

XXXX Nuclear Cardiology Laboratory

Exercise Stress Test Procedure

Rationale: Prior to stress myocardial perfusion imaging, an exercise treadmill test is usually performed with the patient continuously monitored. Patients who are unable to exercise for non-cardiac reasons (e.g. severe pulmonary disease, arthritis, amputation, or neurological disease, etc.) may be stressed pharmacologically. In patients who are capable of performing an adequate exercise stress, exercise is generally preferred.

Indications: See Also Myocardial Perfusion Protocol

1. Detecting the presence and location of coronary artery disease.
2. Myocardial risk stratification.
3. Management of patients with chronic coronary artery disease with low risk who can be managed medically or those who should be considered for re-vascularization procedure.
4. Pre-operative evaluation
5. Evaluating the physiologic significance of known or suspected coronary artery stenosis for re-vascularization procedures or medical management.
6. Determining the prognosis after myocardial infarction.
7. Left ventricular function evaluation and wall motion.
8. Myocardial viability determination.
9. Evaluation of the efficacy of therapeutic interventions in patients with known coronary artery disease.
10. Monitoring the effects of revascularization and medical therapy.

Contraindications and Precautions:

1. Unstable angina with recent (<48 hrs) angina.
2. Acute myocardial infarction
3. Uncontrolled systemic hypertension (systolic > 200 mm Hg or diastolic > 100 mm Hg) or pulmonary hypertension
4. Untreated arrhythmias causing symptoms or hemodynamic compromise
5. Untreated congestive heart failure
6. Recent pulmonary embolism
7. History of aortic dissection
8. Acute myocardial infarction
9. Known left main coronary stenosis
10. Electrolyte abnormalities
11. Tachyarrhythmias or bradyarrhythmias
12. 2nd or 3rd degree AV block
13. Severe pulmonary hypertension
14. Acute myocarditis
15. Acute pericarditis
16. Moderate mitral or aortic stenosis
17. Moderate obstructive cardiomyopathy including IHSS
18. Acute systemic illness
19. Mental or physical impairment leading to inability to exercise adequately

Exercise Stress Test Procedure

Limitations:

Exercise stress testing has a limited value in patients who cannot achieve an adequate heart rate and blood pressure response due to a non-cardiac physical limitation such as pulmonary, peripheral vascular, musculoskeletal abnormalities or due to a lack of motivation. These patients should undergo pharmacological stress perfusion imaging.

Patient Preparation:

1. NPO for 3 hours including food, tobacco, alcohol, caffeine and smoking.
2. Comfortable clothes.
3. Removal of metal and objects that might attenuate in the field of view.
4. Recommendation that calcium channel blocking drugs and beta-blocking drugs that may alter the heart rate and blood pressure response to exercise be withheld for 24-48 hours.

Beta Blockers

<u>Generic Name</u>	<u>Trade Name</u>
Atenolol	Tenormin
Betaxolol	Kerlone
Bisoprolol	Zebeta
Carvedilol	Coreg
Esmolol	Brevibloc
Labetalol	Normodyne
Metoprolol	Lopressor
Nadolol	Corgard
Pindolol	Visken
Propranolol	Inderal
Sotalol	Betapace
Timolol	Blocadren

Calcium Channel Blockers

<u>Generic Name</u>	<u>Trade Name</u>
Amiodipine	Norvasc
Diltiazem	Cardizem, Dilacor, Tiazac
Bepridil	Bepadin, Vascor
Felodipine	Plendil
Isradipine	DynaCirc
Nicardipine	Cardene
Nifedipine	Adalat, Procardia
Nimodipine	Nimotop
Nisoldipine	Sular
Verapamil	Calan, Covera, Isoptin, Verelan

Exercise Stress Test Procedure

Clearance Data:

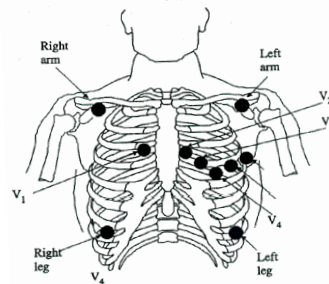
- Patients should be evaluated prior to the study for their ability to undergo physical stress safely. Patients should be capable of a workload of at least 5 METs. Patients who are unable to exercise may be stressed pharmacologically.
- Cardiovascular History including: indication for the examination, medications, symptoms, cardiac risk factors, and prior diagnostic or therapeutic procedures should be reviewed by the stress physician
- 12-lead ECG for evidence of acute ischemia, arrhythmia or conduction disturbances (i.e. Left Bundle Branch Block)
- Cardio-respiratory auscultation for wheezing, rales, murmur etc.
- Vital signs: Heart Rate, Blood Pressure, Pulse Oximetry (as needed)
- Life support instruments and emergency drugs must be immediately available. In addition, an ACLS trained individual must be available to supervise procedure.

