WINNIPEG CARDIAC SCIENCES PROGRAM | PROGRAMME DES SCIENCES CARDIAQUES

Stress Testing And Nuclear Imaging Reports Translated

Cardiology Day

September 29, 2017

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Conflict of Interest Disclosure

Stress Testing And Nuclear Imaging Reports Translated

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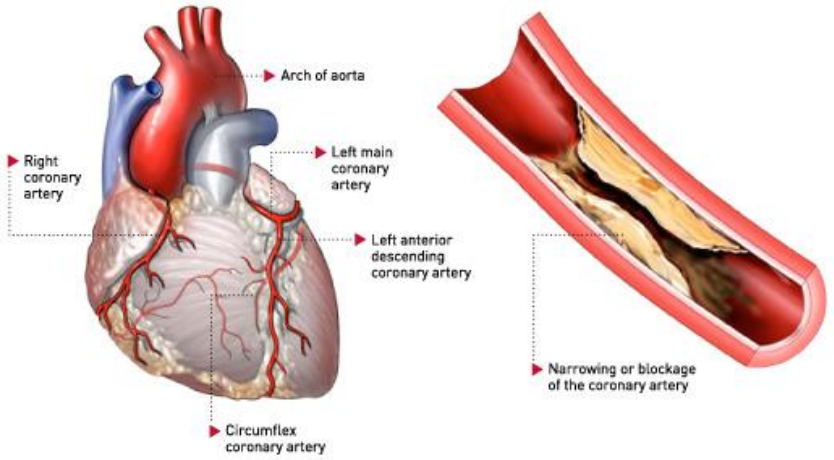
- **Consultant for: None.**
- **Speaker for: None.**
- **Received grant/research support from: None.**
- **Received honoraria from: None.**

Objectives

- Review how to read and interpret reports of the following non-invasive diagnostic studies:
  - Graded exercise tolerance test (GXT or ETT)
  - Myocardial perfusion imaging study (MPI or “MIBI”)
  - Multigated acquisition scan (MUGA)



GXT diagnostic accuracy in suspected CAD

85% MAPHR
MAPHR = 220- Age

- **GXT sensitivity ~67%**
- **GXT specificity ~70%**

- The predictive value of the GXT increases with the more positive the exercise test result

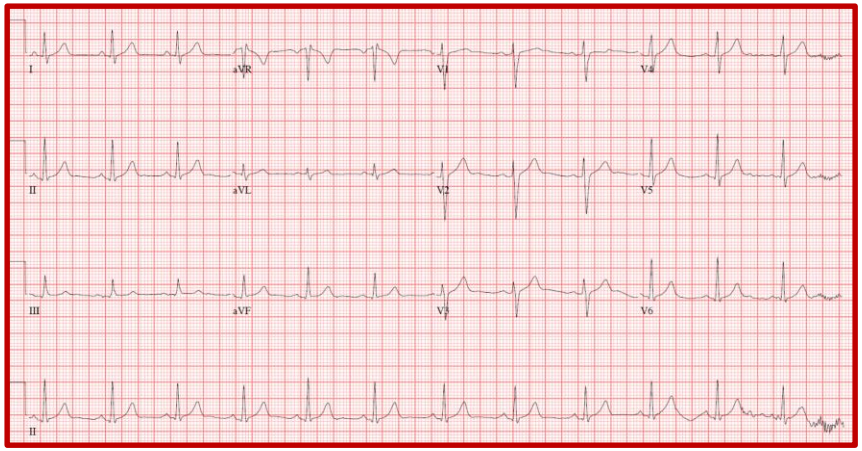
Mark DB, et al. *Ann Intern Med*. Jun 1987;106(6):793-800

GXT additional prognostic value

- Variables measured during GXT that predict outcome (indicators of general fitness and function of the autonomic nervous system):
  - Exercise duration
  - Functional class
  - BP response to exercise
  - HR response to exercise
  - HR recovery after exercise
  - Ventricular ectopy & arrhythmias

"You have a rare condition called 'good health'. Frankly, I'm not sure how to treat it."

- 55-year old-man with right sided CP with exertion and relieved by rest
- ECG showed normal sinus rhythm, normal ECG
- You ordered a GXT
- You receive the GXT report….



The GXT Report

Clinical Data

Myocardial Infarction ☐ Angina ☐ Atypical Angina ☐ Non-anginal Chest Pain ☐ Other _____

Medications: Nitrates ☐ ß Blocker ☐ Ca++ Blocker ☐ Digoxin ☐ Diuretic ☐ ACE Inhibitor ☐ Other _____

Type of Test: Graded Exercise Test ☐ Thallium ☐ MIBI ☐ Exercise MUGA ☐ Tilt Table ☐ Stress Echo ☐

Protocol: Bruce ☐ Modified Bruce ☐ Naughton ☐ Upright Bicycle ☐ Persantine ☐ Dobutamine ☐

Target Heart Rate = _____ (_____ % of Age Predicted Maximum)

Time - Load	Mets	Heart Rate	Blood Pressure	ST. Shift Amount/slope*	Symptoms and Arrhythmia
Rest Supine					

DP: _____

*ST slope: H = Horizontal; D = Downsloping; SU = Slow Upslope; RU = Rapid Upslope; E = Elevation

Reason for Termination:
Chest Pain ☐ Fatigue ☐ Leg Discomfort ☐ Dyspnea ☐ Dizziness ☐ ST Changes ☐ Arrhythmia ☐ Hypotension ☐ Other ☐

Test Report

Chest Pain: Angina ☐ Atypical Angina ☐ Nonanginal Chest Pain ☐ None ☐

Heart Rate Response: Normal ☐ Low ☐

Blood Pressure Response: Normal ☐ Low ☐ High ☐ Borderline ☐

ST Shift: (at 80 msec) None ☐ Borderline ☐ (< -1 mm) Mild ☐ (-1 to -2 mm) Moderate ☐ (-2 to -3 mm) Severe ☐ (> -3 mm)

slope: Rapid Upslope ☐ Slow Upslope ☐ Horizontal ☐ Downsloping ☐ Elevation ☐

Nondiagnostic GXT ☐

Target Heart Rate not attained without angina or ST changes ☐ Conduction Disturbance ☐ Resting ST changes ☐ Drugs ☐

