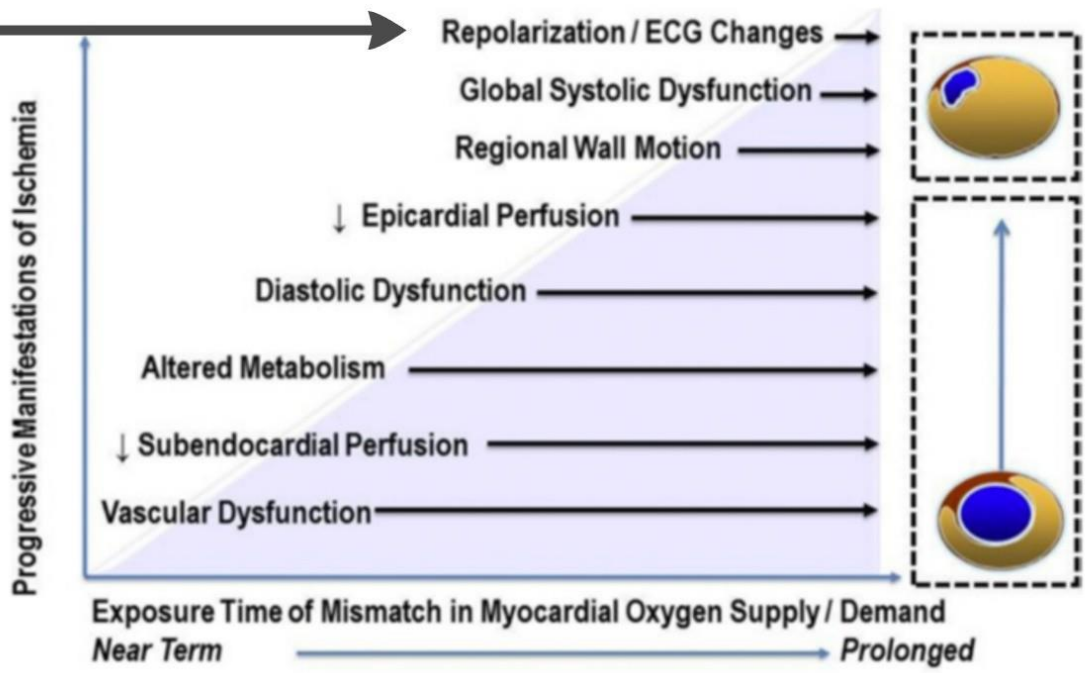
ETT

Echo



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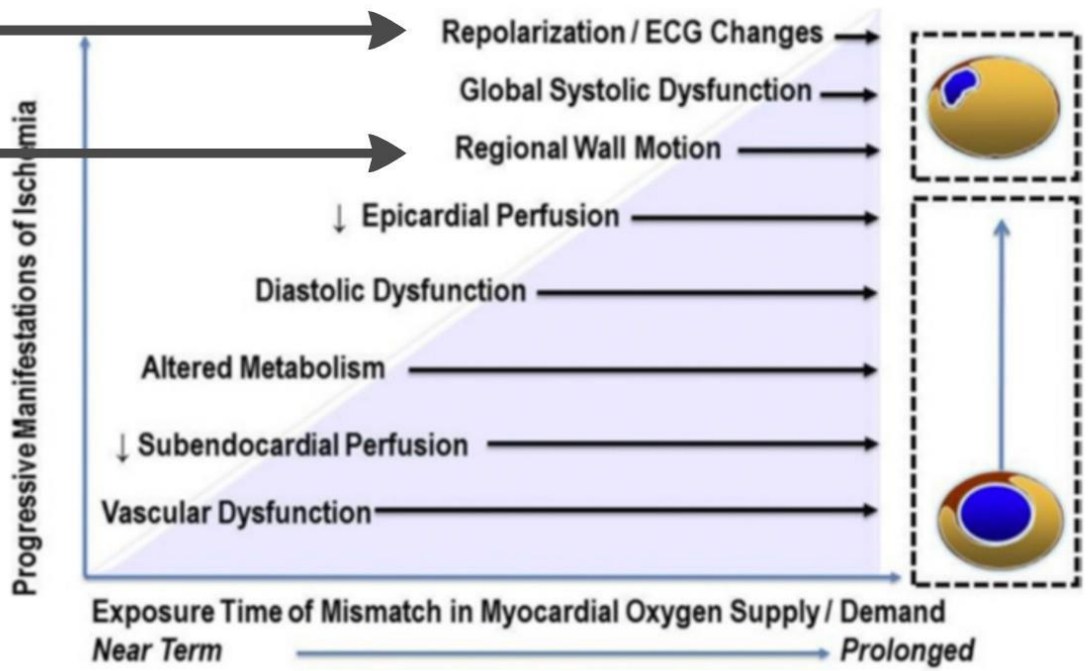

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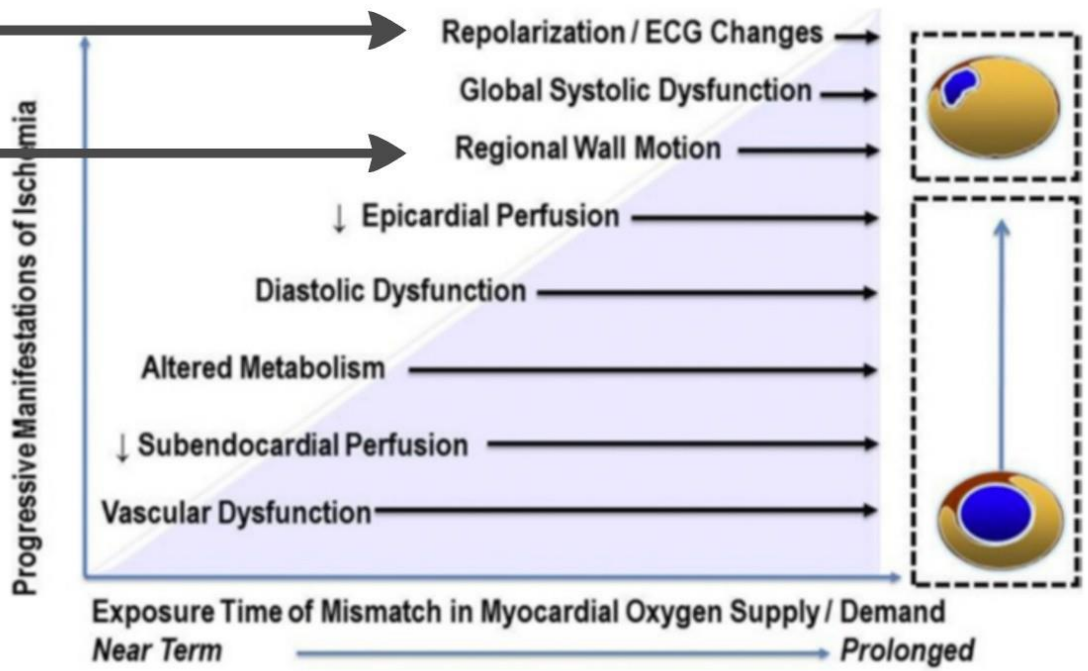
ETT

Echo

SPECT



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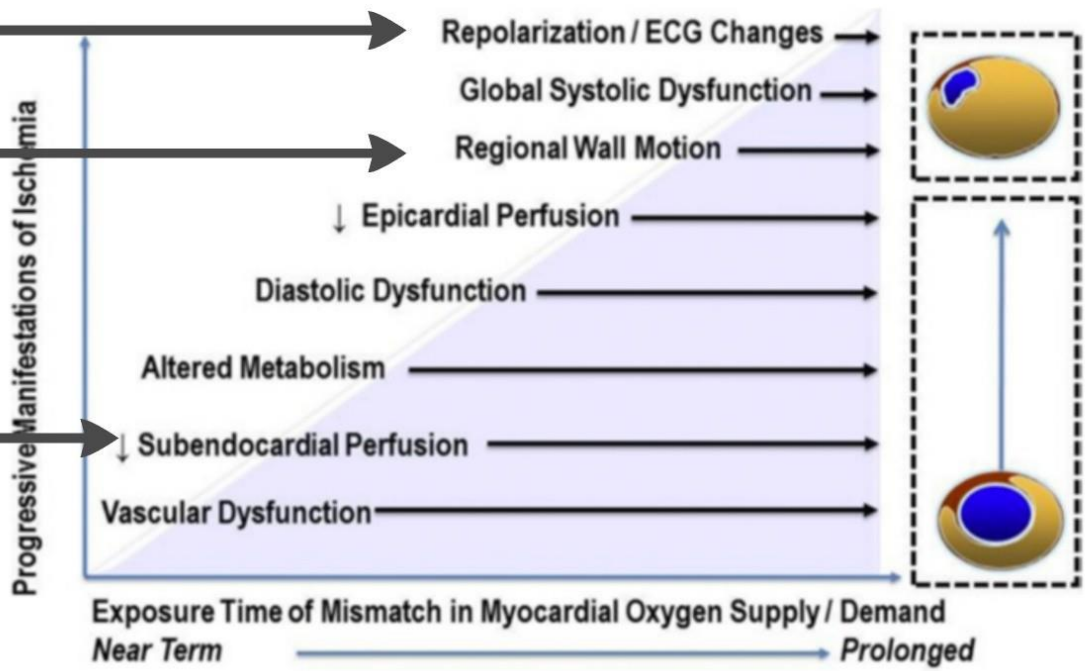
ETT

Echo

SPECT



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Stress Testing

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- Stress echo
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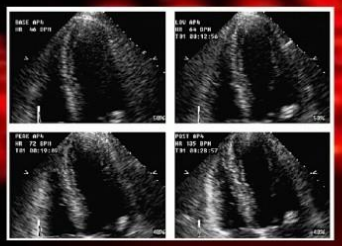

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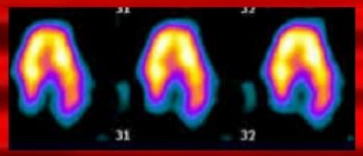

ETT

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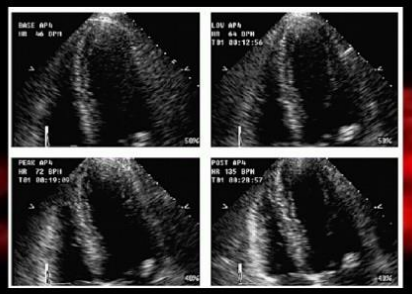

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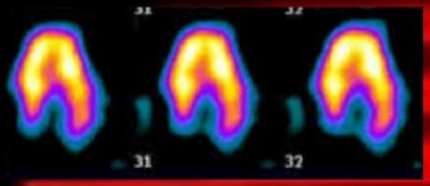

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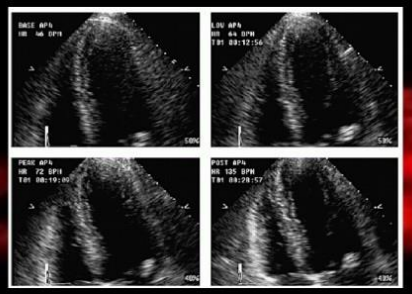

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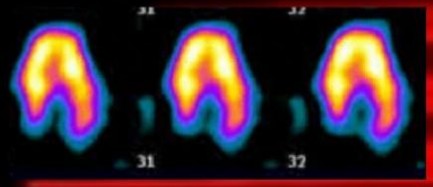

Test	Stress Analysis	Stressor
ETT	ECG	Exercise
Stress Echocardiogram	ECG + Echo	Exercise Dobutamine
Nuclear Stress Test	ECG + SPECT: -Technetium -Thallium	Exercise Microvascular dilators: • Regadenoson • Adenosine • Persantine Dobutamine

