

STRESS ECHOCARDOGRAPHY:

THEORETICAL AND PRACTICAL CONSIDERATIONS



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ASCeXAM/ReASCE
REVIEW COURSE
The most comprehensive review to help you prepare for the NBE certification examinations.

19th
ANNUAL

DISCLOSURES

- NO FINANCIAL DISCLOSURES
- NO CONFLICTS OF INTEREST*

* Inherent personal distaste for both stress AND exercise

THE NBE IS NOT VERY SPECIFIC ABOUT CONTENT:

ASCeXAM Exam Content

The National Board of Echocardiography, Inc. (NBE) worked in collaboration with the National Board of Medical Examiners (NBME) to develop this examination to allow physicians to test and demonstrate their knowledge in echocardiography based on objective standards.



III. Chamber Size and Function

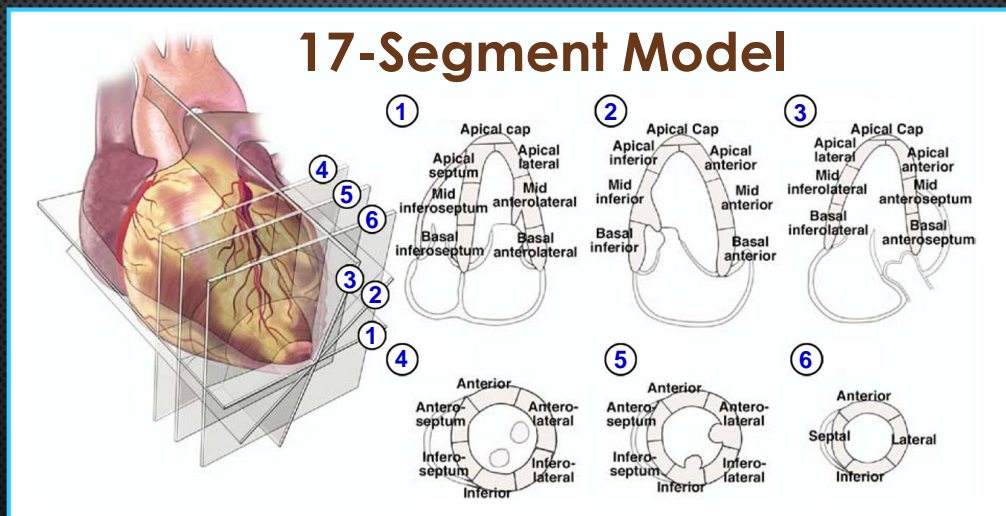
A. Coronary Artery Disease, Stress Echocardiography

From: **Examination of Special Competence in Adult Echocardiography (ASCeXAM)** brochure

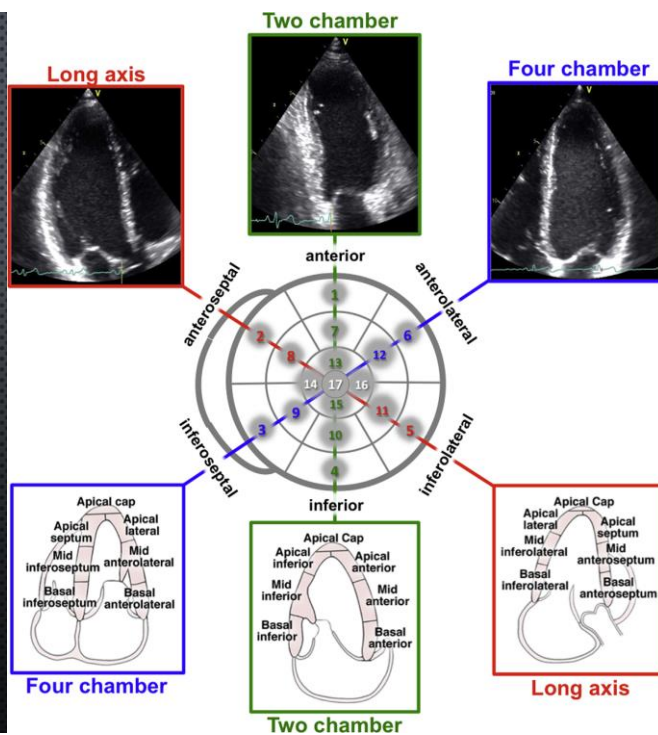
OBJECTIVE – SCORE “YUUGE” ON STRESS!!

- ASE SEGMENTAL MODEL – KNOW YOUR WALLS
- STRESS MODALITIES & METHODOLOGY
 - SELECTION, PREPARATION, CONCLUSION, SIDE EFFECTS
- DIAGNOSIS:
 - ISCHEMIA, VIABILITY
- PROGNOSIS
- NON-ISCHEMIC APPLICATIONS
 - DIASTOLIC STRESS; VALVULAR HEART DISEASE

KNOW THE ASE SEGMENTS

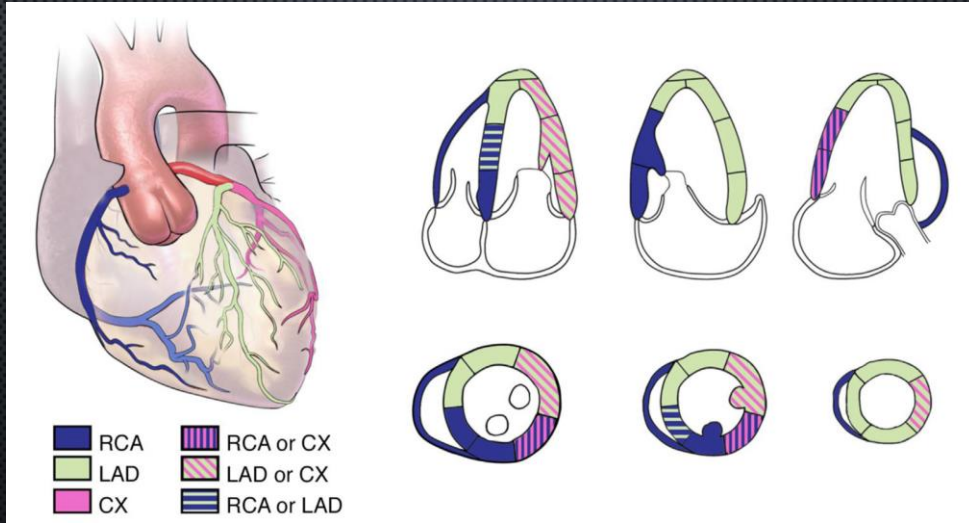


“ALTERNATE” ILLUSTRATION SAME CONCEPT



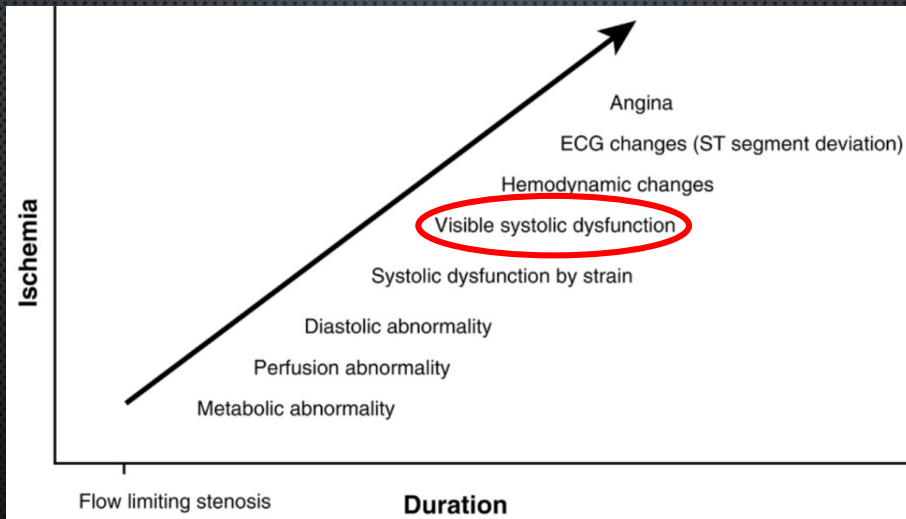
Lang RM, et al. J Am Soc Echocardiol (2015) 28:1-39