Interpretation:

Probability of Ischemia: Low ☐ Moderate ☐ High ☐ Indeterminate ☐

Exercise Tolerance: Low ☐ Moderate ☐ High ☐

Cardiac Risk: Low ☐ Moderate ☐ High ☐ Indeterminate ☐

OTHER COMMENTS: _____

_____ Cardiologist _____ Technologist

FORM # NS00055

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GXT Report and Interpretation

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FORM # NS00055

Clinical Data c̄ PCI → LAD (May 2016)

Myocardial Infarction ☑ Angina ☑ Atypical Angina ☐ Non-anginal Chest Pain ☐ Other EF ↓ 30%

Medications: Nitrates ☐ ß Blocker ☑ Metoprolol Hold Ca++ Blocker ☐ Digoxin ☐ Diuretic ☑ Lasix ACE Inhibitor ☑ Ramipril Other ASA

Type of Test: Graded Exercise Test ☐ Thallium ☐ MIBI ☑ Exercise MUGA ☐ Tilt Table ☐ Stress Echo ☐

Protocol: Bruce ☑ Modified Bruce ☐ Naughton ☐ Upright Bicycle ☐ Persantine ☐ Dobutamine ☐

Target Heart Rate = 161 54 (85 % of Age Predicted Maximum)

Time - Load	Mets	Heart Rate	Blood Pressure	ST. Shift Amount/slope*	Symptoms and Arrhythmia
Rest Supine		62	120/76		LVH
Standing		75	140/90		
1'41" @ I	4.0	104	158/70		PVC's
					c/o SOB ØCP
		(62% mHR)			couplets
					Test proceeding to Persantine protocol.
Post.					
1.		53	102/78	Knees Up	
2.		68	154/90		
3.		67			
4		67	140/80		

DP: 16432

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Chest Pain ☐ Fatigue ☐ Leg Discomfort ☐ Dyspnea ☑ Dizziness ☐ ST Changes ☐ Arrhythmia ☐ Hypotension ☐ Other ☐

Test Report

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OTHER COMMENTS: PVCs + couplets, + 1 3 pt. See Persantine MPI.

Cardiologist

Technologist

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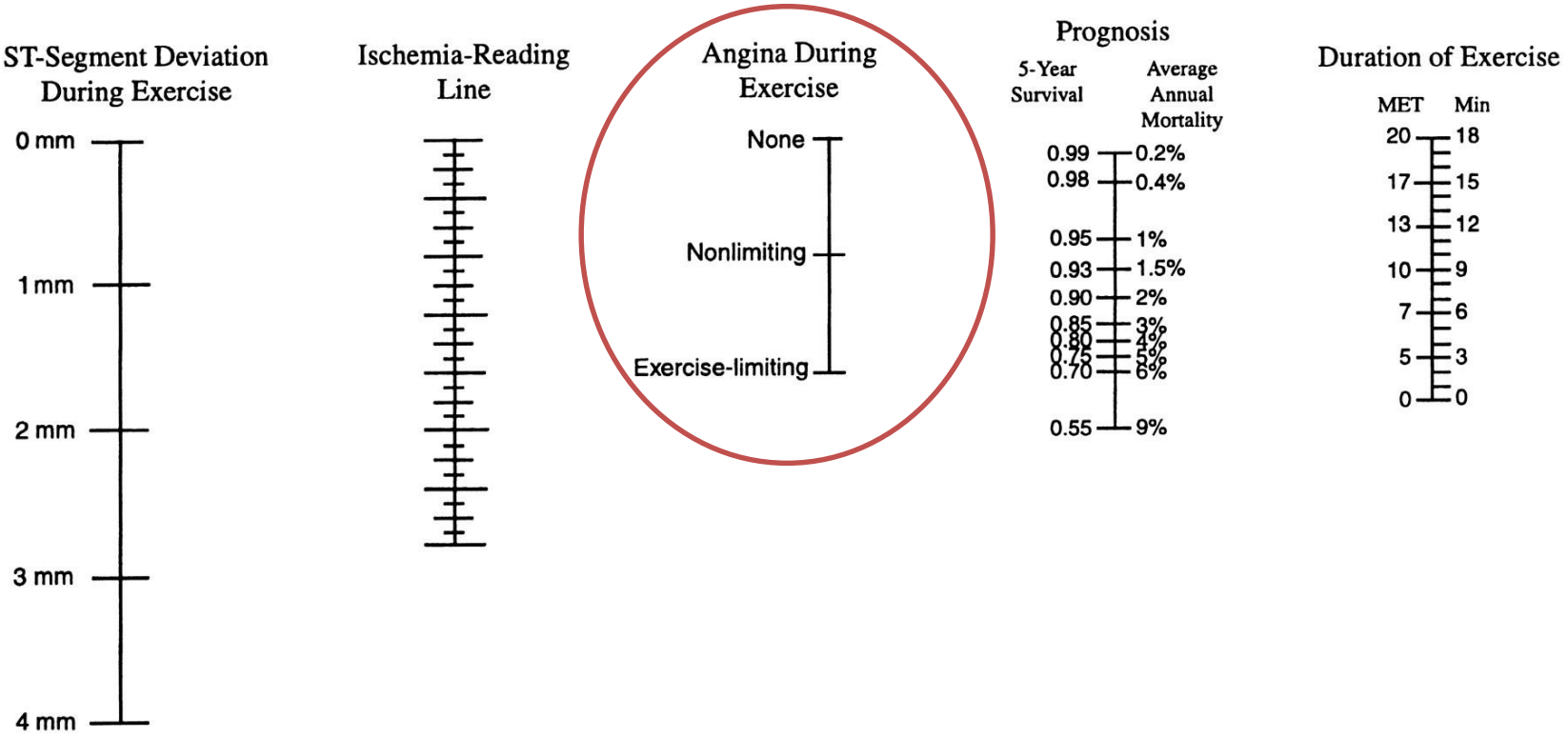
Nomogram of the prognostic relations embodied in the treadmill score



Circulation 1997;96:345-354

American Heart Association.