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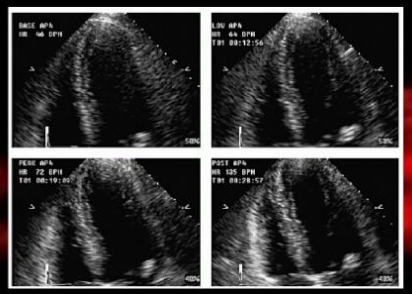

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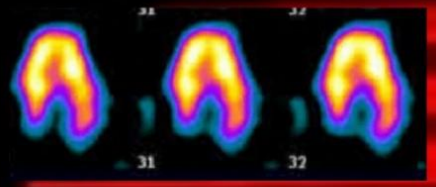

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Exercise Treadmill Test

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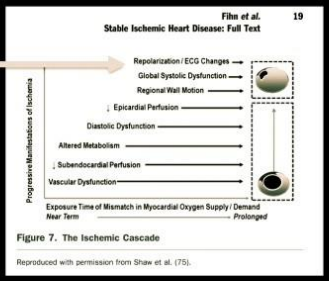
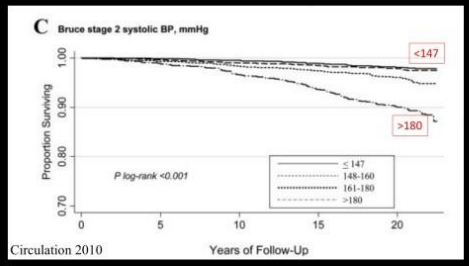
Stress ECG





$$\text{Duke Treadmill Score} = \text{Exercise Duration (min)} - 5\,(\text{ST Deviation (mm)}) - 4\,(\text{Angina Index})$$

Angina Index

0 – none, 1 – typical angina, 2 – angina causing test cessation

Score	Risk Group	Stenosis ≥ 75%	Multivessel Disease	1-Year Mortality
≥ 5	Low	40.1%	23.7%	0.25%
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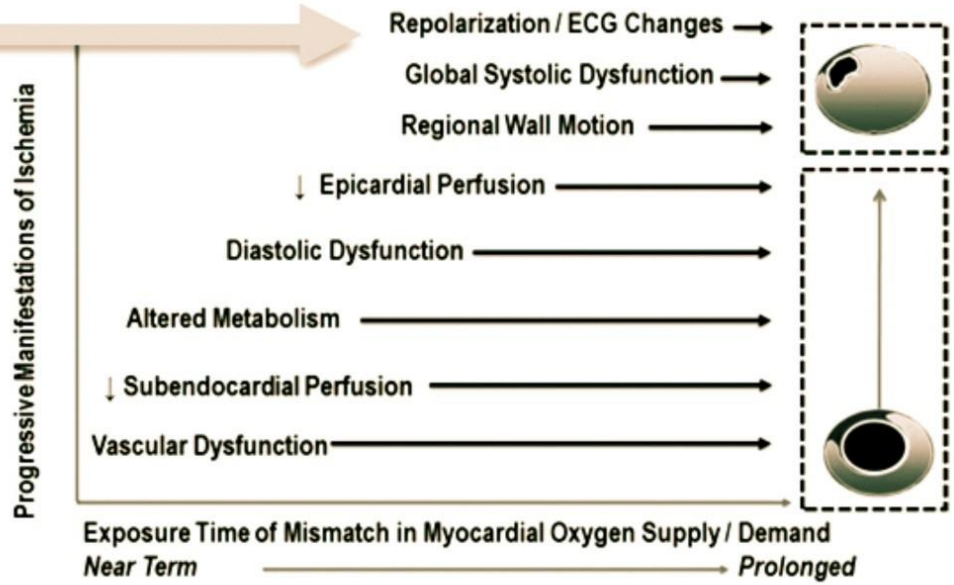
When is ETT NOT Recommended:

- Inability to exercise
- Baseline ECG ST/T-wave abnormality
- LBBB
- High pretest probability

Of note, ECG changes are not localizing

Guidelines:

Stress ECG



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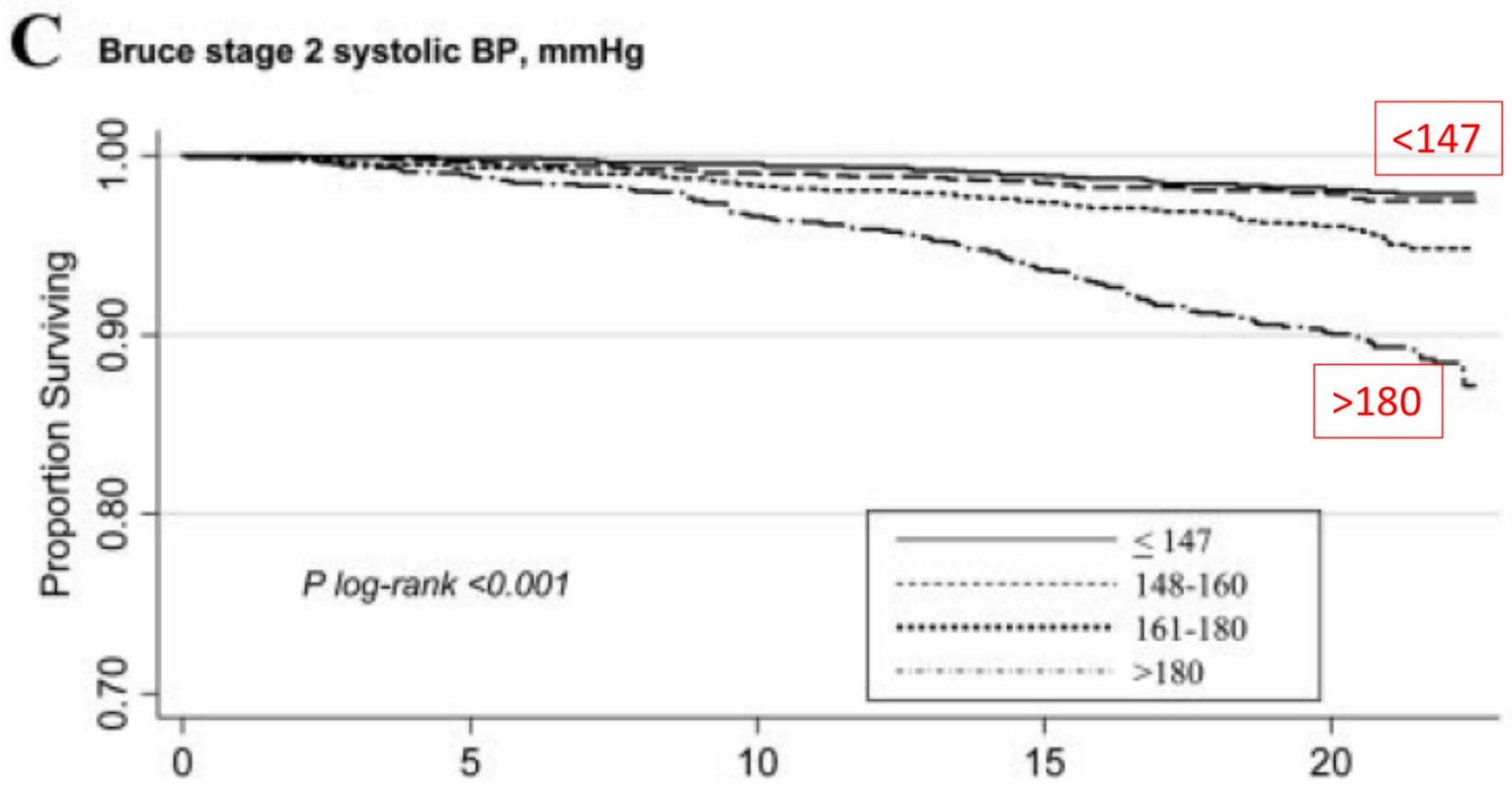

Circulation 2010

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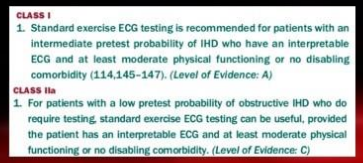

CLASS I

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)*

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)*

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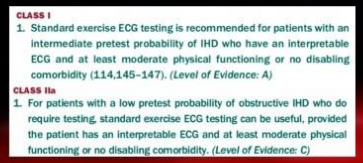

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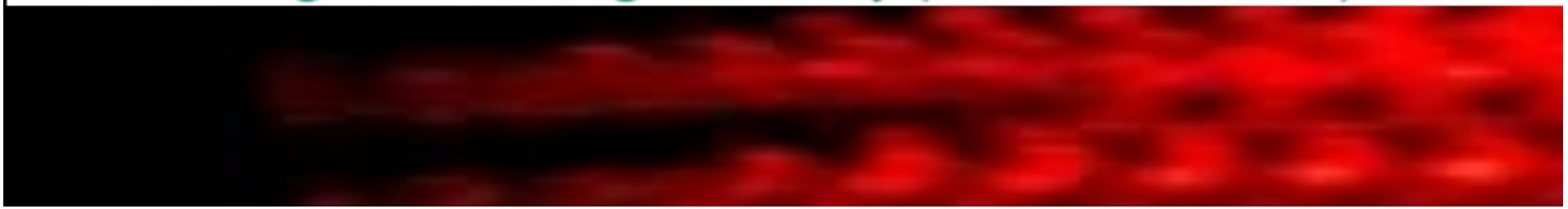

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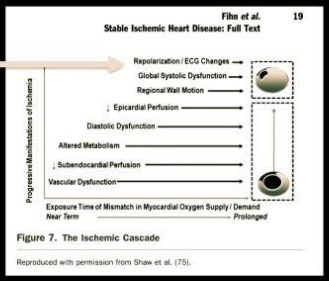

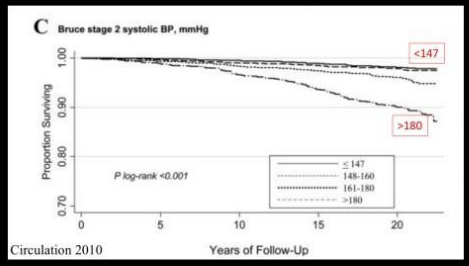

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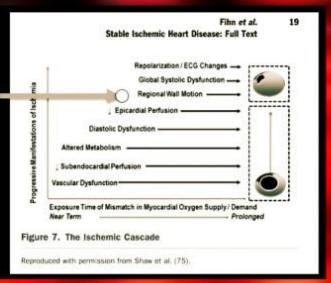
Stress Echocardiography

Stress Echo



When is Stress Echo NOT Recommended:

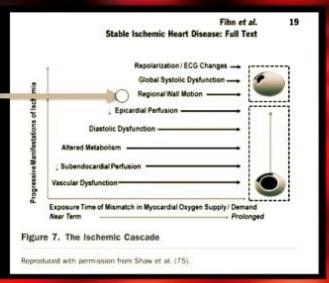
- RBBB/LBBB
- Morbid Obesity poor baseline echo windows
- High pretest probability (lower sensitivity high specificity)
- Prior myocardial infarct (NEVER)
- Prior CABG and prior PCI

Guidelines:

Stress Echocardiography

Resting Imaging

Stress Echo



When is Stress Echo NOT Recommended:

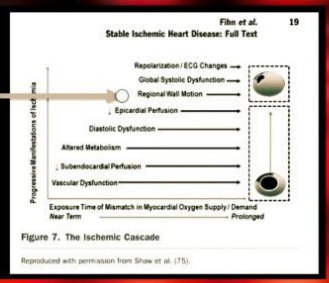
- RBBB/LBBB
- Morbid Obesity poor baseline echo windows
- High pretest probability (lower sensitivity high specificity)
- Prior myocardial infarct (NEVER)
- Prior CABG and prior PCI

Guidelines:

Stress Echocardiography

Resting Imaging

Stress Echo



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Stress:
-Exercise
-Dobutamine
ECG monitoring

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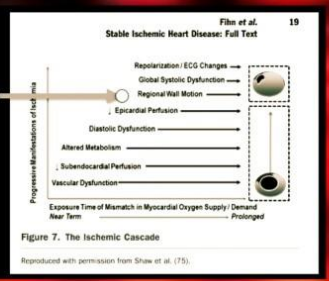

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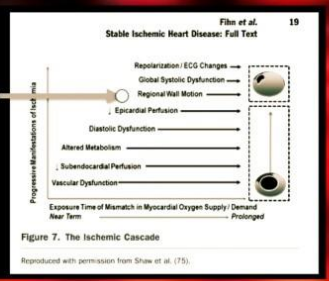

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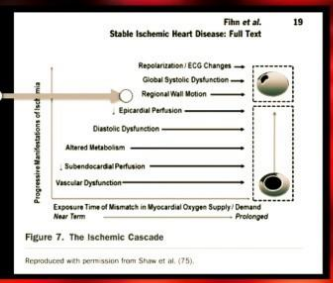

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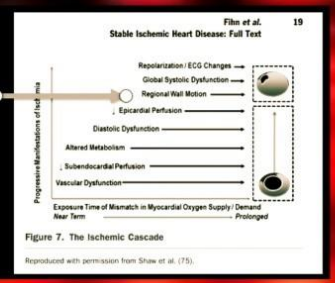

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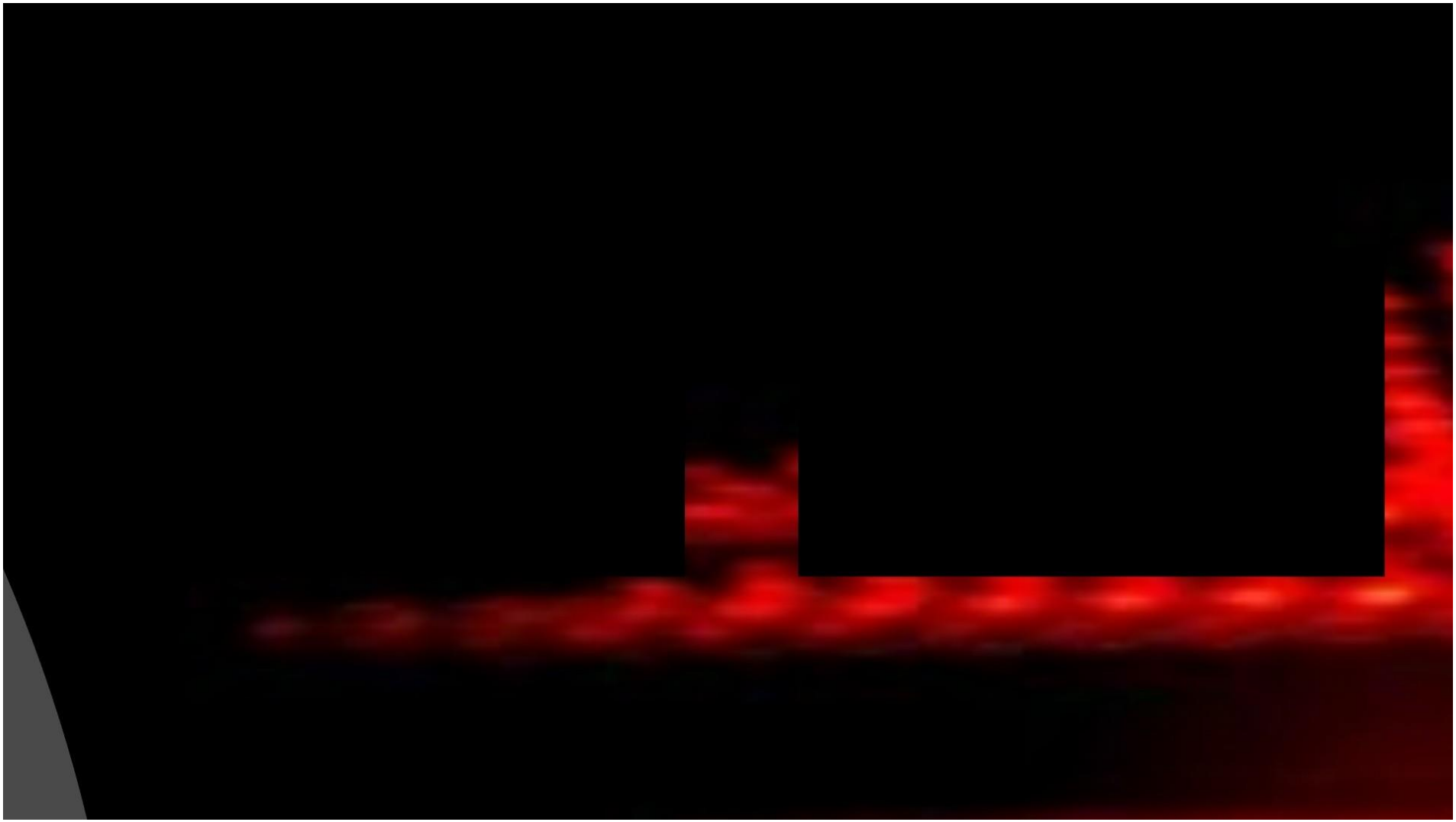