KNOW YOUR PERFUSION DISTRIBUTION



Lang RM, et al. *J Am Soc Echocardiol* (2015) 28:1-39

ISCHEMIC CASCADE



PROPER ASSESSMENT OF WALL MOTION

- **ENDOCARDIAL EXCURSION**
 - EASY FRAME OF REFERENCE
 - BEWARE THE "FAKE OUT" – PASSIVE DRAGGING

- **WALL THICKENING**
 - SOMETIMES MORE DIFFICULT TO DISCERN
 - % THICKENING ESTIMATE IS KEY
 - LESS "FAKE OUT"
 - UNAFFECTED BY PASSIVE DRAGGING & SHAPE CHANGES

GRADING WALL MOTION:

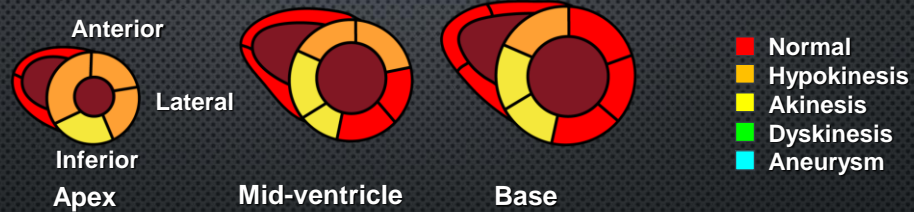
Score	Wall Motion Category	Endocardial Motion	Wall Thickening
1	Normokinetic	Normal, Inward	Normal (>30%)
2	Hypokinetic	Reduced, Inward (<5 mm)	Reduced (<30%)
3	Akinetic	Absent (<2 mm)	Absent (<10%)
4	Dyskinetic	Outward	Thinning
5	Aneurysmal	Outward; Diastolic Deformity	Absent and Thinning

WALL MOTION SCORE INDEX (WMSI)

= sum of scores / number of segments visualized

Rest

WMSI: 2.00 (nl = 1.00)



Stress

WMSI: 2.38



CHAUDRY FA, ET AL. J AM COLL CARDIOL (1999) 34:730-738

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STRESS ECHO MODALITIES

- **EXERCISE**

- TREADMILL
- BICYCLE ERGOMETER

- **PHARMACOLOGIC STRESS**

- DOBUTAMINE

MOST IMPORTANT
for the examination

- **VASODILATORS**

- DIPYRIDAMOLE, ADENOSINE, REGADENOSON

- **PACING**

PHYSIOLOGIC DIFFERENCES

Modality	Inotropic State	HR	BP	SVR	Venous Return
Upright Exercise	↑↑	↑↑↑	↑↑+	↓	↑
Supine Bicycle	↑↑	↑↑+	↑↑↑	↓	↑↑↑
Dobutamine	↑↑↑	↑↑	↑+	↓↓↓	↓
Vasodilators	↑	↑	↓	↓↓↓	↓↓

adapted from: KOSMALA W AND MARWICK TH IN *ASE'S COMPREHENSIVE ECHOCARDIOGRAPHY* (2016) LANG RM, ET AL, EDS

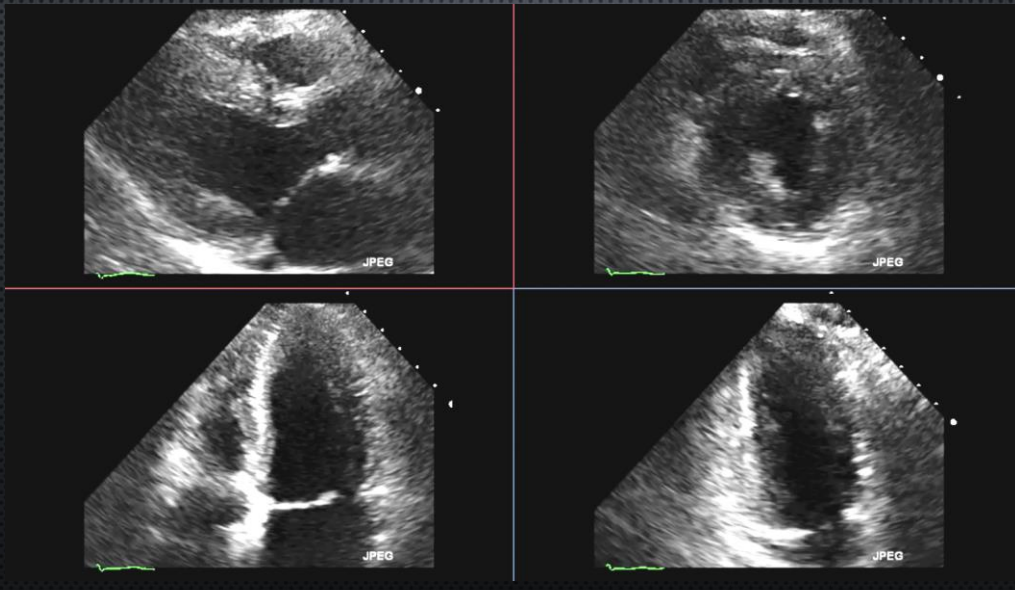
METHODOLOGY: EXERCISE STRESS

- ADVANTAGES OF EXERCISE:
 - DETERMINE FUNCTIONAL CAPACITY
 - EVALUATE HR AND BP RESPONSE
- BASELINE ECHO – BEYOND THE LV
 - VALVE FUNCTION (STENOSIS/REGURGITATION)
 - ASSESS PROXIMAL AORTA
 - DIASTOLIC PARAMETERS (MV DOPPLER / MITRAL TDI)
 - RV – SIZE, FUNCTION, RVSP

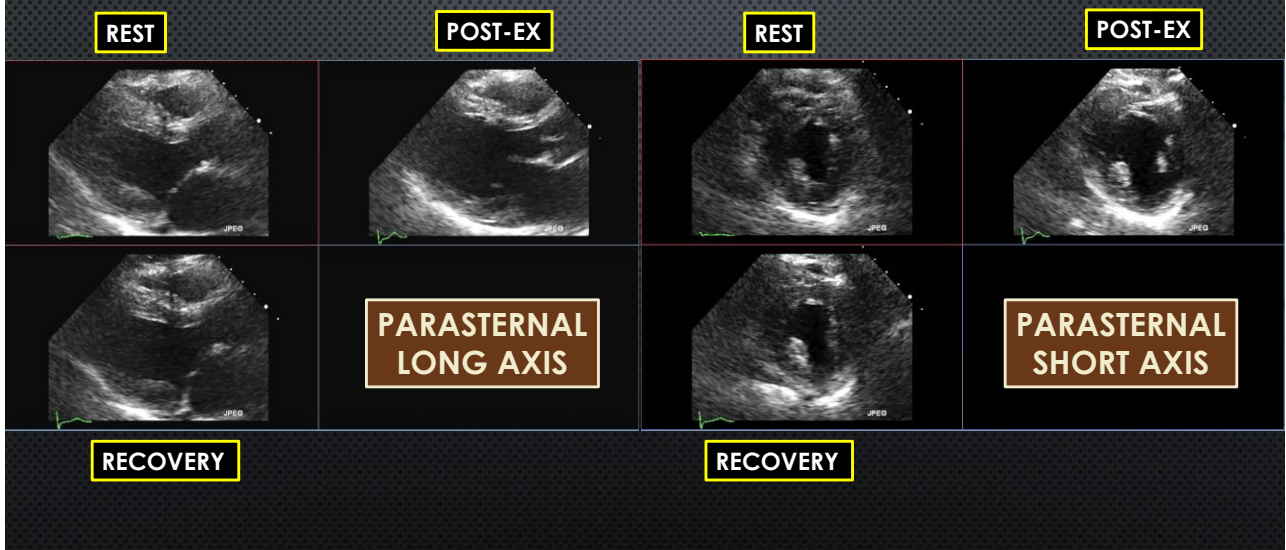
METHODOLOGY: EXERCISE STRESS 2

- TREADMILL:
 - MULTISTAGE PROTOCOLS – BRUCE, MOD BRUCE, NAUGHTON
 - CONTINUOUS MONITORING – HR, BP, ECG
 - SYMPTOM LIMITED – IMAGES W/I 1 MIN POST-PEAK
- BICYCLE ERGOMETRY:
 - UPRIGHT, SEMI-RECUMBENT, RECUMBENT
 - VARIABLE RESISTANCE – WATTS / METS
 - CONTINUOUS MONITORING – HR, BP, ECG
 - SYMPTOM LIMITED - IMAGES AT PEAK