Duke Treadmill Score (DTS)

DTS= Exercise time (min) – 5 x max ST deviation – 4 x degree of CP

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  - Low 0.5-0.6% 1-yr mortality
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GXT Report and Interpretation

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Nondiagnostic GXT ☐

Target Heart Rate not attained without angina or ST changes ☐ Conduction Disturbance ☐ Resting ST changes ☐ Drugs ☐

Chronotropic insufficiency

GXT Report and Interpretation

Test Report

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Exercise hypotension

- Reflects a failure of cardiac output to increase during exercise
  - Severe coronary artery disease (left main coronary artery or three-vessel involvement)
  - Left ventricular systolic dysfunction
  - Combination of both
  - LV outflow tract obstruction (HOCM, AS, etc.)

- Associated with a threefold higher risk of cardiac events over 2 years[1]

- Consider obtaining an echocardiogram and/or IM or CV referral

1. hemic response during treadmill testing *Circulation.* 1988;78:1380-1387

MILLER T D Cleveland Clinic Journal of Medicine 2008;75:424-430

Exercise hypertension

- Exercise HTN is as a rise in systolic blood pressure during exercise above a threshold, usually between 190 - 220 mm Hg

- Possibly predicts future arterial HTN in people with normal resting blood pressure
  - BP monitoring
  - ? Role for 24-hour BP monitoring

MILLER T D Cleveland Clinic Journal of Medicine 2008;75:424-430

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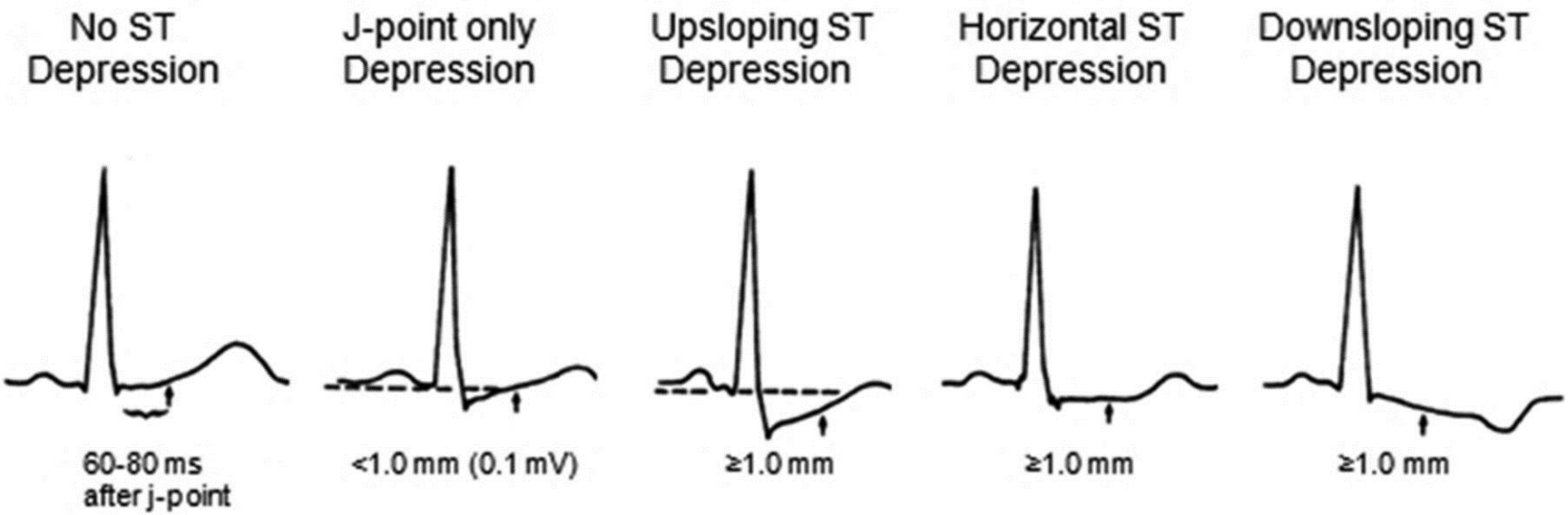
ST SEGMENT DEPRESSION DURING EXERCISE



Not reaching 85% of MAPHR without significant ST changes

Fletcher G F et al. *Circulation*. 2013;128:873-934

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HSC is an operating division of the Winnipeg Regional Health Authority

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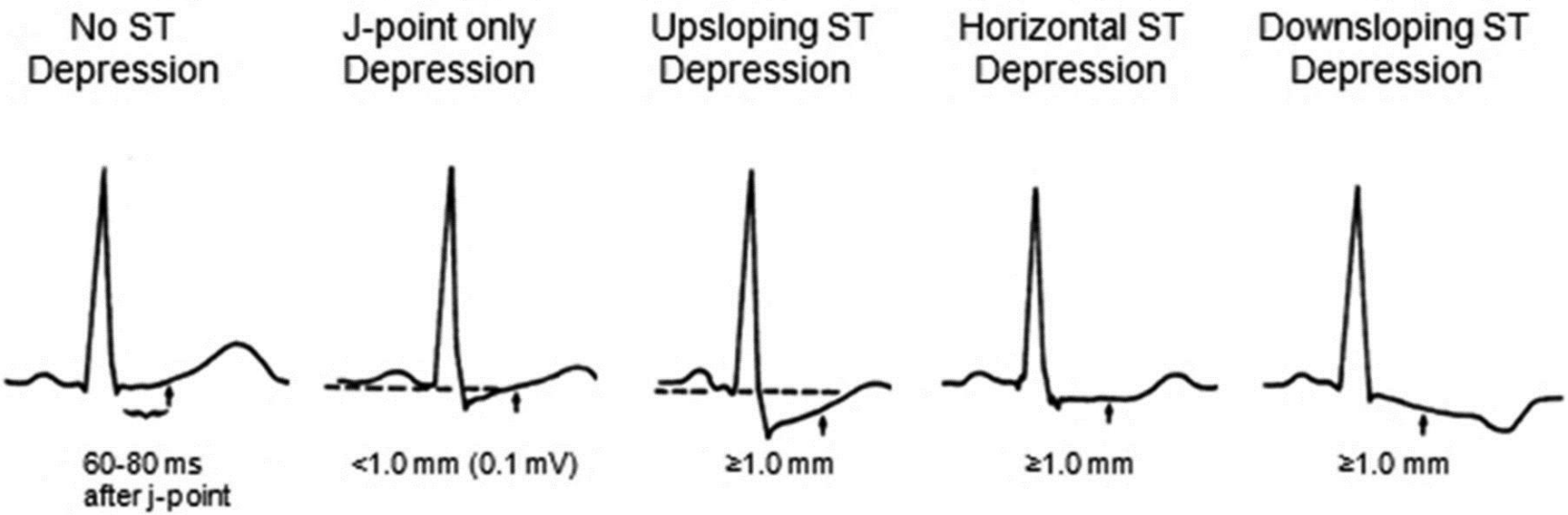