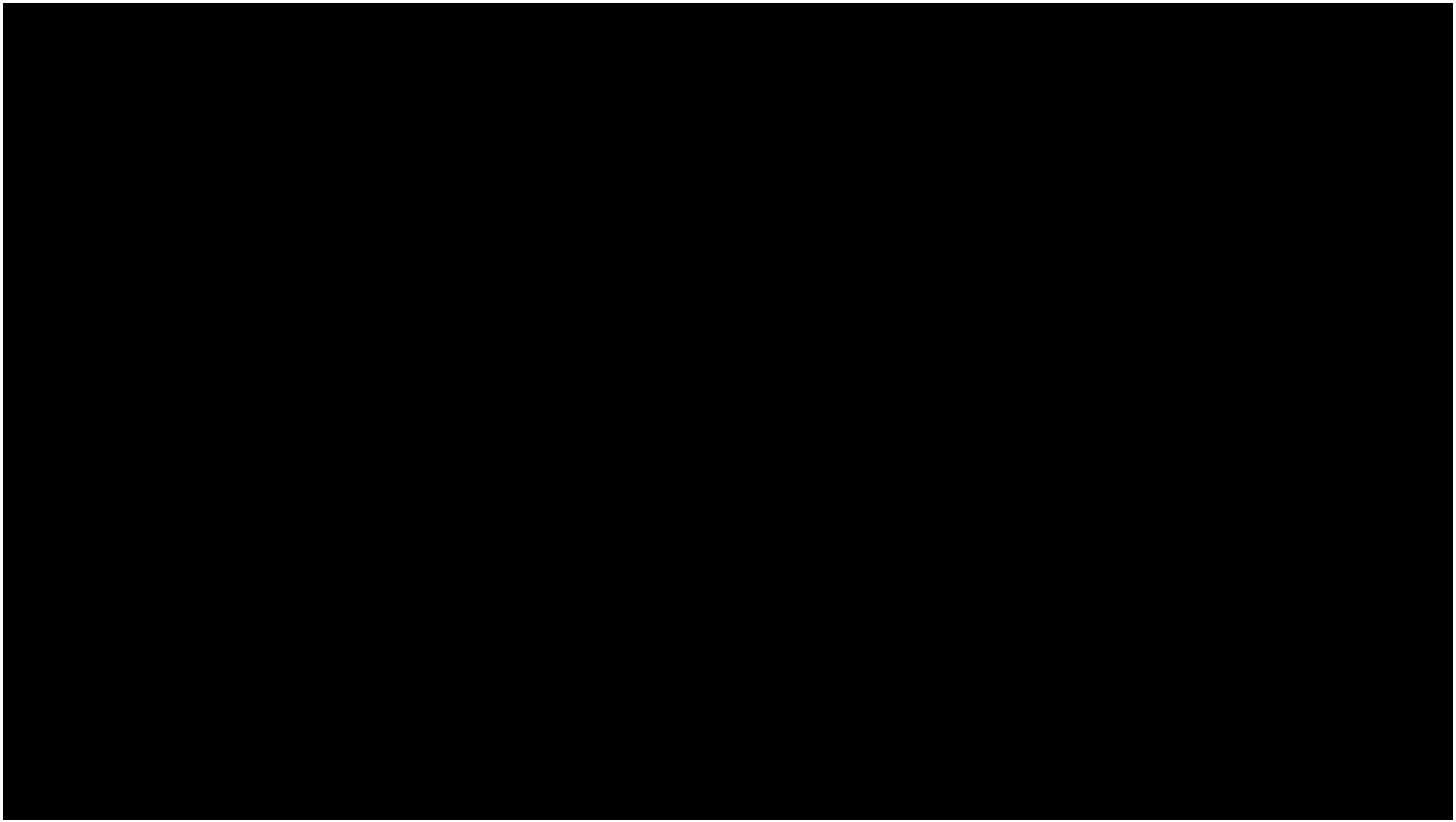

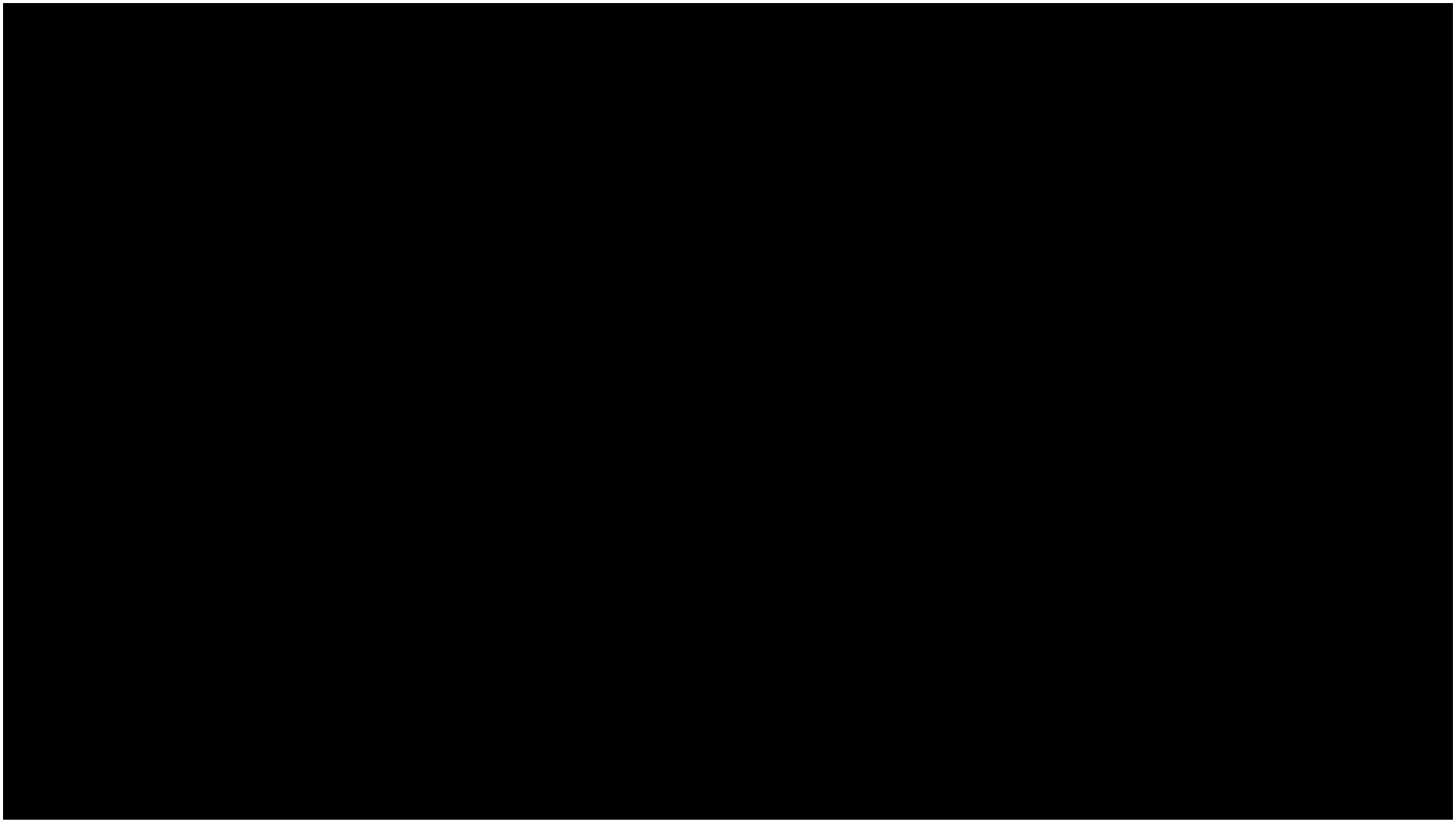

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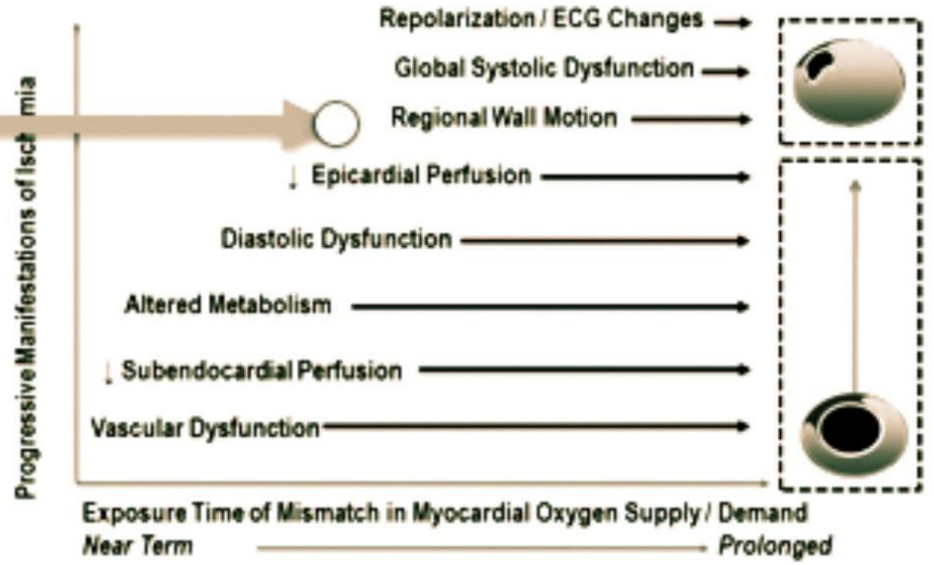

Figure 7. The Ischemic Cascade

Reproduced with permission from Shaw et al. (75).

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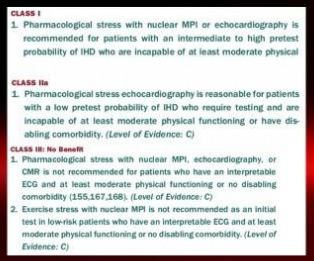

CLASS I

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CLASS IIa

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CLASS III: No Benefit

1. Pharmacological stress with nuclear MPI, echocardiography, or CMR is not recommended for patients who have an interpretable ECG and at least moderate physical functioning or no disabling comorbidity (155,167,168). *(Level of Evidence: C)*
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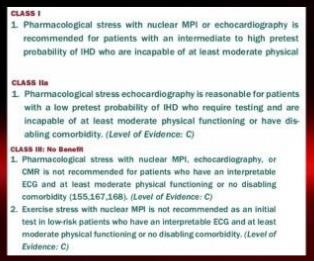

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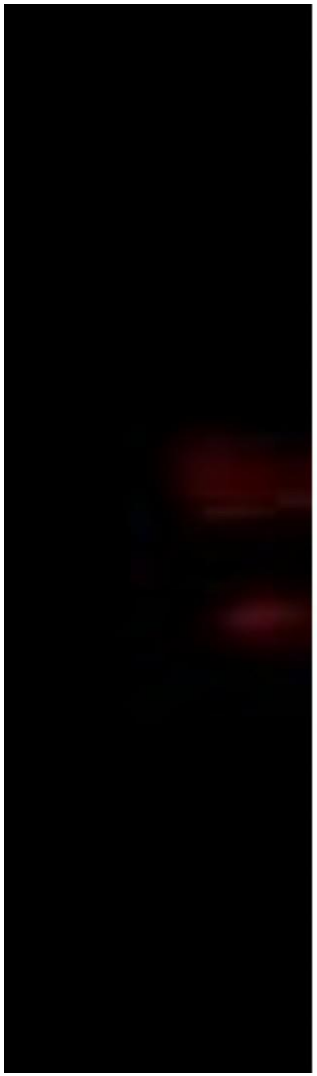

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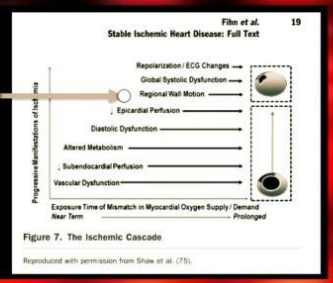
Resting Imaging → Stress:
-Exercise
-Dobutamine
ECG monitoring → Stress Imaging

Stress Echo



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Resting Imaging (Technetium)

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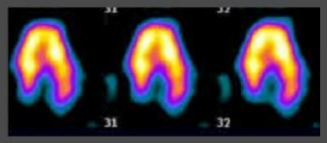
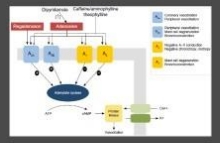
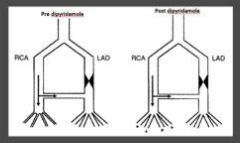
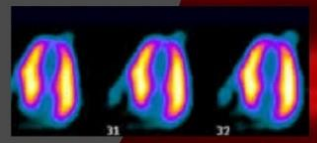
Stress Imaging (Technetium)









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Stress:
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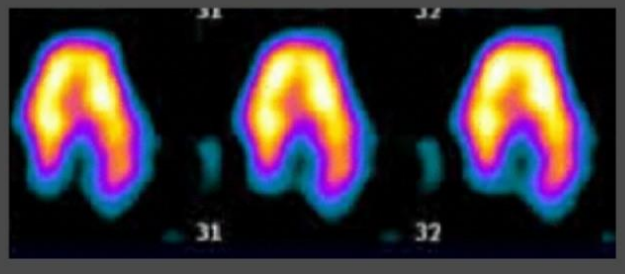

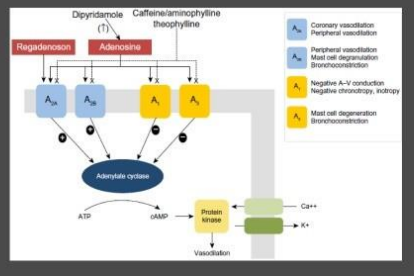

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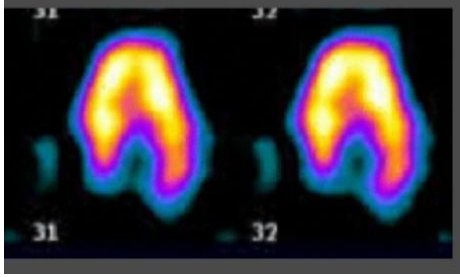
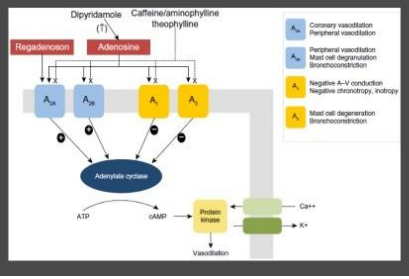
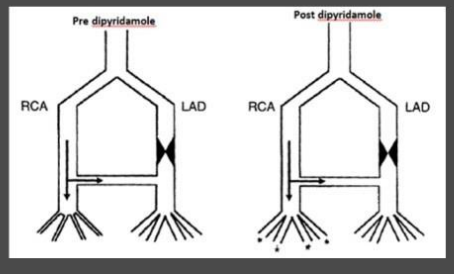
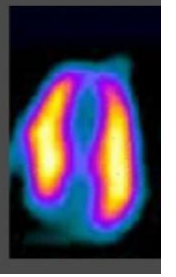
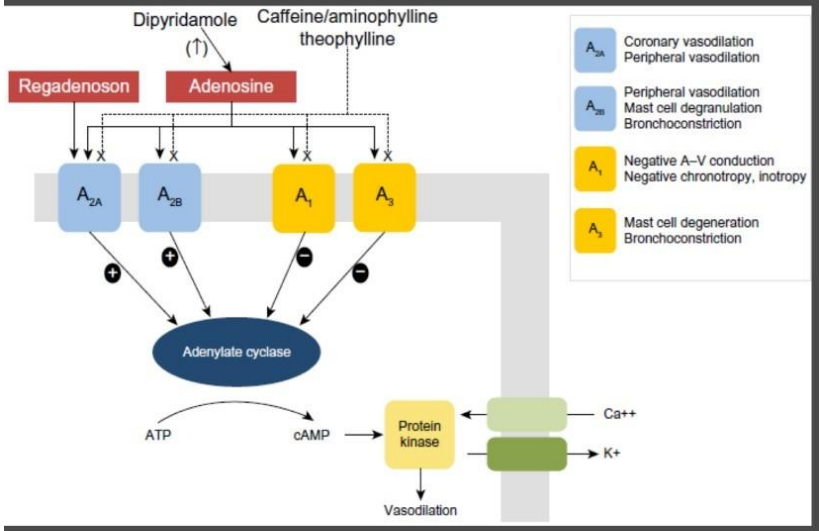
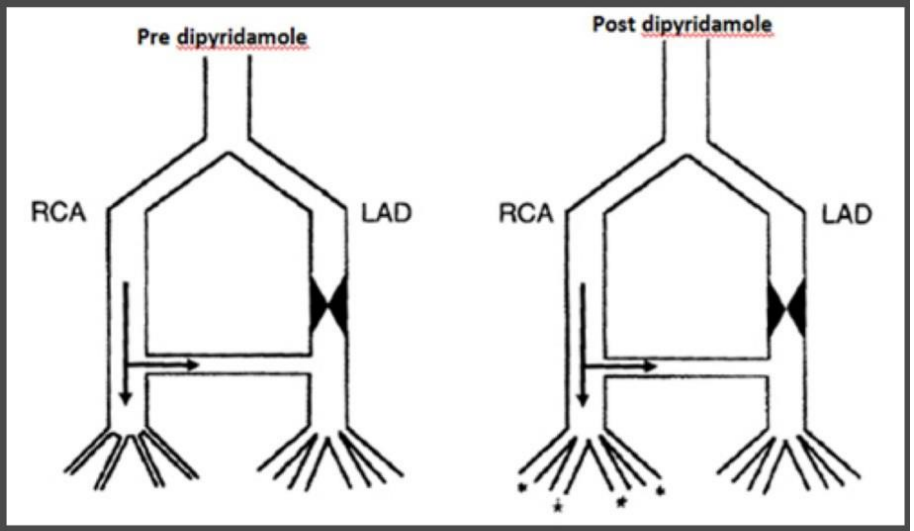