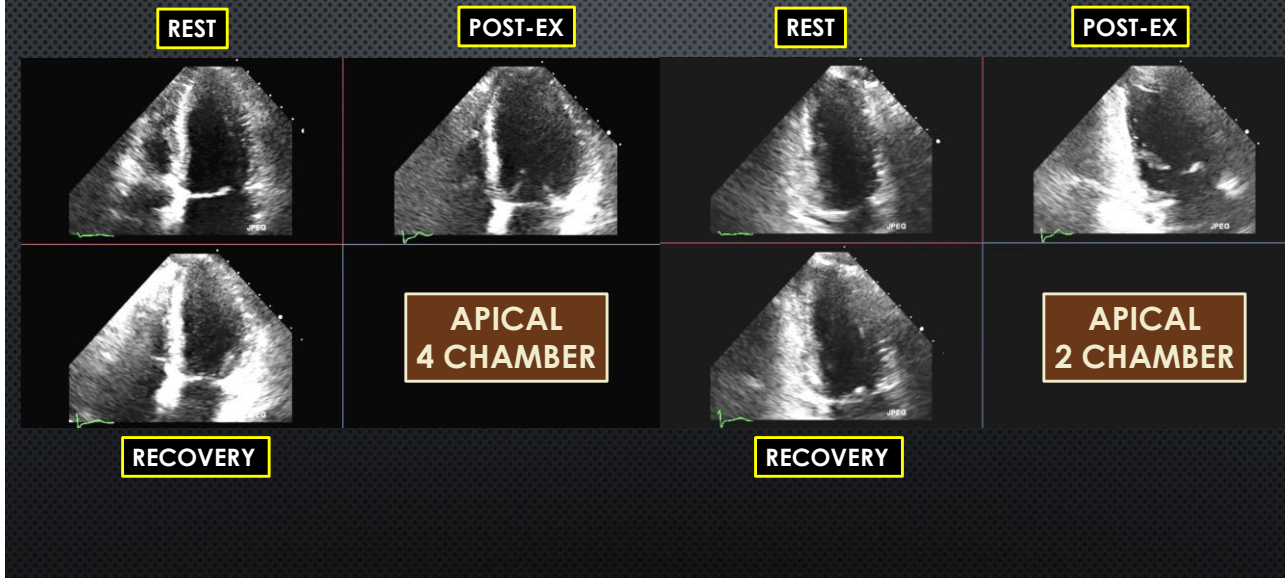
EXERCISE STRESS – BASELINE IMAGES



EXERCISE STRESS - STAGE IMAGES



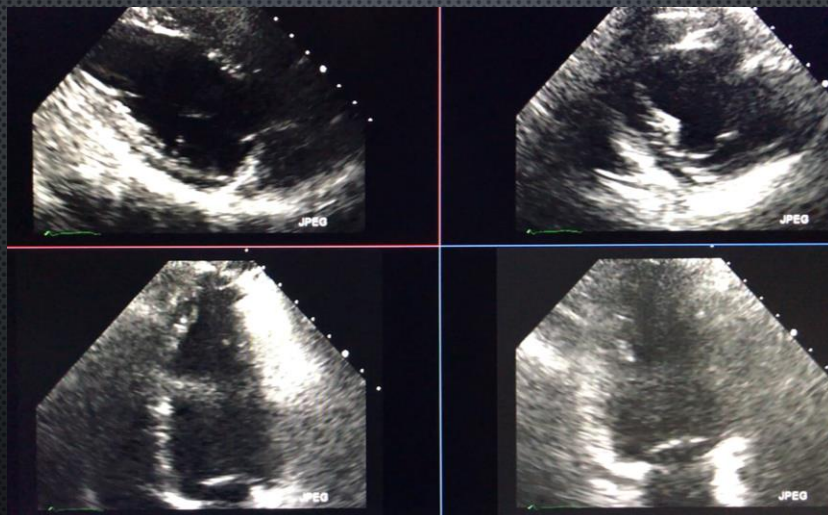
EXERCISE STRESS – STAGE IMAGES



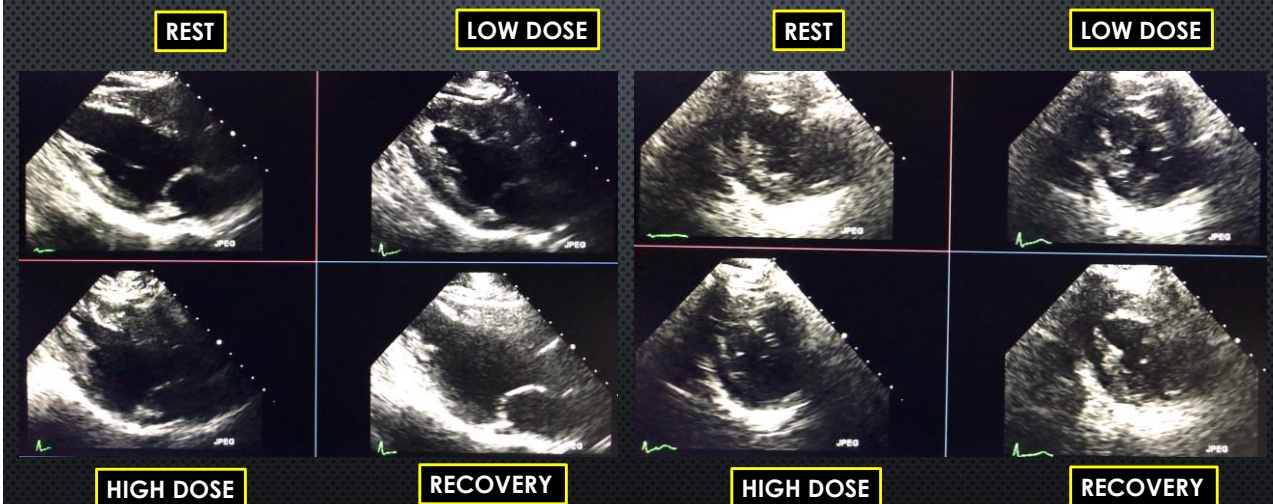
METHODOLOGY: PHARMACOLOGIC STRESS

- **DOBUTAMINE**
 - LOW DOSE (<10 MCG/KG/MIN) – BETA-1, INOTROPIC EFFECT
 - HIGH DOSE (11-40 MCG/KG/MIN) – BETA-2, ALPHA-1, CHRONOTROPIC
- **STANDARD PROTOCOL**
 - 3 MINUTE STAGES; CONTINUOUS HR, BP, ECG MONITORING
 - START 5 MCG/KG/MIN, INCREASE IN STAGES TO 40 MCG/KG/MIN
 - ATROPINE (0.5 MG, MAX 2MG) OR HANDGRIP/LEG EXERCISE IF HR SUBMAX
 - IMAGING @ BASELINE, LOW DOSE, HIGH DOSE (PEAK), RECOVERY
- **TERMINATION: 85% OF MAXIMAL AGE-PREDICTED HEART RATE**