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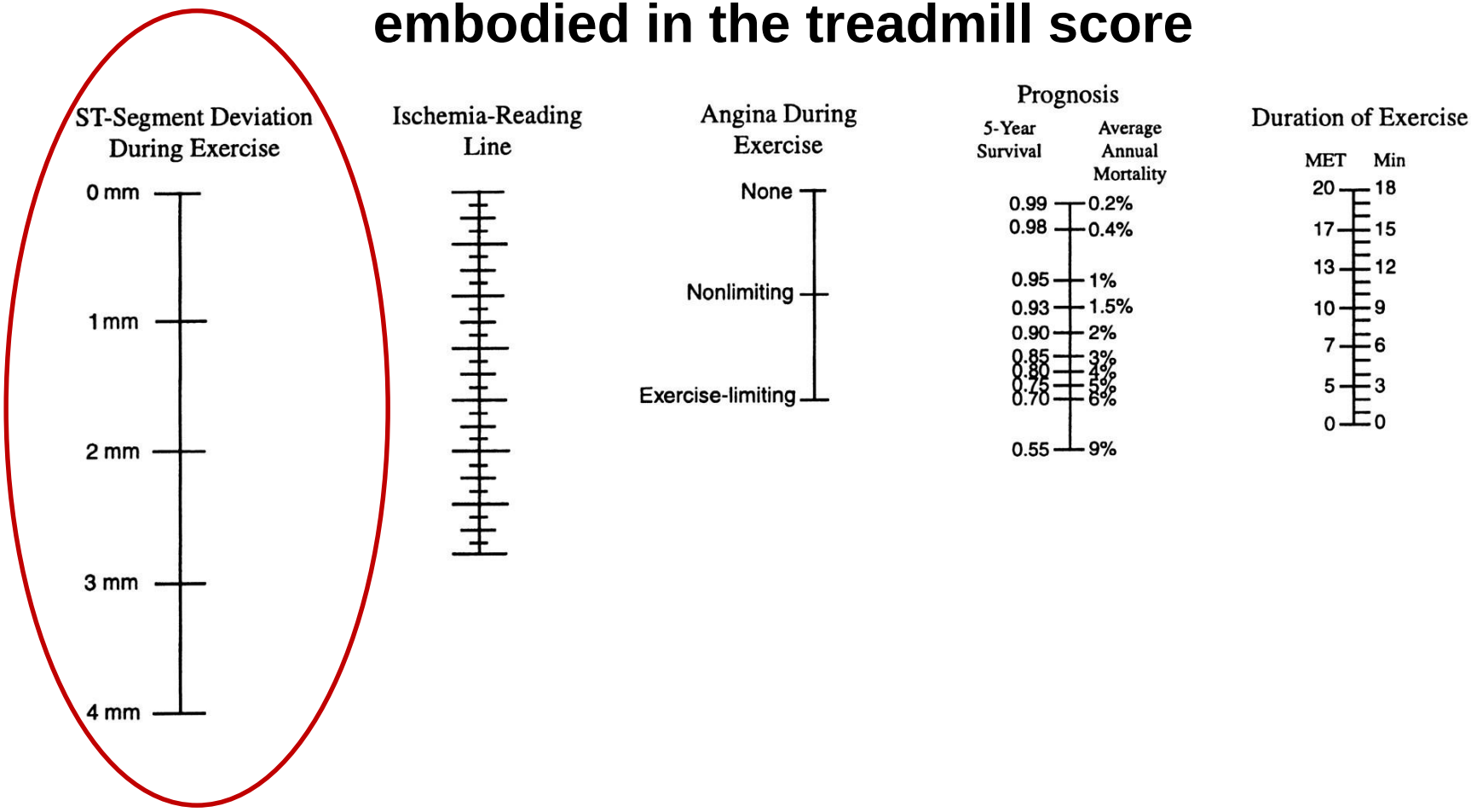
Nomogram of the prognostic relations embodied in the treadmill score



Circulation 1997;96:345-354

American Heart Association.