Dipyridamole
(↑)
Caffeine/aminophylline
theophylline
Regadenoson
Adenosine
A2A
A2B
A1
A3
Adenylate cyclase
ATP
cAMP
Protein
kinase
Ca++
K+
Vasodilation
Coronary vasodilation
Peripheral vasodilation
Peripheral vasodilation
Mast cell degranulation
Bronchoconstriction
Negative A–V conduction
Negative chronotropy, inotropy
Mast cell degeneration
Bronchoconstriction


Pre dipyridamole
RCA
LAD
Post dipyridamole
RCA
LAD

ss:

ercise

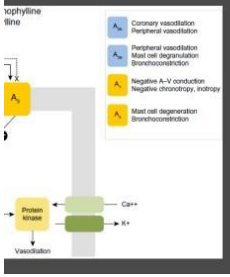
gadenason

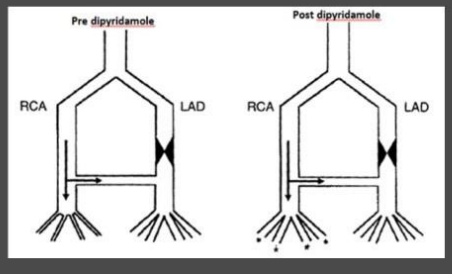
enosine

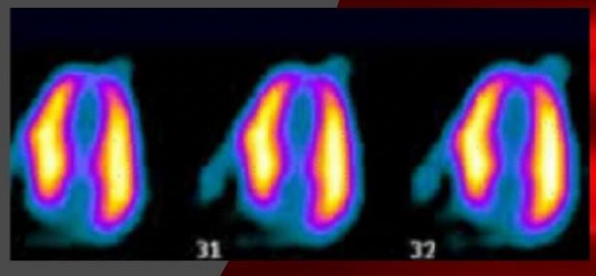
rsantine

CG monitoring

Stress Imaging
(Technetium)







Nuclear Stress Testing

Resting Imaging (Technetium)

Stress:
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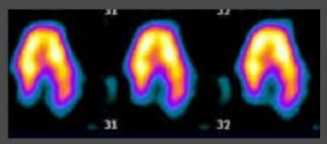
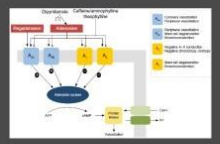
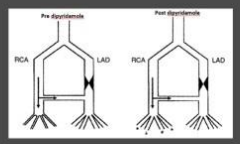
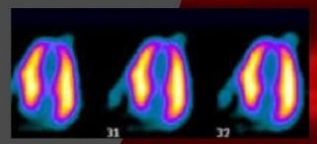
ECG monitoring

Stress Imaging (Technetium)



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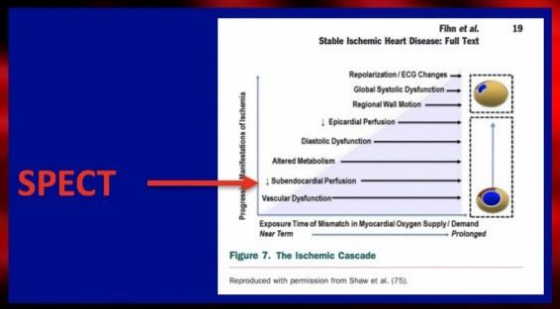
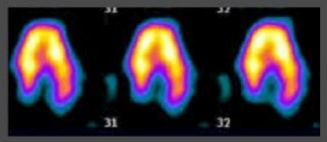
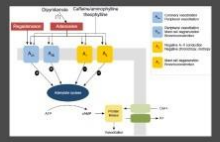
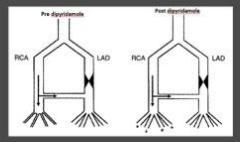
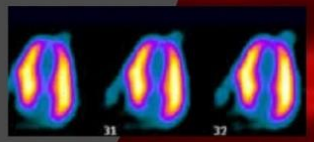
SPECT











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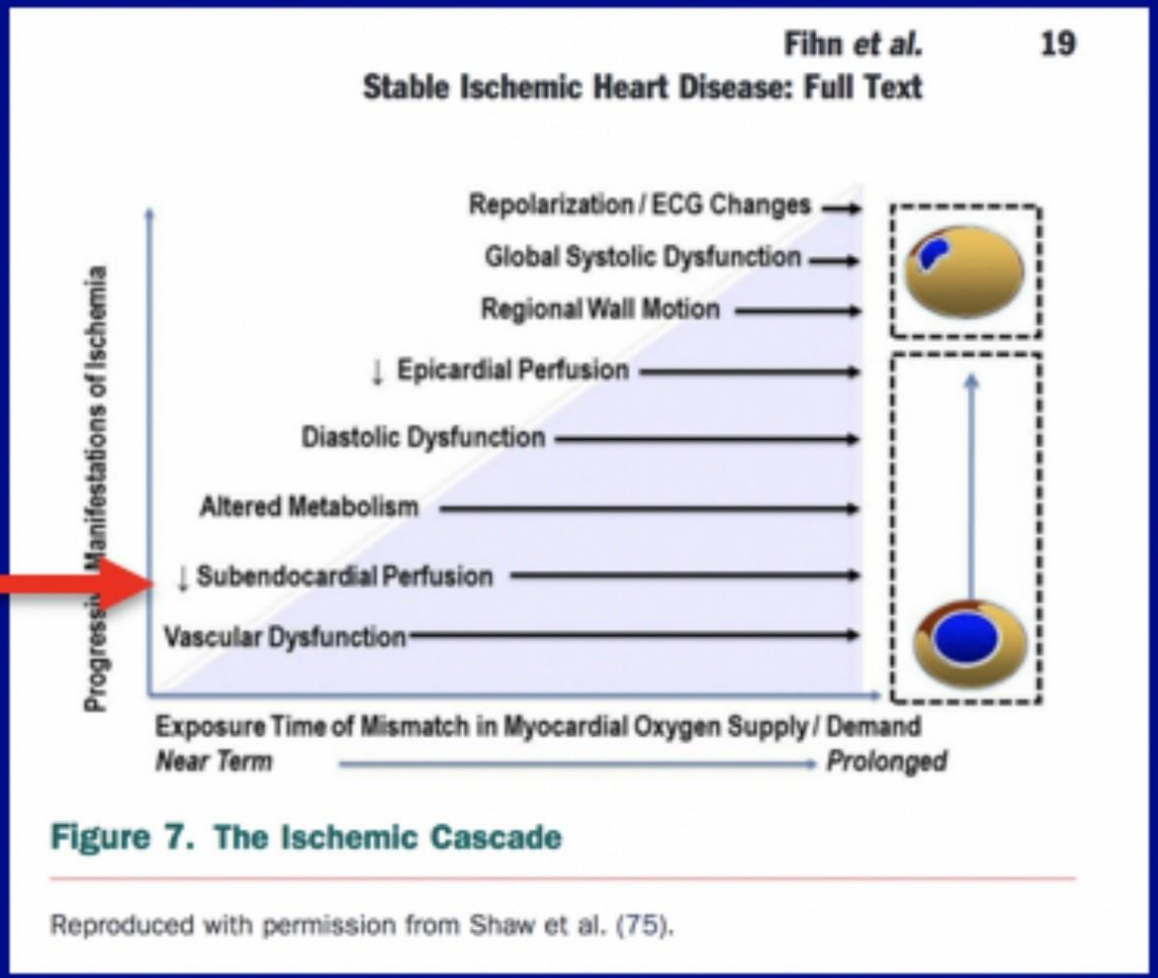

Figure 7. The Ischemic Cascade

Reproduced with permission from Shaw et al. (75).

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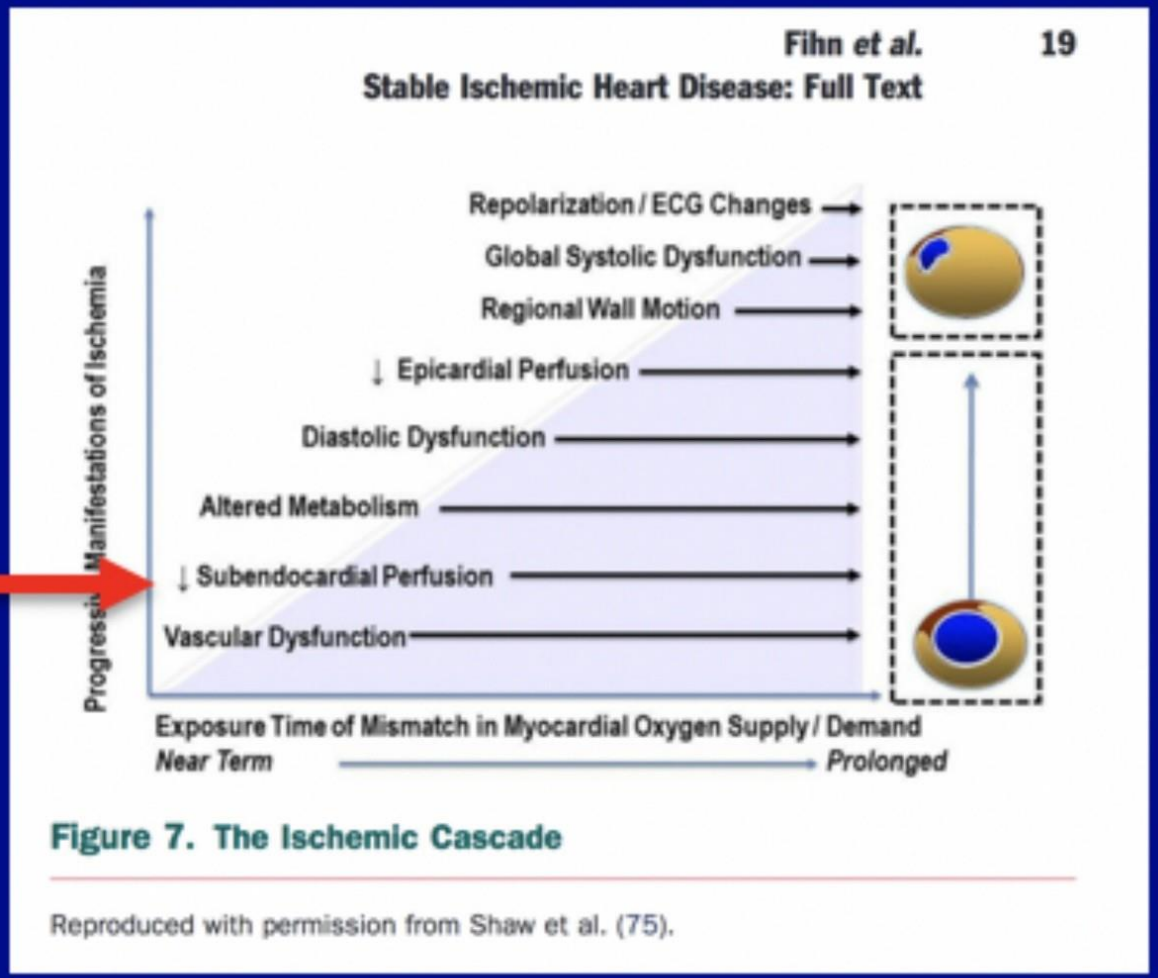