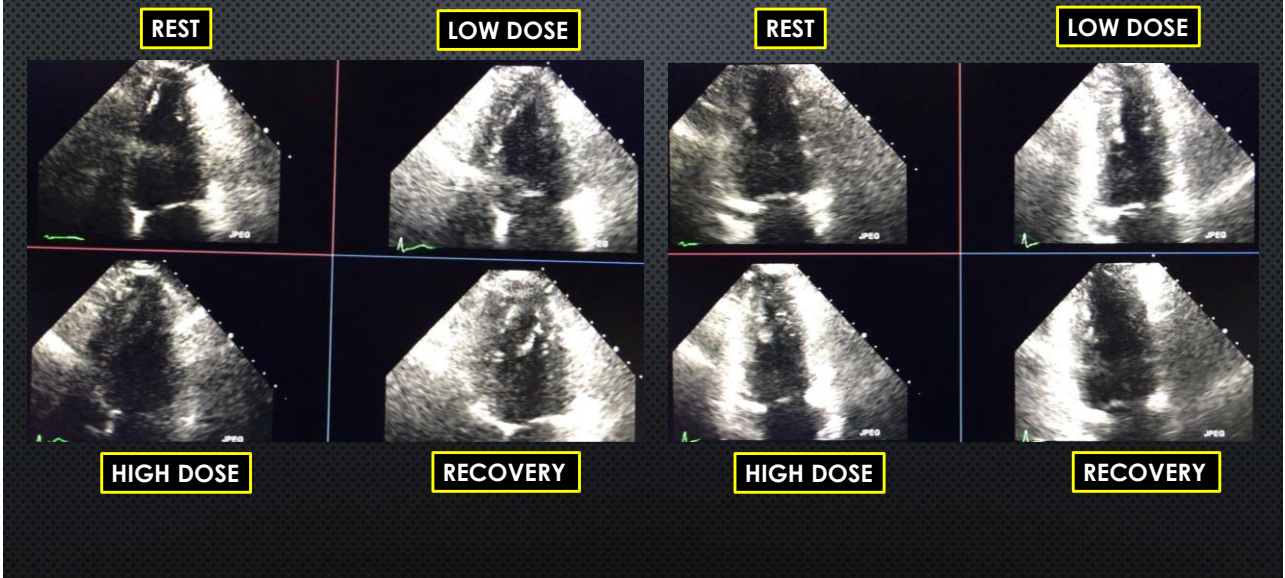
DOBUTAMINE STRESS – BASELINE IMAGES



DOBUTAMINE STRESS – STAGE IMAGES



DOBUTAMINE STRESS – STAGE IMAGES



WHEN DO I STOP??

• ABSOLUTE STOPPING POINTS

- ST ELEVATIONS >1MM IN LEADS WITHOUT Q WAVES
- VT
- DECREASE SBP>10MMHG (w/SIGNS OF ISCHEMIA)
- MODERATE TO SEVERE ANGINA
- SIGNS OF POOR PERFUSION

• RELATIVE STOPPING POINTS

- ST DEPRESSIONS (HORIZONTAL, DOWNSLOPING) >2MM
- NEW BBB THAT CANNOT BE DISTINGUISHED FROM VT
- DECREASE SBP>10MMHG (w/O SIGNS OF ISCHEMIA)
- HYPERTENSIVE RESPONSE (>250 MMHG SBP / >115 MMHG DBP)
- INCREASING ANGINA

ROY RR, MCCULLY R AND LESTERY SJ IN *ASE'S COMPREHENSIVE ECHOCARDIOGRAPHY* (2016) LANG RM, ET AL, EDS

IS THIS SAFE?

	Ex Echo n=8592	DSE n= 6755	P value	Total n = 5349
Overall Complication Rate	8 (0.09%)	47 (0.7%)	<0.001	55 (0.36%)
Arrhythmia Requiring Rx	4 (0.05%)	39 (0.58%)	<0.001	43 (0.28%)
SVT / AF	4 (0.05%)	33 (0.49%)	<0.001	37 (0.24%)
VT / VF	0	6 (0.09%)	<0.005	6 (0.04%)
Markedly + / Prolonged CP requiring hospitalization	3 (0.03%)	5 (0.07)	0.56	8 (0.05%)
Symptomatic hypotension requiring hospitalization	1 (0.01%)	3 (0.04%)	0.44	4 (0.03%)
Transfer to Hospital	5 (0.06%)	21 (0.31%)	0.0005	26 (0.17)
Cardiac Rupture or Death	0	0	---	0

Kane GC, et al. *J Am Soc Echocardiol* (2008) 21:333-341

OBJECTIVE – SCORE “YUUGE” ON STRESS!!

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- STRESS MODALITIES & METHODOLOGY
 - SELECTION, PREPARATION, CONCLUSION, SIDE EFFECTS
- **DIAGNOSIS:**
 - **ISCHEMIA, VIABILITY**
- PROGNOSIS
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WHAT MAKES A “POSITIVE” TEST

- GOAL – DIAGNOSE HEMODYNAMICALLY SIGNIFICANT CORONARY STENOSIS
 - >50% ANGIOGRAPHIC STENOSIS = WMA WITH STRESS
- ONE SEGMENT W/NEW OR WORSENING HK = POSITIVE
 - MAXIMIZES SENSITIVITY OF THE TEST
 - >1 SEGMENT = POSITIVE: ↓ SENSITIVITY, ↑ SPECIFICITY
- ADDITIONAL FEATURES RAISE SUSPICION
 - STRESS-INDUCED LV DILATION (>17% INCREASE)
 - FAILURE TO AUGMENT LV EJECTION FRACTION

DIAGNOSIS – ISCHEMIA

- CORONARY ANGIOGRAPHY
 - “GOLD STANDARD” FOR HEMODYNAMICALLY SIGNIFICANT CAD
 - >50% STENOSIS BY QUANTITATIVE ANGIOGRAPHY
 - >70% STENOSIS BY VISUAL ESTIMATION

• SENSITIVITY – 75-85%

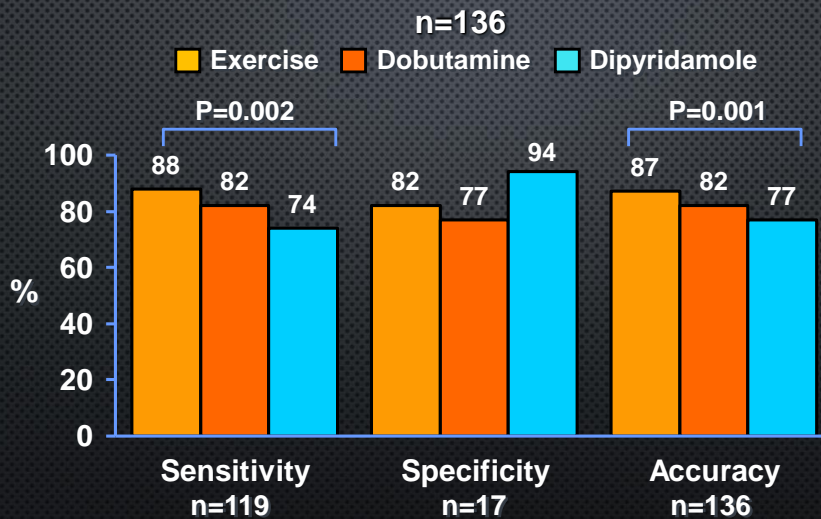
• SPECIFICITY – 80-90%

For Stress Echo “Overall”

- COMPARABLE IN MEN AND WOMEN
- BEST SENSITIVITY WHEN HR >85% AGE-PREDICTED MAX HR

GELEIJNSE ML, ET AL. *J Am Soc Echocardiogr* (2009) 22:1199-1208
HOFFMANN R, ET AL. *EUR HEART J* (1999) 20:1485-1492

ISCHEMIA DETECTION: COMPARING MODALITIES



Beleslin and Ostojic. *Circulation* (1994)

ISCHEMIA – FACTORS AFFECTING ACCURACY

FALSE POSITIVE

- CARDIOMYOPATHY
 - IDIOPATHIC, STRESS CMP
 - FOCAL MYOCARDITIS
- PARADOXICAL SEPTAL MOTION
 - LBBB, RV PACING
 - POST-THORACOTOMY
 - RV VOLUME OVERLOAD
- MICROVASCULAR DISEASE
 - SYNDROME X
 - DIABETES
 - LVH, HYPERTROPHIC CMP
- HYPERTENSIVE RESPONSE
- CORONARY VASOSPASM
- FOCAL BASAL INFERIOR WMA