Duke Treadmill Score (DTS)

DTS= Exercise time (min) – 5 x max ST deviation – 4 x degree of CP

- **DTS validated tool** to risk stratify pts after a GXT:
  - Low 0.5-0.6% 1-yr mortality
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Exercise duration and functional class

$$1\ \mathrm{MET} \equiv 1\frac{\mathrm{kcal}}{\mathrm{kg} * h} \equiv 4.184\frac{\mathrm{kJ}}{\mathrm{kg} * h}$$

FUNCTIONAL CLASS	CLINICAL STATUS	O_2 COST ml/kg/min	METS	BICYCLE ERGOMETER	TREADMILL PROTOCOLS				METS
				1 WATT = 6.1 Kpm/min	BRUCE MODIFIED 3 min Stages	MPH	BRUCE 3 min Stages	MPH	NAUGHTON
				FOR 70 KG BODY WEIGHT Kpm/min	%GR	%GR	%GR	%GR	
					6.0	22	6.0	22	
					5.5	20	5.5	20	
					5.0	18	5.0	18	
NORMAL AND I	HEALTHY, DEPENDENT ON AGE, ACTIVITY	56.0	16						16
		52.5	15						15
		49.0	14						14
		45.5	13	1500	4.2	16	4.2	16	13
		42.0	12	1350					12
		38.5	11	1200					11
	SEDENTARY HEALTHY	35.0	10		3.4	14	3.4	14	10
		31.5	9	1050					9
		28.0	8	900					8
		24.5	7	750					7
II	LIMITED	21.0	6		2.5	12	2.5	12	6
		17.5	5	600					5
III	SYMPTOMATIC	14.0	4	450					4
		10.5	3	300	1.7	10	1.7	10	3
		7.0	2	150	1.7	5			2
IV		3.5	1		1.7	0			1

NAUGHTON 2 min Stages	MPH	%GR
	2	17.5
	2	14.0
	2	10.5
	2	7.0
	2	3.5
	2	0
	1	0

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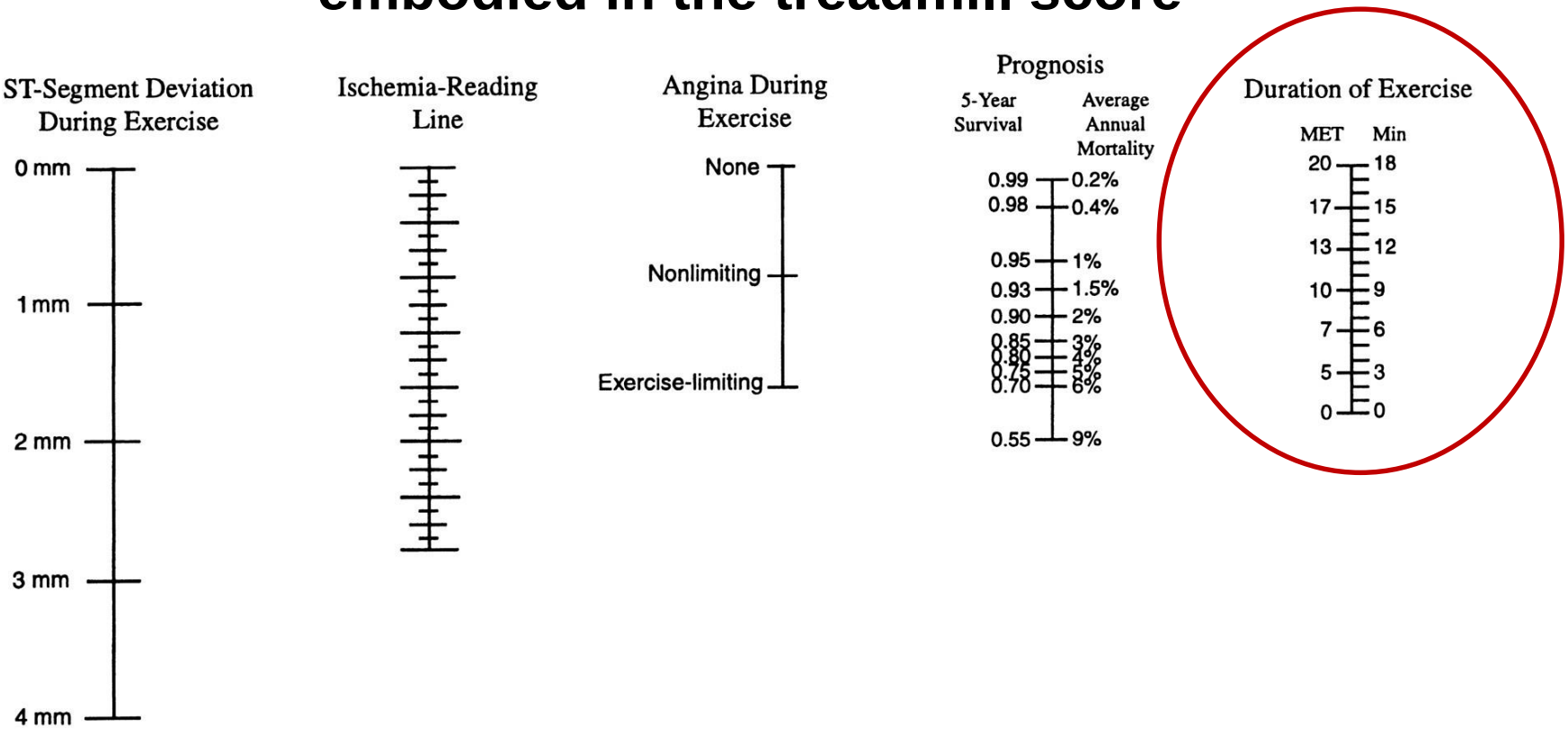