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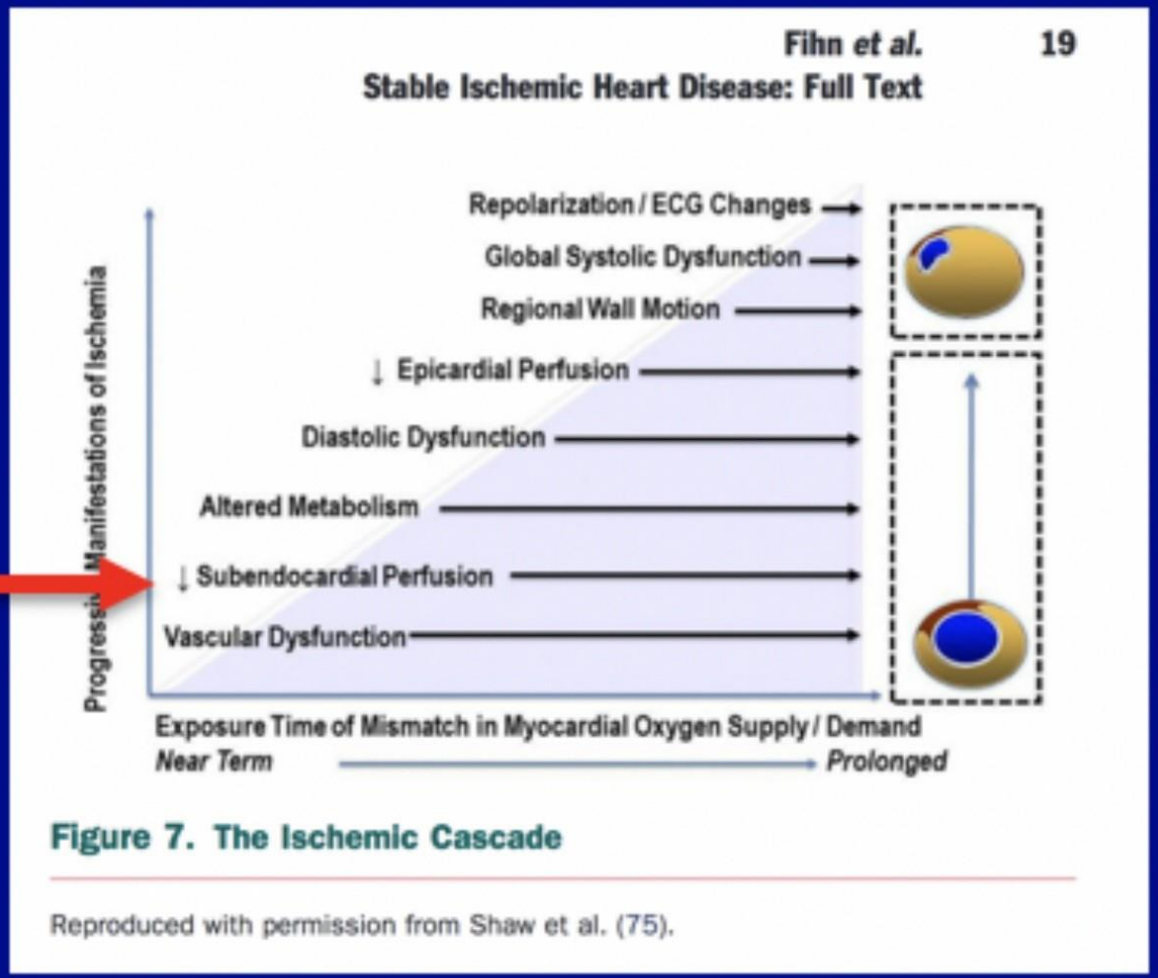

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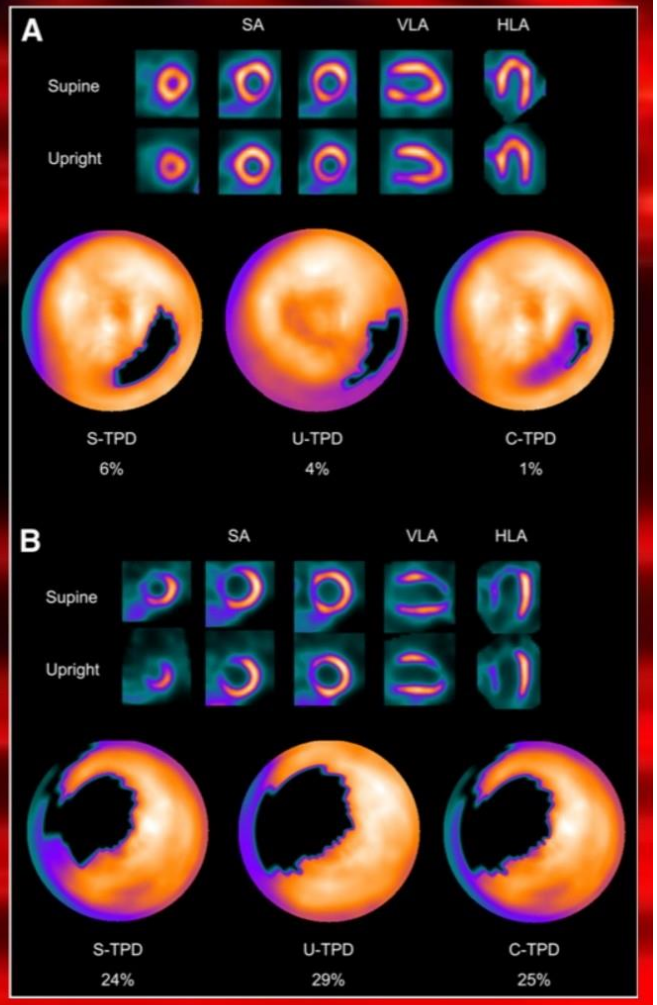
- High sensitivity, good for high risk patients
- Helps guide target lesion during cath
- The degree of ischemia can be quantified and localized
- Ischemia and mortality
- TID Index



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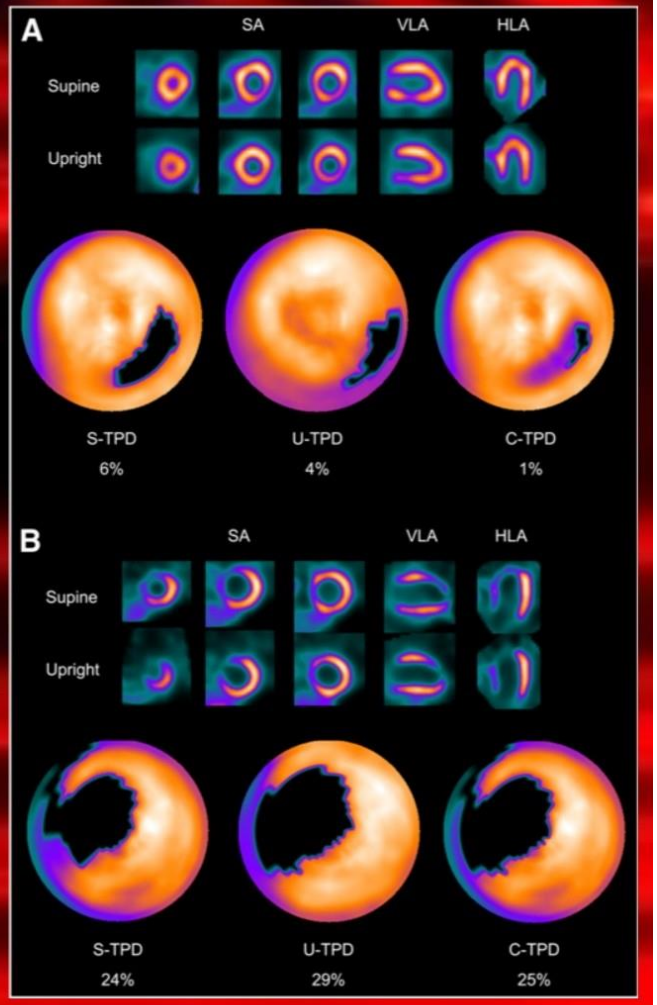
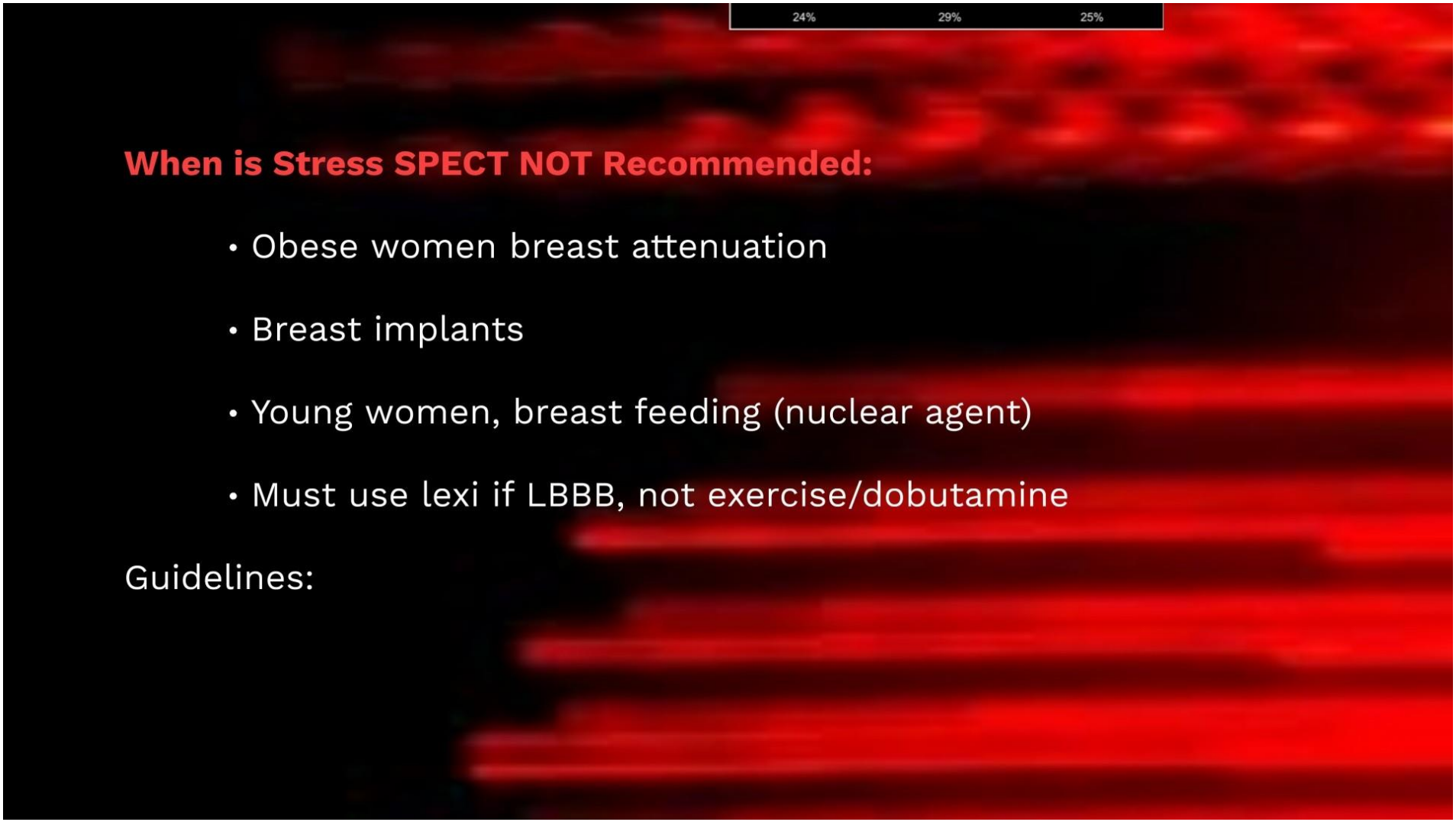
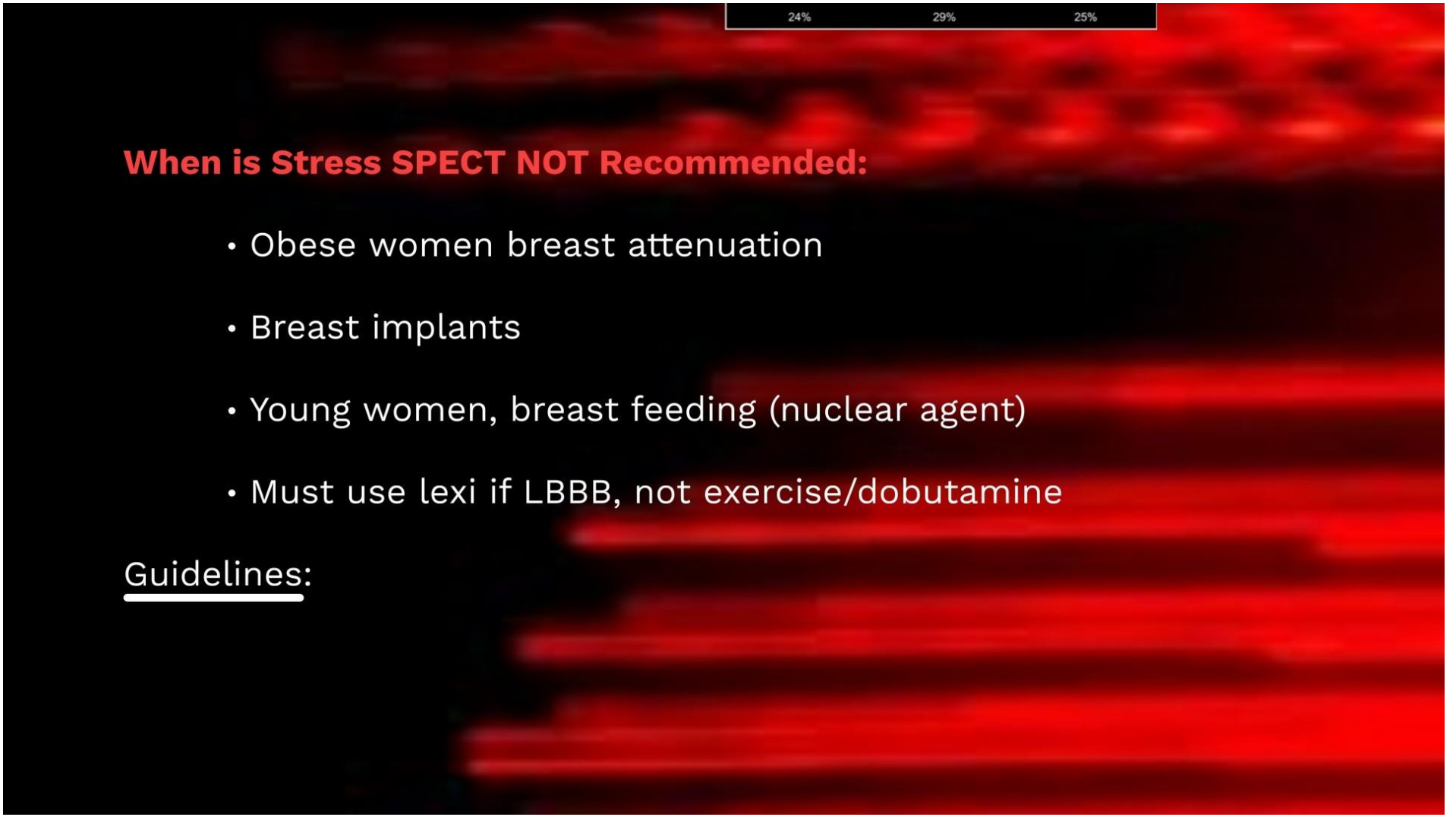