FALSE NEGATIVE

- SUBMAXIMAL STRESS
 - <85% MAX PREDICTED HR
- DELAYED IMAGE ACQUISITION
- POOR IMAGE QUALITY
- ANTI-ANGINAL DRUG THERAPY
 - CA⁺⁺ CHANNEL BLOCKERS, BETA BLOCKERS, NITRATES – DAY OF EXAM
- MILD ISCHEMIA
 - CIRCUMFLEX STENOSIS
 - BRANCH STENOSIS
 - DISTAL STENOSIS
- CORONARY COLLATERAL RESERVE

DECIDING WHEN TO USE S.E. FOR ISCHEMIA

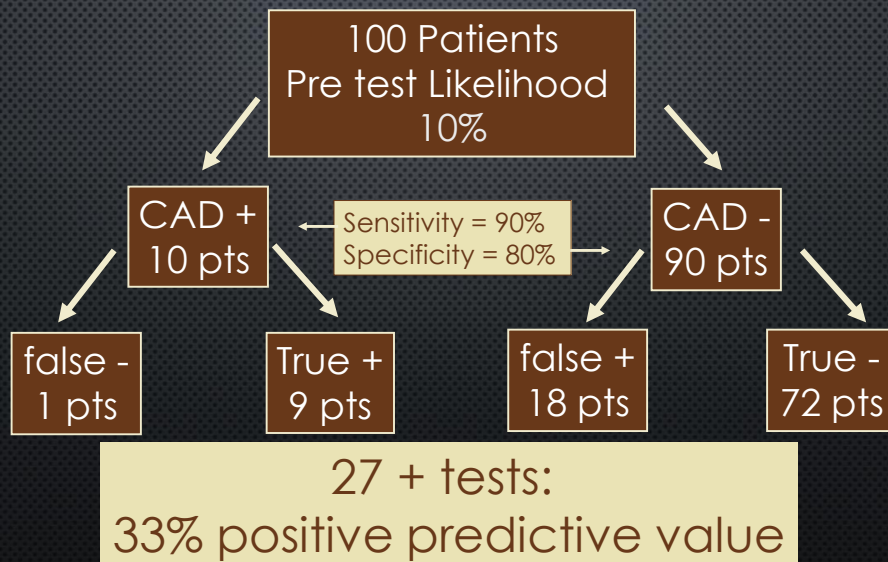
- MOVE BEYOND SENSITIVITY AND SPECIFICITY
- ESTIMATE “PRE-TEST PROBABILITY”
 - WILL THE TEST HELP YOU? WILL IT CHANGE YOUR MIND?

Likelihood of CAD	CAD Prevalence	Does testing help?
Low	<10%	NO, CAD unlikely – SE predictive power poor
Medium	10-90%	YES
High	>90%	NO, CAD likely – Move on to cath

- How?
 - SYMPTOMS (TYPICAL/ATYPICAL), PAST ISCHEMIC EVENTS, ECG ABNORMALITIES, RISK FACTORS FOR CAD, FAMILY HISTORY
 - DIAMOND & FORRESTER, NHLBI GLOBAL CAD RISK, OTHER MODELS

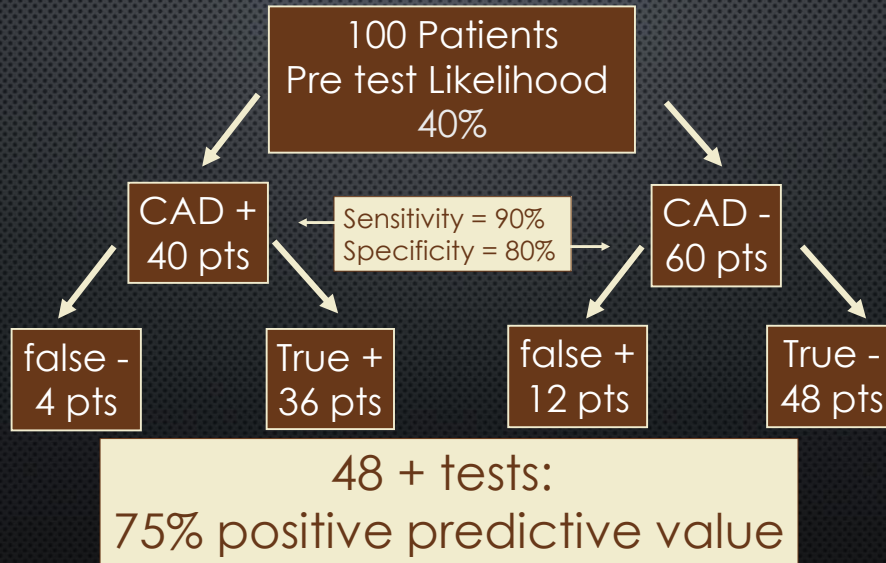
Fihn SD, et al. *JACC* (2012) 60:e44-e164
Wolk MJ, et al. *JACC* (2014) 63: 380-406

IMPACT OF PRETEST PROBABILITY



Courtesy of
S. Lester

IMPACT OF PRETEST PROBABILITY



APPROPRIATE USE – DX ISCHEMIA SYMPTOMATIC PATIENTS

Indication Text		Exercise ECG	Stress RNI	Stress Echo	Stress CMR	Calcium Scoring	CCTA	Invasive Coronary Angiography
1.	<ul style="list-style-type: none"> Low pre-test probability of CAD ECG interpretable AND able to exercise 	A	R	M	R	R	R	R
2.	<ul style="list-style-type: none"> Low pre-test probability of CAD ECG uninterpretable OR unable to exercise 		A	A	M	R	M	R
3.	<ul style="list-style-type: none"> Intermediate pre-test probability of CAD ECG interpretable AND able to exercise 	A	A	A	M	R	M	R
4.	<ul style="list-style-type: none"> Intermediate pre-test probability of CAD ECG uninterpretable OR unable to exercise 		A	A	A	R	A	M
5.	<ul style="list-style-type: none"> High pre-test probability of CAD ECG interpretable AND able to exercise 	M	A	A	A	R	M	A
6.	<ul style="list-style-type: none"> High pre-test probability of CAD ECG uninterpretable OR unable to exercise 		A	A	A	R	M	A

A = Appropriate M = May be Appropriate R = Rarely Appropriate

Wolk MJ, et al. Multimodality AUC for Stable Ischemic Heart Disease. *JACC* (2014) 63: 380-406

APPROPRIATE USE – DX ISCHEMIA ASYMPTOMATIC PATIENTS

Indication Text	Exercise ECG	Stress RNI	Stress Echo	Stress CMR	Calcium Scoring	CCTA	Invasive Coronary Angiography
7. <ul style="list-style-type: none"> Low global CHD risk Regardless of ECG interpretability and ability to exercise 	R	R	R	R	R	R	R
8. <ul style="list-style-type: none"> Intermediate global CHD risk ECG interpretable and able to exercise 	M	R	R	R	M	R	R
9. <ul style="list-style-type: none"> Intermediate global CHD risk ECG uninterpretable OR unable to exercise 		M	M	R	M	R	R
10. <ul style="list-style-type: none"> High global CAD Risk ECG interpretable and able to exercise 	A	M	M	M	M	M	R
11. <ul style="list-style-type: none"> High global CAD Risk ECG uninterpretable OR unable to exercise 		M	M	M	M	M	R

A = Appropriate M = May be Appropriate R = Rarely Appropriate

Wolk MJ, et al. Multimodality AUC for Stable Ischemic Heart Disease. *JACC* (2014) 63: 380-406

OTHER FORMS OF STRESS

• VASODILATOR

- DIPPYRIDAMOLE, ADENOSINE
- DIFFERENTIAL FLOW (STEAL) **MAY** LEAD TO RWMA
- LESS SENSITIVE THAN DOBUTAMINE
 - ATROPINE ADMINISTRATION IMPROVES SENSITIVITY