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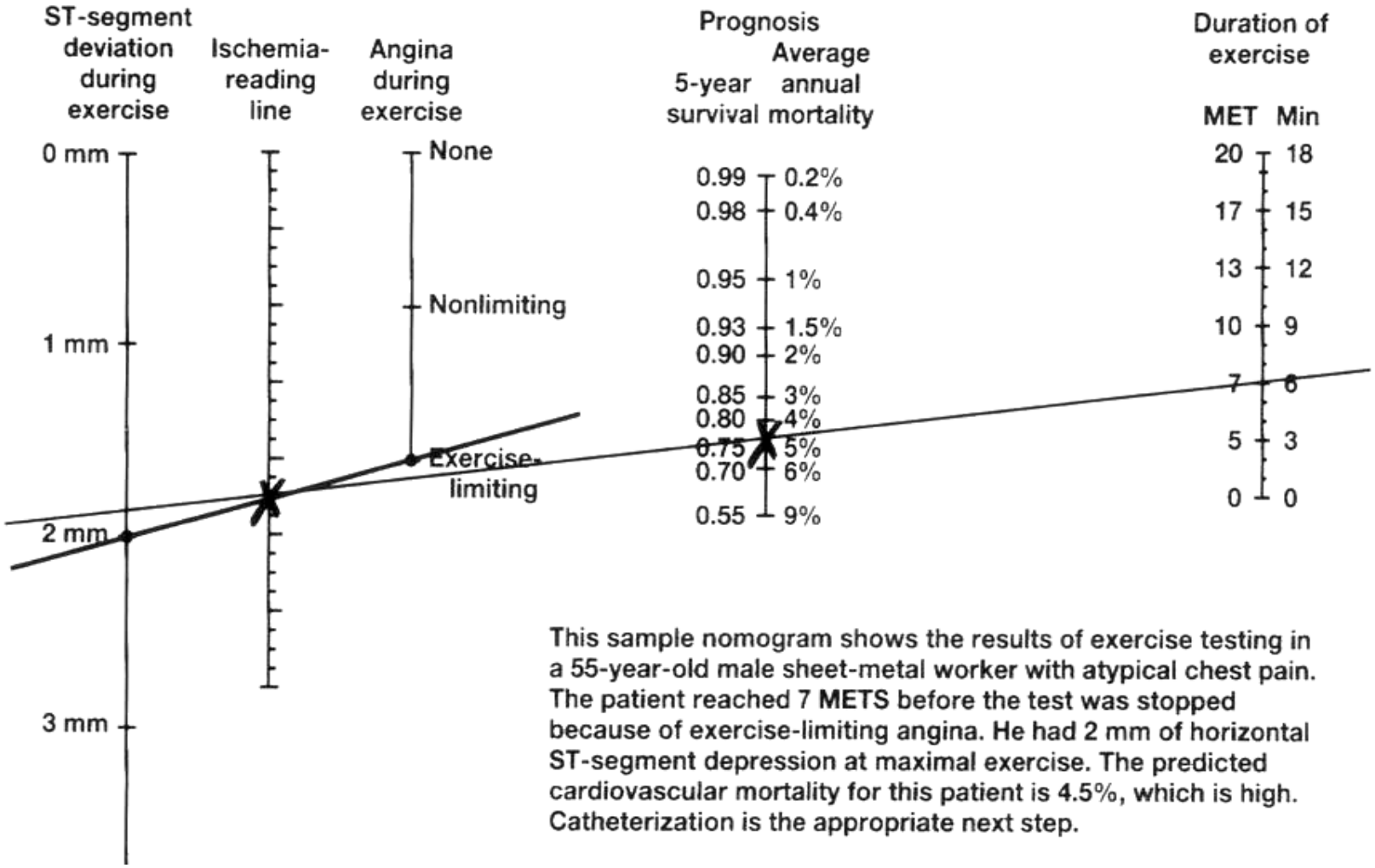

This sample nomogram shows the results of exercise testing in a 55-year-old male sheet-metal worker with atypical chest pain. The patient reached 7 METS before the test was stopped because of exercise-limiting angina. He had 2 mm of horizontal ST-segment depression at maximal exercise. The predicted cardiovascular mortality for this patient is 4.5%, which is high. Catheterization is the appropriate next step.

Circulation 1997;96:345-354

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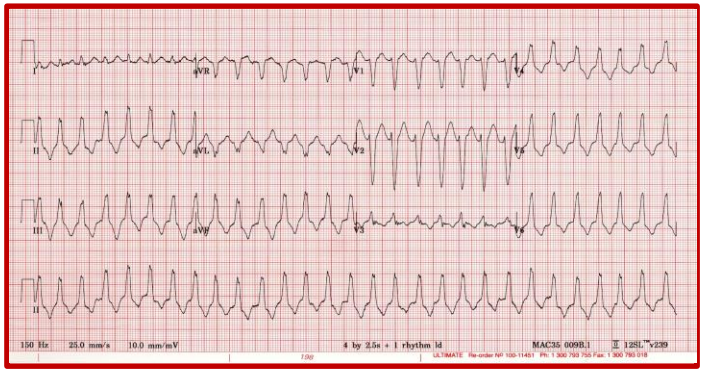
FORM # NS00055

1. Comment on: Ectopy & arrhythmias (mostly ventricular)

Exercise-induced Ventricular ectopy

- Ventricular arrhythmias can occur during exercise testing:
  - Sustained VT or Vfib due to CAD or LV dysfunction
  - Rare but life-threatening
  - Should prompt referral to CV (Echo, angiogram, etc.)
  - RVOT tachycardia in young adults without structural heart disease → usually benign
  - Arrhythmias related to cardiomyopathy can also occur in healthy young adults → poor prognosis
  - Less common than single PVCs, couplets, or short runs of NSVT



EXERCISE LABORATORY REPORT TEST: MULTISTAGE TREADMILL ☐ BICYCLE ☐ TARGET HEART RATE (130) BRM 85 % OF AGE ADJUSTED MAXIMUM OF 154 BPM] MAXIMUM HEART RATE

	ELAPSED TIME (MIN)	LOAD	METS	HEART RATE	BLOOD PRESSURE (mm.Hg)	SYMPTOMS	E.K.G. PREMATURE BEATS
EXERCISE	(0) CONTROL	SUPINE		72		MOD BRUCE	
		SITTING		75	176/99		
	Ø 1	2.7-0		82	–		
	2	↓		88	–		
	3	↓	2.2.	86	178/104		
	1/2 4	2.7-5		90	–		
	5	↓		92	–		
	6	↓	3.4	93	178/104		
	I 7	2.7-10		93	–		
	8	↓		98	–	slight SOB / leg fatigue.	
	9	↓	4.6	100	202/100		
	II 10	4.0-12		103	–		PVC.
	11	↓		107	–		
	12	↓	7.0	109	191/102		
	~~III 12 slowdown~~	5.4-14	7.3	114	–	fatigue @ peak / NO CP.	
POST EXERCISE	Recovery						
	1			95	–		
	2			82	190/95		
	3			84	178/93		
	4			81	–		
	5			80	169/94	pt. feeling fine.	