24%
29%
25%
When is Stress SPECT NOT Recommended:
• Obese women breast attenuation
• Breast implants
• Young women, breast feeding (nuclear agent)
• Must use lexi if LBBB, not exercise/dobutamine
Guidelines: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Guidelines:

24%	29%	25%

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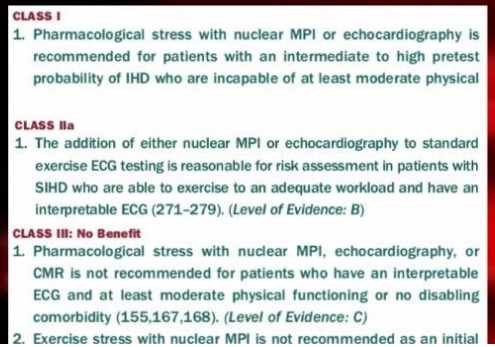

CLASS I

1. Pharmacological stress with nuclear MPI or echocardiography is recommended for patients with an intermediate to high pretest probability of IHD who are incapable of at least moderate physical

CLASS IIa

1. The addition of either nuclear MPI or echocardiography to standard exercise ECG testing is reasonable for risk assessment in patients with SIHD who are able to exercise to an adequate workload and have an interpretable ECG (271–279). (*Level of Evidence: B*)

CLASS III: No Benefit

1. Pharmacological stress with nuclear MPI, echocardiography, or CMR is not recommended for patients who have an interpretable ECG and at least moderate physical functioning or no disabling comorbidity (155,167,168). (*Level of Evidence: C*)
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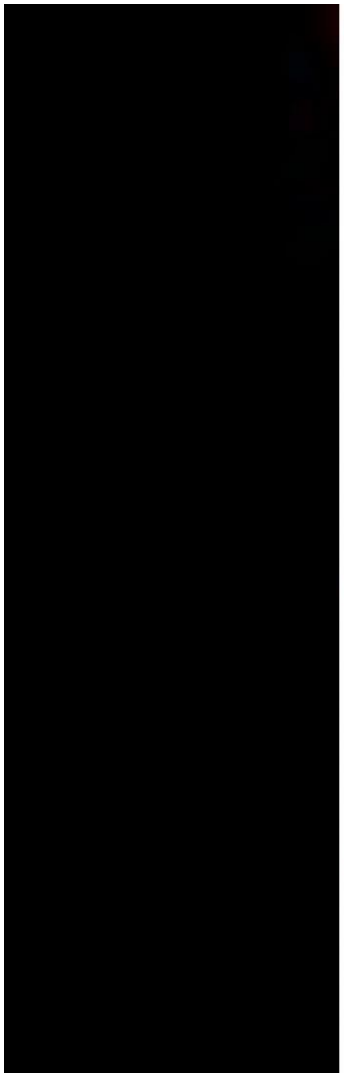

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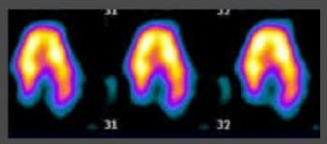
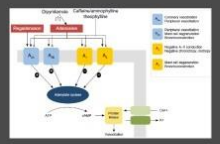
Nuclear Stress Testing

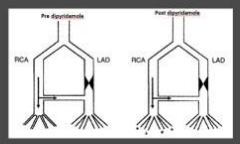
Resting Imaging (Technetium)

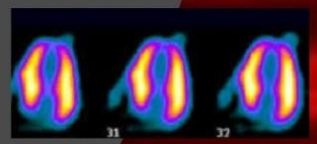
Stress:
-Exercise
-Regadenason
-Adenosine
-Persantine
ECG monitoring

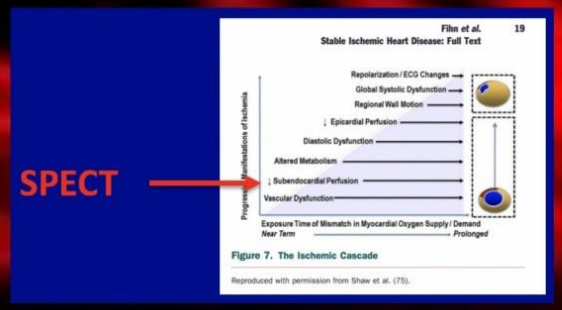
Stress Imaging (Technetium)





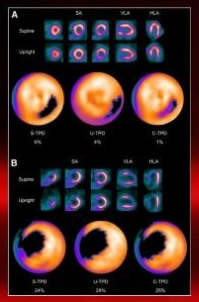






Advantages to Stress Nuclear:

- High sensitivity, good for high risk patients
- Helps guide target lesion during cath
- The degree of ischemia can be quantified and localized
- Ischemia and mortality
- TID Index



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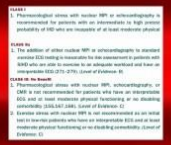

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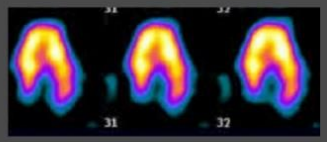

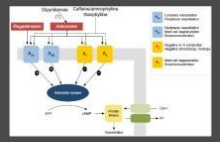

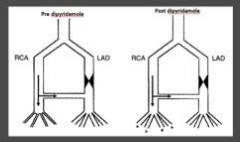

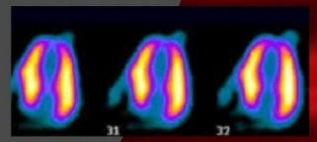

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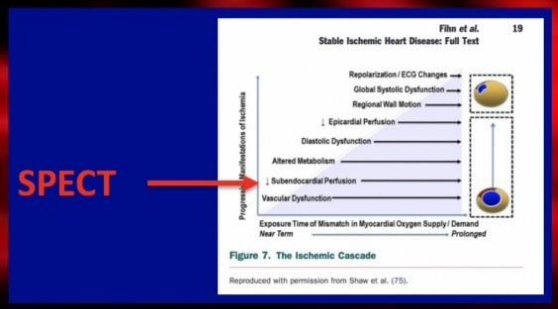

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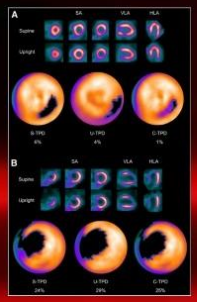

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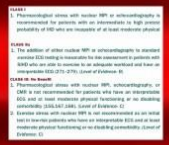

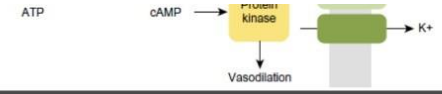

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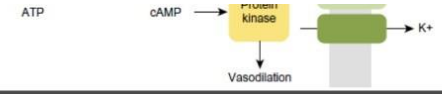
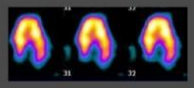


83 year old with a history of CABG, LIMA to LAD, SVG to OM and PDA who had a prior stent to the SVG to OM, now with chest pain on moderate exertion. 