• PACING

- USING PACEMAKER OR TRANSESOPHAGEAL WIRE
- CHRONOTROPIC – MIN BP RESPONSE / INOTROPIC CHANGE

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DIAGNOSIS – VIABILITY

- HYPOKINETIC MYOCARDIUM AT REST:
 - **INFARCTED**– PERMANENTLY DAMAGED/DEAD MYOCARDIUM
 - **VIABLE**– ACUTELY OR CHRONICALLY HYPOFUNCTIONAL

	CAUSE	FATE
STUNNED	ACUTE ISCHEMIC INJURY	RECOVERS FUNCTION OVER TIME
HIBERNATING	CHRONIC HYPO-PERFUSION	RECOVERS WITH REVASCULARIZATION

- LOW-DOSE DOBUTAMINE:
 - VIABLE, HYPOKINETIC MYOCARDIUM SHOWS IMPROVED CONTRACTILITY
 - PREDICTS RECOVERY OF FUNCTION – **PPV 77%; NPV 84%**

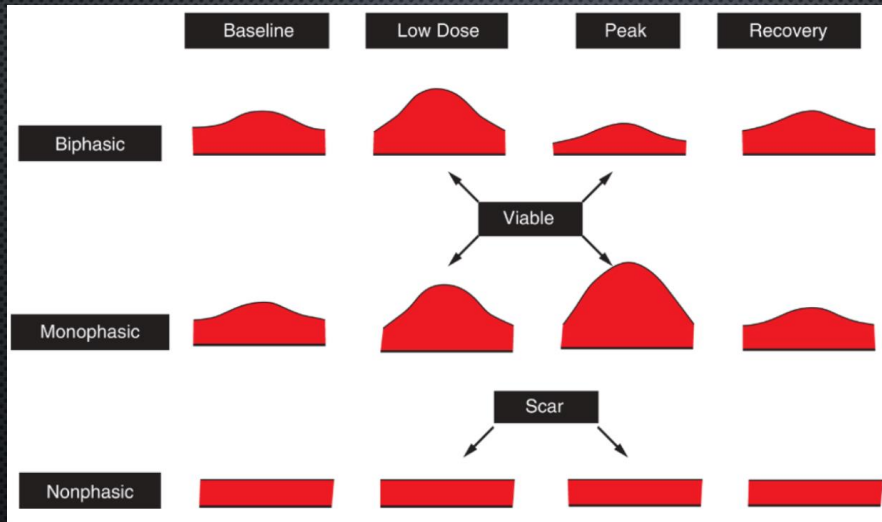
VIABILITY – WHY AND HOW?

- REVASCULARIZATION OF VIABLE MYOCARDIUM:
 - INCREASED EF
 - DECREASED CHF
 - IMPROVED SURVIVAL (LIKELY)
- WHAT'S "LOW DOSE"?
 - TYPICALLY <10 MCG/KG/MIN (4-8 MCG/KG/MIN "IDEAL")
 - START @ 2.5 MCG/KG/MIN – OR – @ 5 MCG/KG/MIN
 - 3 MIN STAGES, THROUGH TO HIGH DOSE
 - GOAL 85% HR OR TERMINATION CRITERIA

CLASSIFYING SEGMENTAL RESPONSE

- **MONOPHASIC**
 - IMPROVEMENT AT LOW DOSE; IMPROVEMENT AT HIGH DOSE
 - **VIABLE MYOCARDIUM – NO FLOW LIMITATION**
- **BIPHASIC**
 - IMPROVEMENT AT LOW DOSE; DETERIORATION AT HIGH DOSE
 - **VIABLE MYOCARDIUM – FLOW-LIMITING STENOSIS**
- **ISCHEMIC**
 - DECREASED FUNCTION/WALL MOTION AT ALL DOSES
 - **STRESS-INDUCED ISCHEMIA – FLOW LIMITING STENOSIS**
- **NONPHASIC**
 - NO CHANGES SEEN
 - **NON-VIABLE MYOCARDIUM - SCAR**

DOBUTAMINE RESPONSE

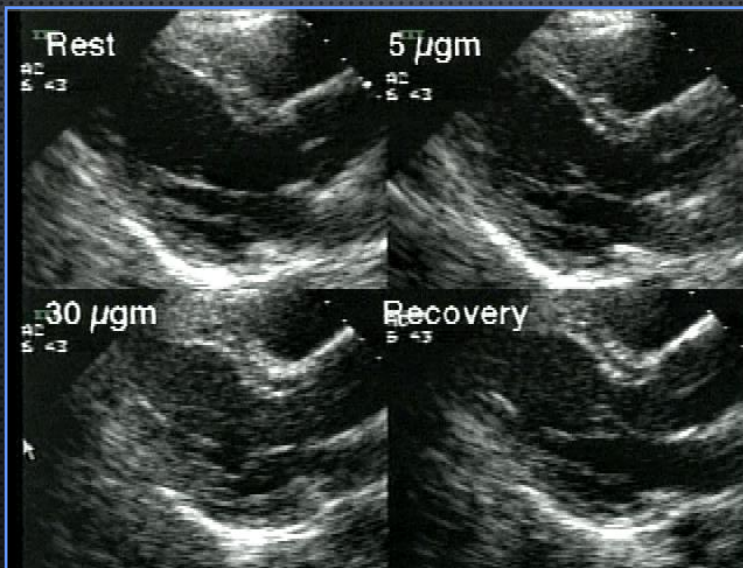


MOST SPECIFIC
79% Sens, 89% Spec

MOST SENSITIVE
86% Sens, 68% Spec

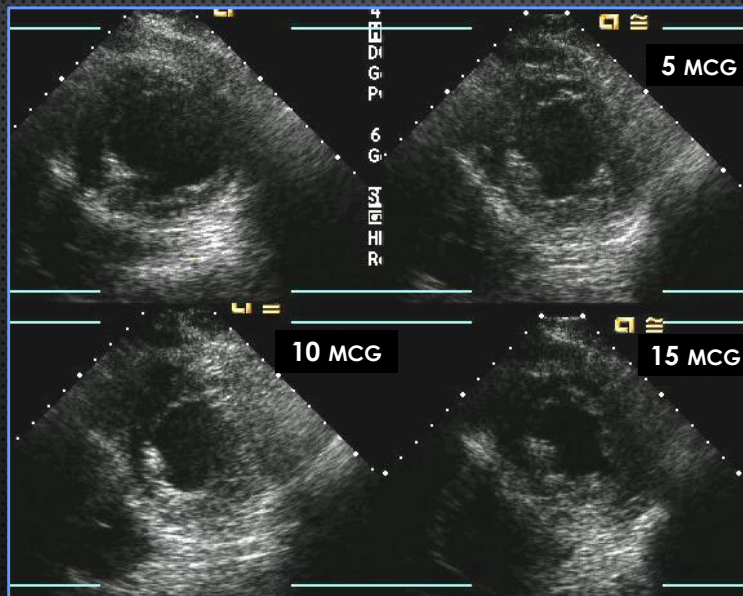
Usually thin (<5 mm),
Hyper-refractile

DOBUTAMINE – MONOPHASIC RESPONSE



Courtesy of
Sunil Mankad

DOBUTAMINE - BIPHASIC RESPONSE:



Courtesy of
Sunil Mankad

ECHO CONTRAST UTILIZATION

- **LV OPACIFICATION (LVO)** – FDA APPROVED
 - TWO CONTIGUOUS SEGMENTS NON-VISUALIZED AT REST
 - SENS/SPEC LVO = SENS/SPEC HIGH QUALITY NON-CONTRAST
 - MI <0.3; FR >30 Hz; FAR FIELD FOCUS; 1-BEAT LOOP
 - MINIMIZE MYOCARDIAL TISSUE SIGNALS
 - 2 SYRINGES; BEGIN INFUSION 30 SEC BEFORE EX TERMINATION
- **REAL TIME PERFUSION ECHO (RTPE)** – NOT FDA APPROVED
 - RTPE PERFUSION ABN **BEFORE** WALL MOTION ABN
 - MI <0.2; FR 20-25 Hz; FAR FIELD FOCUS; 10-SEC LOOP