TEST END-POINT
- TARGET HEART RATE ☐
- CHEST PAIN ☐
- FATIGUE ☒
- DYSPNOEA ☐
- DIZZINESS ☐
- CLAUDICATION ☐
- E.K.G.CHANGE ☐
- OTHER (SPECIFY) ☐

FINAL INTERPRETATION
- POSITIVE ☐
- NEGATIVE ☒
- BORDERLINE ☐
- NON-DIAGNOSTIC ☐

PHYSICIAN'S COMMENT

① No exercise-induced angina. ② Hypertensive and blunted response to exercise. ③ PVCs. No significant arrythmias with exercise. ④ Negative for ischemia. ⑤ Functional class I (7.3 METS).

April 10, 2017

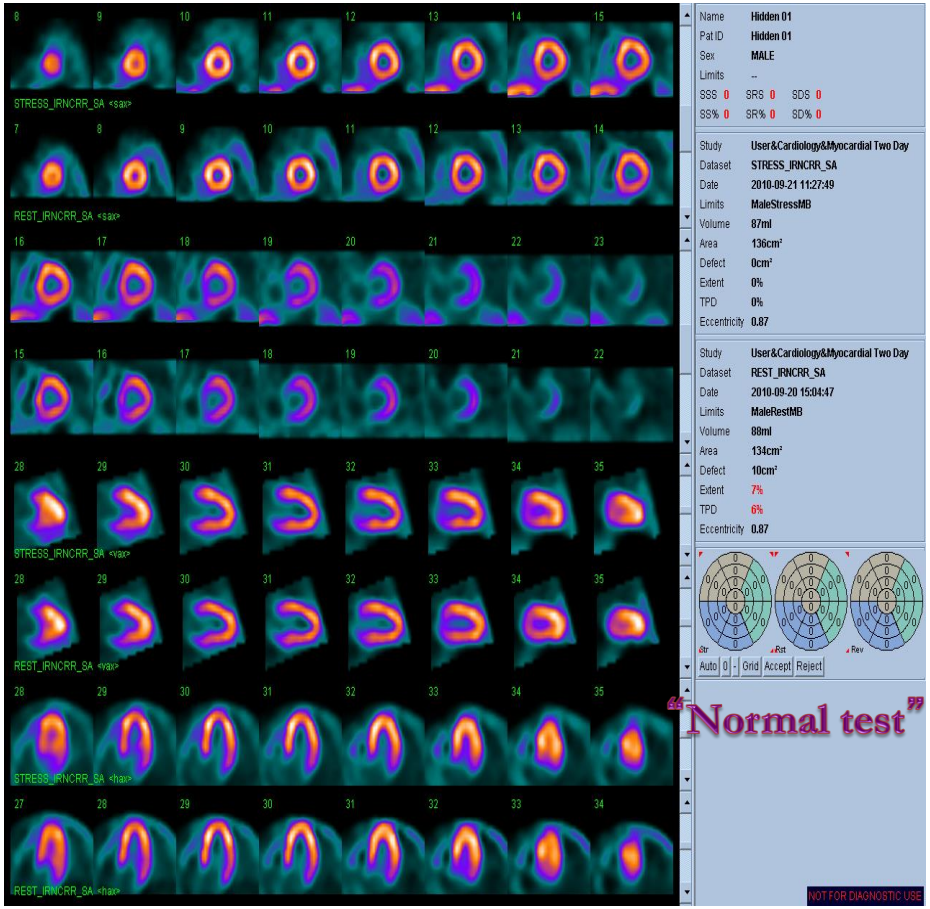
SIGNATURE CARDIOLOGIST

TIME OF TEST 12:19 DAY APR MONTH 6 YEAR 2017

Myocardial Perfusion Imaging Study (MPI)

- Stress-
  - –GXT **85% MPHR**
  - –Pharmacologic Vasodilator Stress
    - Dypiridamole
    - Adenosine
    - Regadenoson
  - –Pharmacologic Adrenergic Stress
    - Dobutamine **85% MPHR**

    Reactive airway disease
- MPI-
  - –Radiopharmaceutical
    - Thallium- Ta^{121}
    - Technetium sestamibi- Tc^{99}
    - Technetium tetrofosmin- Tc^{99}
  - –Identify infarction or ischemia
  - –Gated SPECT- LV volume & LV EF



The MPI or "MIBI" Report

Exam Date: 01 Feb 2017

MYOCARDIAL PERFUSION IMAGING STUDY

Clinical History: Chest pain and inconclusive GXT.

Radiopharmaceuticals:

99m Tc Tetrafosmin 640 MBq intravenously administered on February 1, 2017.
99m Tc Tetrafosmin 630 MBq intravenously administered on February 2, 2017.

Gated tomographic images were obtained following the completion of an exercise stress test and at rest. Patient exercised for a total of 6 minutes according to the standard Bruce protocol and reached a workload of seven METs. Peak heart rate was 162 bpm, which is 91 % of age predicted maximum; BP increased to 176/94 mmHg. Patient did not experience any chest pain and there were borderline ST segment shifts..

The myocardial perfusion images are of good quality. The left ventricle is small in size. There are no significant reversible perfusion abnormalities. There is mild, fixed reduction tracer activity involving the mid anterior wall. This area is worse at rest and there is normal contractility of the corresponding wall segments in keeping with attenuation artifact.

The gated images show no significant segmental wall motion abnormalities. Left ventricular ejection fraction is 67%.

Impression:

1. Normal perfusion study.
2. Normal left ventricular size and global and segmental systolic function.
3. Low probability of significant inducible ischemia.
4. Low cardiac risk based on perfusion criteria.