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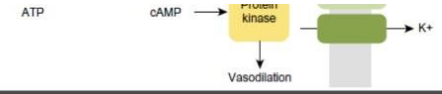

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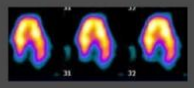

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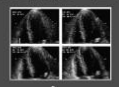

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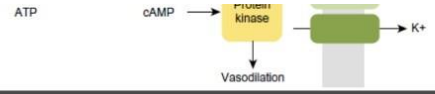

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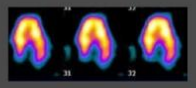

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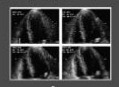

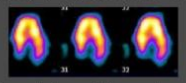

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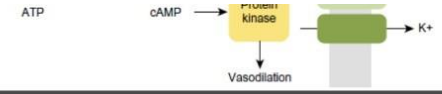

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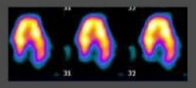

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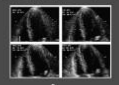

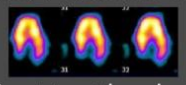

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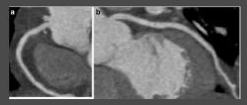

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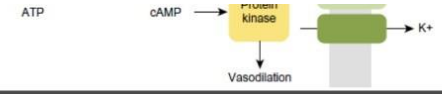

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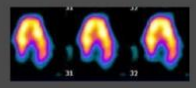

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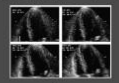

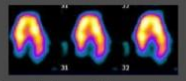

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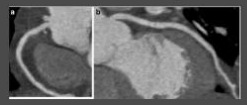

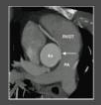

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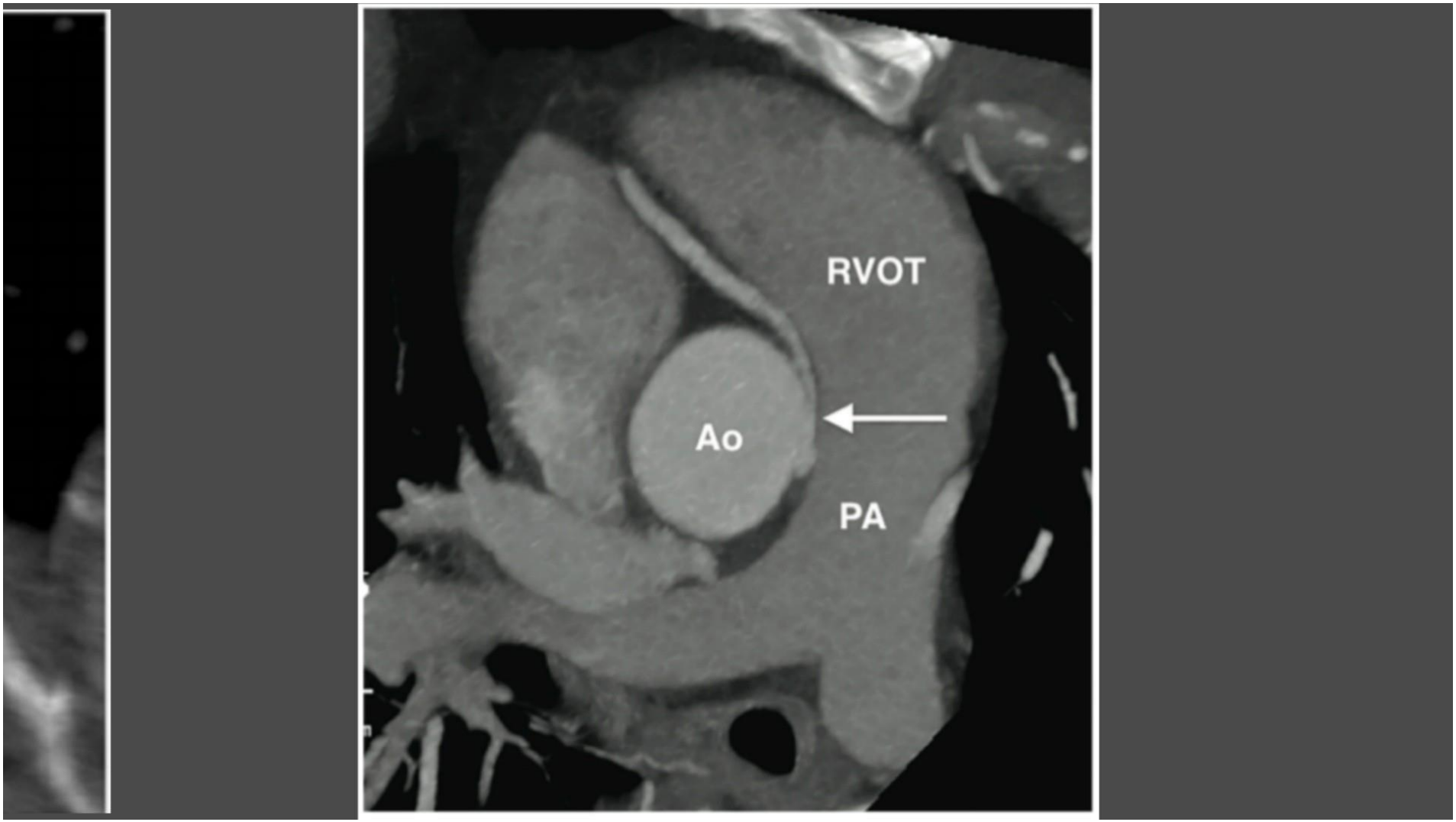
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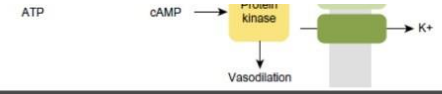

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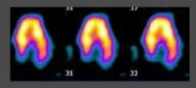

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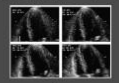

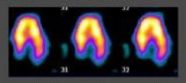

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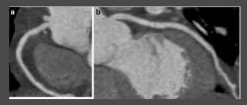

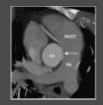

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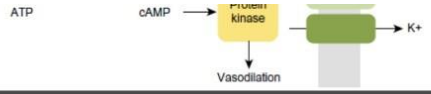

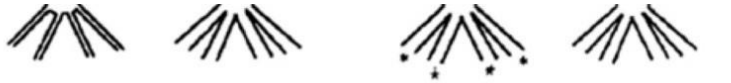

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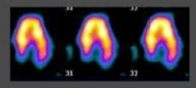

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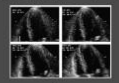

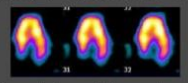

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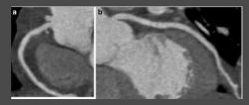

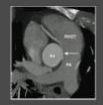

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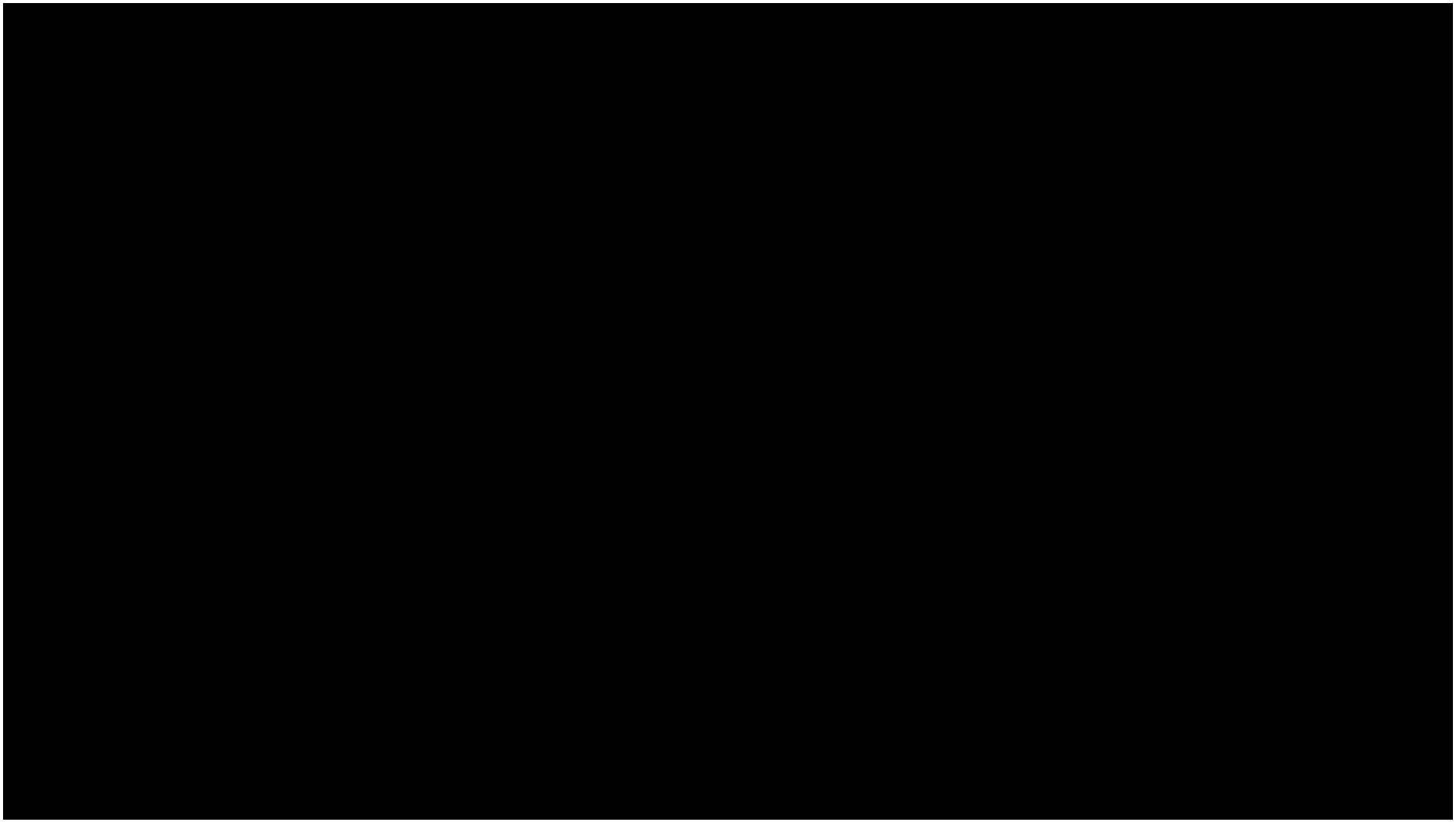

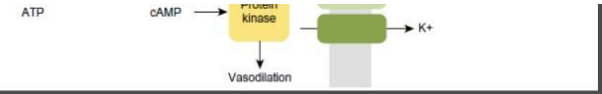

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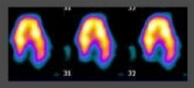

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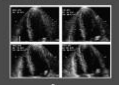

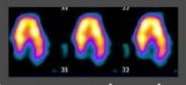

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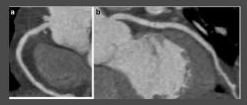

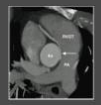

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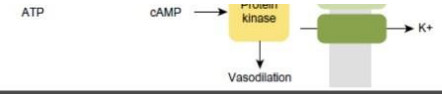

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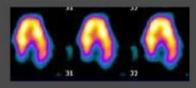

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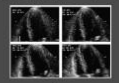

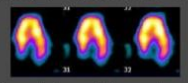

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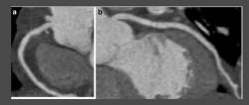

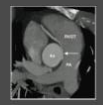

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Preoperative Evaluation and Stress Testing
Yousef Bader MD
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