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PROGNOSTIC POWER – THE BAD

- **HIGHER WMSI** = WORSE PROGNOSIS
 - INDEPENDENT OF EXTENT OF CAD
- **EXTENT** OF ISCHEMIA:
 - MORE SEGMENTS = BAD
- **SEVERITY** OF ISCHEMIA:
 - MAGNITUDE OF SEGMENT(S) SEVERITY = BAD
- SEVERITY OF **INDUCED LV SYSTOLIC ABNORMALITY**
 - LOWER STRESS EF = BAD
- ISCHEMIC **DILATATION** OF LV

PROGNOSTIC POWER – THE GOOD

- NORMAL WALL MOTION RESPONSE
- DECREASE IN LV VOLUME
- INCREASE IN LV EJECTION FRACTION
- LONG DURATION OF EXERCISE
- RISK OF MI, CARDIAC DEATH OR REVASCULARIZATION:

	<1% per year	1-3% per year
Stress	Maximal (>85%)	Submaximal
Resting EF	>50%	<40%
Anti-ischemics	Off	On

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PROGNOSTIC POWER

- NOT JUST WHEN DIAGNOSING CAD:
 - CHRONIC/ESTABLISHED CAD
 - POST-MYOCARDIAL INFARCTION
 - PERIOPERATIVE RISK
 - KNOWN DEPRESSED EF

APPROPRIATE PROGNOSTIC USE

Indication Text		Exercise ECG	Stress RNI	Stress Echo	Stress CMR	Calcium Scoring	CCTA	Invasive Coronary Angiography
Newly Diagnosed Heart Failure (Resting LV Function Previously Assessed but No Prior CAD Evaluation)								
12.	• Newly diagnosed systolic heart failure	M	A	A	A	R	A	A
13.	• Newly diagnosed diastolic heart failure	M	A	A	A	R	M	M
Evaluation of Arrhythmias								
Without Ischemic Equivalent (No Prior Cardiac Evaluation)								
14.	• Sustained VT	A	A	A	A	R	M	A
15.	• Ventricular Fibrillation	M	A	A	A	R	M	A
16.	• Exercise induced VT or nonsustained VT	A	A	A	A	R	M	A
17.	• Frequent PVCs	A	A	A	M	R	M	M
18.	• Infrequent PVCs	M	M	M	R	R	R	R
19.	• New-onset atrial fibrillation	M	M	M	R	R	R	R
20.	• Prior to initiation of anti-arrhythmia therapy in high global CAD risk patients	A	A	A	A	R	M	R
Syncope Without Ischemic Equivalent								
21.	• Low global CAD Risk	M	M	M	R	R	R	R
22.	• Intermediate or High Global CAD Risk	A	A	A	M	R	M	R

A = Appropriate M = May be Appropriate R = Rarely Appropriate

Wolk MJ, et al. Multimodality AUC for Stable Ischemic Heart Disease. *JACC* (2014) 63: 380-406

EACVI/ASE CLINICAL RECOMMENDATIONS

The Clinical Use of Stress Echocardiography in Non-Ischaemic Heart Disease: Recommendations from the European Association of Cardiovascular Imaging and the American Society of Echocardiography



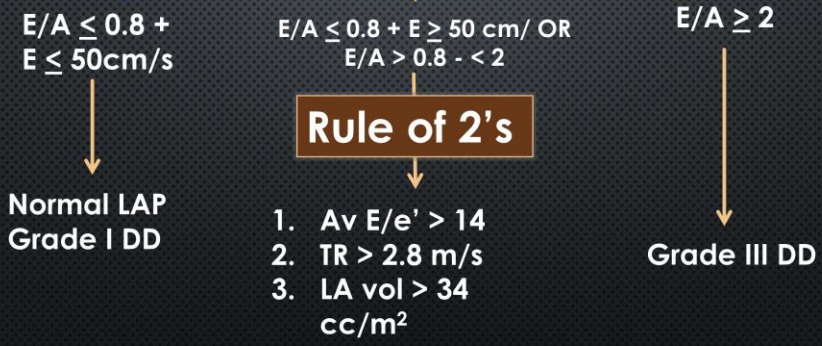
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DIAGNOSIS – DIASTOLIC STRESS TEST

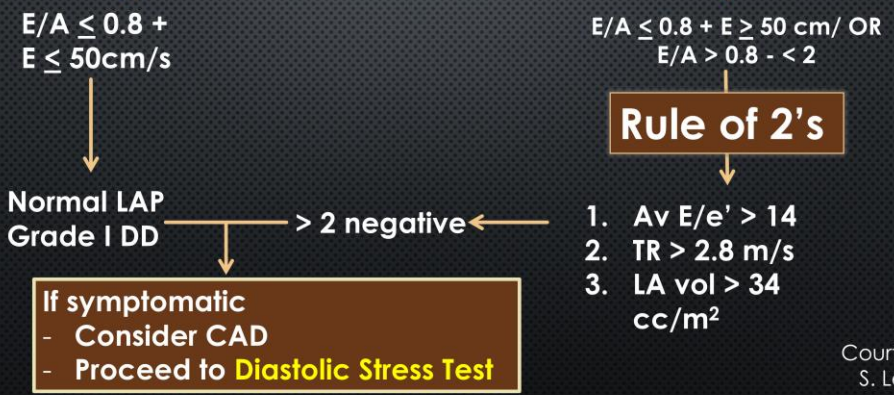
- DIASTOLIC DYSFXN CAUSES DYSPNEA/CHF SX IN 40%
 - EXERCISE DOPPLER ECHO – DETECT “SUBCLINICAL” DYSFUNCTION
 - AKA – “IMPAIRED DIASTOLIC FUNCTIONAL RESERVE”
- SUPINE BICYCLE EXERCISE PREFERRED
 - INSTANTANEOUS DOPPLER AT EACH STAGE
- TREADMILL EXERCISE ALTERNATIVE
 - DIASTOLIC ABNORMALITIES PERSIST INTO RECOVERY
 - PASSIVE LEG LIFT MAY AUGMENT
- STAND-ALONE VS. COMBINED W/ISCHEMIC EVAL