Dictated by:

Electronically signed by:

Transcribed by: SpeechRec
dd: 03 Feb 2017 1346
dt: 03 Feb 2017 1346

The MPI or "MIBI" Report

Exam Date: 01 Feb 2017

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dd: 03 Feb 2017 1346
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Exam Date: 21 Sep 2016

History: 54-year-old man with aborted STEMI to NSTEMI and PCI to LAD May 2016. LVEF 55% by left ventriculogram. Now angina and decreased EF to 30% of bedside echo with akinesis anterior, apical and anteroseptal walls
Radiopharmaceutical: Tc-99m MIBI 660 MBq IV September 21, 2016
Tc-99m MIBI 618 MBq IV September 22, 2016

MYOCARDIAL PERFUSION STUDY:

Tomographic images have been obtained after the injection of sestamibi following dipyridamole infusion and again at rest. Gating was performed on both phases of the study. Technical quality of the study is reasonable with some infradiaphragmatic activity on the rest images.

The patient experienced left chest pressure with dipyridamole, spreading to the neck. This was relieved with aminophylline 100 mg IV. There are no ST-segment changes but frequent premature ventricular contractions with couplets. The patient initially attempted exercise but was only able to exercise for 1 minute 41 seconds at Bruce stage I, and his heart rate only increased to 62% of predicted maximum with frequent premature ventricular contractions and couplets. Exercise was discontinued and a dipyridamole study was performed.

There is normal uptake of sestamibi throughout the myocardium on both phases of the examination.

The left ventricle is moderately dilated. There is moderate global hypokinesis with akinesis of the distal anterior and apical segments. The left ventricular ejection fraction is 29%.

IMPRESSION:
1. Normal myocardial perfusion. Low probability of inducible ischemia.
2. Dilated left ventricle with moderate to severe left ventricular systolic dysfunction.
3. Cardiac risk is increased because of the left ventricular dysfunction.

Interpreted with

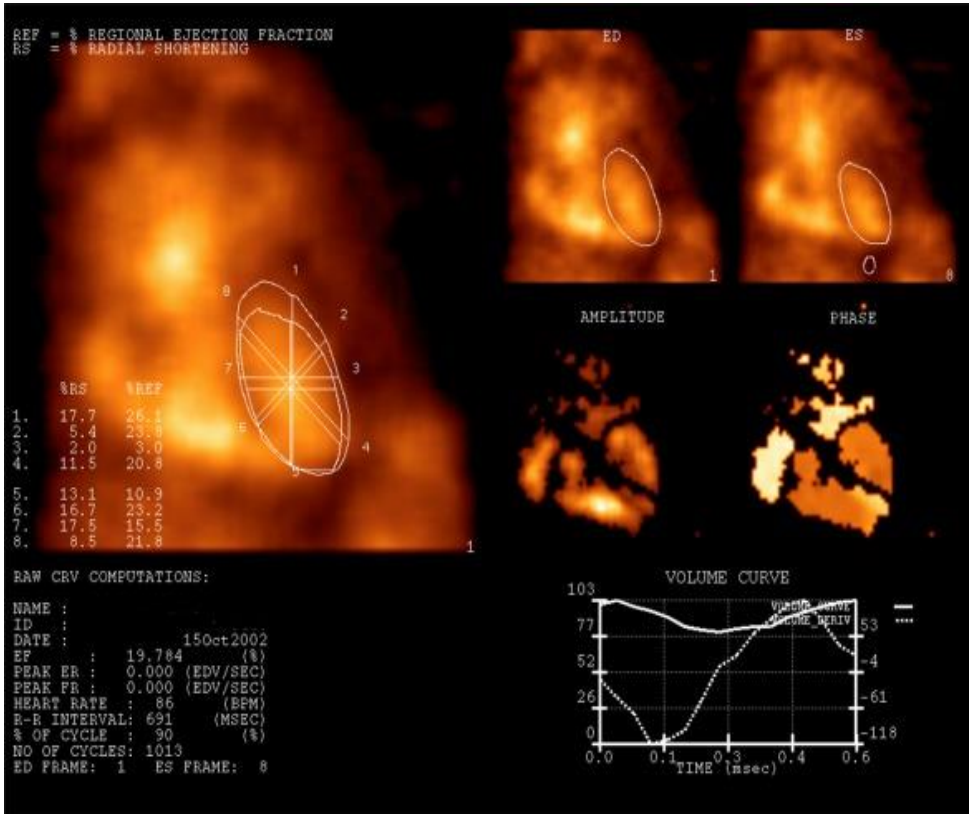
Dictated by:

Electronically signed by:

Transcribed by: SpeechRec
dd: 23 Sep 2016 1137

MUGA Scan

- Nuclear study
- Accurate measure of LVEF
- Normal LVEF by MUGA between 50 to 70%



The MUGA Report

Exam Date: 21 Nov 2016

Clinical History:54 years old male ICM, LVEF of 39% after PC I to LAD FOR STEMI, assess LVEF for ICD consideration

MUGA STUDY:

Technical: A resting three view resting examination was obtained with the patient in sinus rhythm.

Relevant examination: Comparison was made to the myocardial perfusion exam done September 2016 at HSC .

Findings: The left ventricle is moderately dilated. There is a mild hypokinesis to the distal anterior and anteroseptal segments. The LVEF is 42% , previously 29% on myocardial perfusion exam done September 2016.

The right ventricle contractility is within normal.

IMPRESSION:

Mild to moderately reduced left ventricle systolic function

Dictated by:

Electronically signed by

Transcribed by: SpeechRec
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dd: 21 Nov 2016 1352
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Summary

GXT

- Screen for CAD
  - Clinical (CP)
  - ST-segment interpretation
- Additional Prognostic Value
  - BP response
  - HR response
  - Arrhythmias
  - Workload/functional capacity

MPI or “MIBI”

- Screen for CAD
- Ischemia vs. scar
- Risk stratification
- LVEF (low or normal)
- Some of the same additional info as GXT

MUGA

- Accurate LVEF
  - Cardiotoxic ChemoRx
  - Decision on medical Rx (<40%)
  - Decision on device Rx (EPS, ICD, CRT)

Thank you

Questions for our panel members?