WHEN IS DIASTOLIC STRESS TESTING INDICATED? GRADING LV FILLING PRESSURES



Courtesy of S. Lester

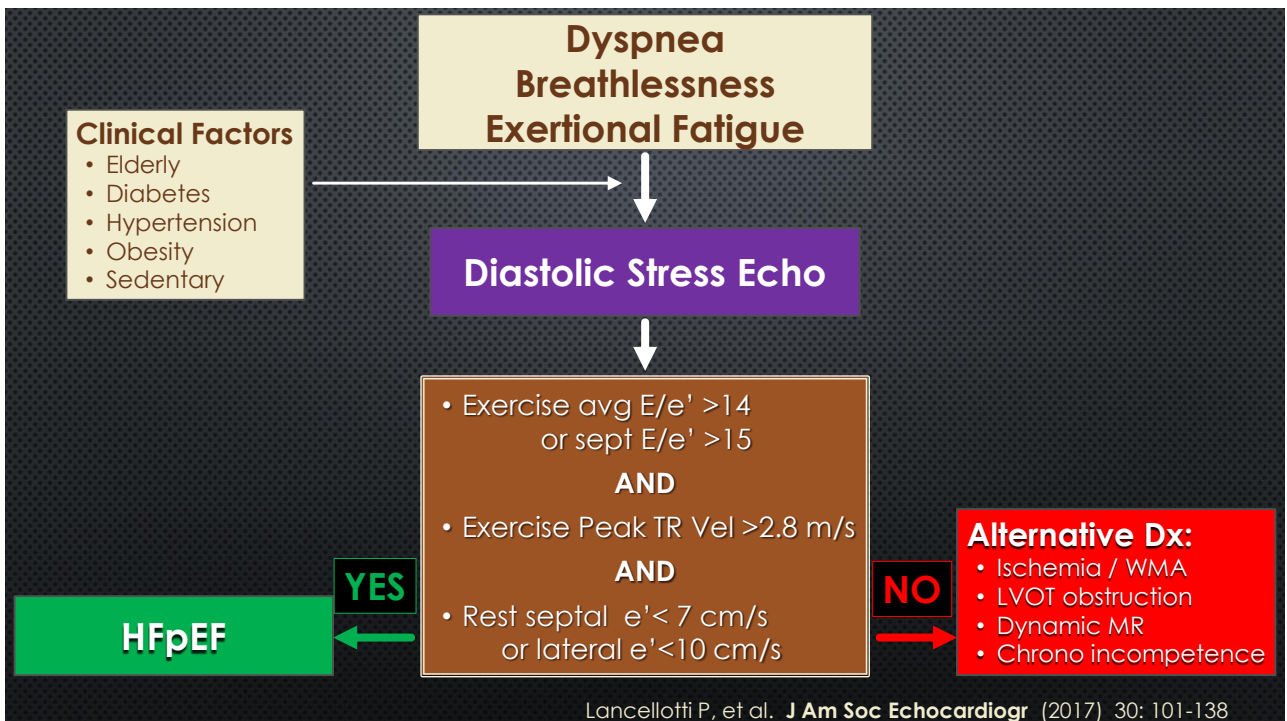
WHEN IS DIASTOLIC STRESS TESTING INDICATED? GRADING LV FILLING PRESSURES



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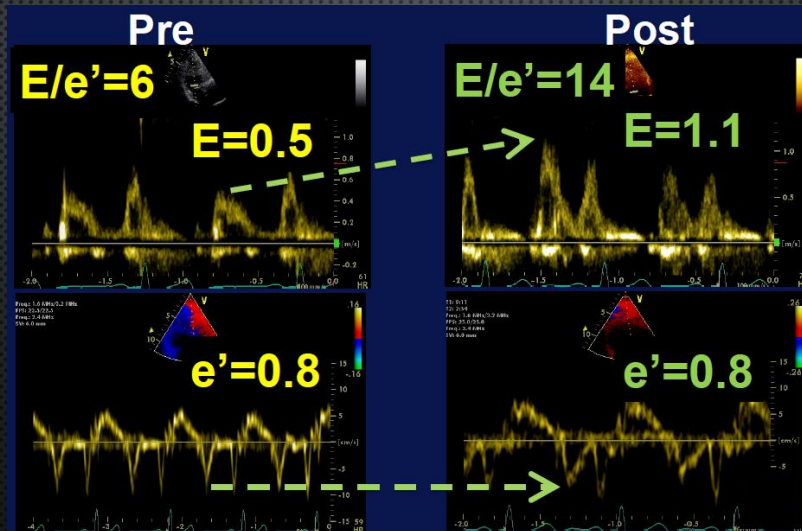
DIASTOLIC STRESS – METHODOLOGY

- IN **NORMALS**, E/e' RATIO DOES NOT CHANGE WITH EXERTION
 - BOTH MV-E VELOCITY AND TD- e' VELOCITY INCREASE
- CAPTURE “QUAD SCREENS” FIRST
 - ISCHEMIC CHANGES PROMINENT IN FIRST MINUTE
- CHECK TR VELOCITY NEXT
- MEASURE MV INFLOW AND ANNULAR TISSUE DOPPLER NEXT
 - REDUCED HR MINIMIZES FUSION OF E & A AND e' & a' (100-110 BPM)
 - DIASTOLIC ABNORMALITY PERSISTS LONGER THAN WMA



67 MAN, DIABETES, HTN, LV HYPERTROPHY

- DYSPNEA ON MOD EXERTION (NYHA II) – LVEF, STRESS WM NORMAL



Courtesy:
S. Lester

OTHER SE APPLICATIONS – VALVE DISEASE

- **SEVERE VALVE DISEASE WITHOUT SYMPTOMS**
 - AS, MS, AI, MR – CONFIRM ABSENCE OF SX, ASSESS HEMODYNAMIC RESPONSE OR DETERMINE PROGNOSIS (CLASS IIA, LOE B)
- **MODEST VALVE DISEASE WITH SYMPTOMS**
 - MS – EVAL RESPONSE OF MG AND PASP WHEN THERE IS DISCREPANCY BETWEEN RESTING DOPPLER AND SYMPTOMS (CLASS I, LOE B)
 - MR, AR – SYMPTOMS DISPROPORTIONATE TO SEVERITY OF MR, AR AT REST.
- **LOW FLOW STATES**
 - AS – LOW DOSE DSE FOR $PV < 4$ M/SEC OR $MG < 40$ MMHG IN PRESENCE OF CA^{++} AV W/ $AVA < 1$ CM^2 (CLASS IIA, LOE B)

STRESS ECHO FOR MITRAL REGURGITATION

- BOTH STRUCTURAL AND FUNCTIONAL MR
- MR OFTEN **DYNAMIC** AND **LOAD-DEPENDENT**
 - TREADMILL/BICYCLE MAY "UNMASK"; DOBUTAMINE EFFECTS UNPREDICTABLE
- MR MAY BE **ISCHEMIC**
 - TREADMILL, BICYCLE, DOBUTAMINE VIABLE ALTERNATIVES
- PISA AND VC, TR/PASP – AT REST AND PEAK
 - OFFLINE ANALYSIS
 - MR FIRST – ISCHEMIA SECOND (TREADMILL)

SIGNIFICANT:

- Incr. MR ≥ 1 grade
- Incr. in ERO ≥ 13 mm²
- Ex PASP ≥ 60 mmHg

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STRESS ECHO FOR AORTIC REGURGITATION

- SYMPTOMS = POOR PROGNOSIS
 - NOT HELPFUL FOR DEFINING AR SEVERITY
- SEVERE AR – ASYMPTOMATIC
 - EXERCISE STRESS – ELICIT SX IN "SEDENTARY ASYMPTOMATIC"
 - ASSESS LV CONTRACTILE RESERVE (<5% \uparrow LVEF POOR)
- NON-SEVERE AR – SYMPTOMATIC
 - EXERCISE STRESS – RULE OUT OTHER ETIOLOGIES
 - ASSESS LV CONTRACTILE RESERVE

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STRESS ECHO FOR MITRAL STENOSIS

- FUNCTIONAL HEMODYNAMICS VS ANATOMY
- SEVERE MS – ASYMPTOMATIC
 - ELICIT SYMPTOMS WHEN $MVA < 1 \text{ cm}^2$
 - ASSESS HEMODYNAMICS WHEN $1.5 \text{ cm}^2 > MVA > 1 \text{ cm}^2$
- NON-SEVERE MS – SYMPTOMATIC
 - ASSESS HEMO'S WHEN $MVA > 1-1.5 \text{ cm}^2$
 - CHANGE IN MV GRADIENT, PASP

SIGNIFICANT:

- \uparrow MG > 15 mmHg (Ex)
- \uparrow MG > 18 mmHg (Dob)
- Ex PASP ≥ 60 mmHg

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STRESS ECHO FOR AORTIC STENOSIS

- ONSET OF SX = CLASS 1 INDICATION FOR AVR
- SE CAN UNMASK THE “TRULY ASYMPTOMATIC”
 - SYMPTOMS **OR** ABN BP RESPONSE
 - ASSESS LV CONTRACTILE RESERVE
 - LOW SENSITIVITY
- SE FOR LOW FLOW / LOW GRADIENT AORTIC STENOSIS
 - COVERED PREVIOUSLY

SIGNIFICANT:

- Symptoms
- \uparrow MG $> 18-20$ mmHg
- Ex PASP ≥ 60 mmHg

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STRESS(FUL) SUMMARY

- KNOW WALLS & CORONARY DISTRIBUTION
- BICYCLE VS. TREADMILL VS. DOBUTAMINE
- CONTRAINDICATIONS TO SE
- STOPPING CRITERIA FOR SE
- WHEN TO USE CONTRAST
- DIASTOLIC STRESS TESTING
- VALVULAR APPLICATIONS



THANK YOU!