Procedure:

1. An IV should have been started for injection of the rest radiopharmaceutical. If not, obtain an IV using the right antecubital, connect 12" IV tubing with a "T" connector, tape IV securely, flush with 1.0 ml heparin flush.
2. ECG preparation:
 - a. The electrode sites should be rubbed with "Nu Prep" and alcohol until the skin is erythematous to remove skin oils and a superficial layer of skin.
 - b. If hair is present the sites should be shaved.
 - c. Electrodes are attached to the skin as per the figure below. It is best, if possible to avoid placing the electrode over large muscles masses.
 - d. Obtain a 12 lead ECG to insure there is no baseline artifact. If baseline artifact is present, repeat skin prep described above and repeat the 12 lead ECG.
3. Obtain baseline blood pressure recording and baseline ECG. Press "Rest ECG" on the console.
4. If patient history demonstrates COPD or moderate to severe dyspnea obtain baseline pulse oximetry measurement.
5. Determine suitable treadmill protocol for patient: Bruce, modified Bruce, Naughton or pharmacologic (see below)
6. Provide patient with demonstration and explanation of treadmill procedure.
7. Start Quahog 2000 treadmill and have patient begin walking as naturally as possible taking long steps and keeping to the front of the treadmill.
8. Press "Start Exercise" on the console
9. The ECG and the presence of symptoms should be monitored continuously during the test.
10. An ECG and heart rate should be taken every minute and a blood pressure should be obtained at the second minute of every stage.
11. Exercise termination should be symptom limited with patients achieving at least 85% or greater of their age predicted maximum heart rate ($220 - \text{age}$).
12. The radiopharmaceutical should be injected close to the peak of exercise. The patient should be encouraged to continue to exercise for an additional 1-2 minutes after the injection of the radiopharmaceutical.
13. Press "Stop Exercise"
14. At the end of the stress the patient should cool down for 1 minute by walking at a slow pace on the treadmill with no elevation.

Exercise Stress Test Procedure

15. The patient should be monitored for 5 minutes after completion of the test. An ECG should be obtained every minute and the blood pressure and symptoms should be obtained every other minute.
16. Continue to monitor if patient continues to have symptoms or ECG changes.
17. Finalize the report to print exercise table and trend reports.
18. If necessary obtain post-imaging ECG to verify return to baseline.



Electrode position for V leads:
V₁: 4th ICS, right sternal border
V₂: 4th ICS, left sternal border
V₃: halfway between V₂ and V₄
V₄: 5th ICS, left midclavicular line
V₅: 5th ICS, anterior axillary line
V₆: 5th ICS, midaxillary line

ICS indicates intercostal space.

Exercise Endpoints:

- Patient requests to stop
- Drop in systolic blood pressure of >20 mm Hg from baseline blood pressure despite an increase in workload, when accompanied by other evidence of ischemia
- Moderate to severe angina
- Marked dyspnea or fatigue
- Increasing nervous system symptoms (e.g., ataxia, dizziness, or near-syncope)
- Signs of poor perfusion (cyanosis or pallor)
- Technical difficulties in monitoring ECG or systolic blood pressure
- Sustained ventricular tachycardia or supraventricular tachycardia
- ST elevation (>1.0 mm) in leads without diagnostic Q-waves (other than V₁ or AVR)
- ST or QRS changes such as excessive ST depression (>3 mm of horizontal or downsloping ST-segment depression) or marked axis shift
- Arrhythmias other than sustained ventricular tachycardia, including multi-focal PVCs, triplets of PVCs, supraventricular tachycardia, heart block, or bradyarrhythmias in the presence of clinical signs and symptoms.
- Fatigue, shortness of breath, wheezing, leg cramps, or claudication
- Development of bundle-branch block or IVCD that cannot be distinguished from ventricular tachycardia
- Increasing chest pain
- Hypertensive response (Systolic blood pressure of >220 mm Hg and/or a diastolic blood pressure of >110) mm Hg.
- 85% Maximum Predicted Heart Rate (MPHR)

Exercise Stress Test Procedure

Protocols:

Bruce:

Stage	Time (min)	Speed (mph)	Elevation (%)	METS
1	3	1.7	10	4
2	3	2.5	12	7
3	3	3.4	14	10
4	3	4.2	16	13
5	3	5.0	18	17
6	3	5.5	20	20
7	3	6.0	22	23

Modified Bruce:

Stage	Time (mins)	Speed (mph)	Elevation (%)	METS
1	3	1.7	0	1.7
2	3	1.7	5	2.8
3	3	1.7	10	5
4	3	2.5	12	7
5	3	3.4	14	9-10
6	3	4.2	16	13-14
7	3	5.0	18	16.7
8	3	5.5	20	19-20
9	3	6.0	22	23

Naughton:

Stage	Time (mins)	Speed (mph)	Elevation (%)	METS
1	2	1.0	0	1.6
2	2	2.0	0	2.0
3	2	2.0	3.5	3.0
4	2	2.0	7.0	4.0
5	2	2.0	10.5	5.0
6	2	2.0	14	6.0
7	2	2.0	17.5	7.0

Treatment of Adverse Reactions:

Any major adverse and symptomatic reactions including severe chest pain, bradycardia, tachycardia, hypotension, hypertension or in the rare instance cardiac arrest should be treated according to the Advanced Cardiac Life Support Algorithms. (See attached)

Minor adverse events:

Mild chest pain – stop exercise, have patient sit down, oxygen 2-4 liters/min, sublingual nitroglycer, consider aspirin 160-325 mg

Shortness of breath – stop exercise, have patient sit down, consider oxygen 2-4 liters/min

Hypotension/Dizziness – stop exercise, have patient lay down, elevate feet

Hypertension – stop exercise, have patient lay down

Exercise Stress Test Procedure

Forms: See Attachments A-C

References:

ACR Practice Guideline for the Performance of Cardiac Scintigraphy. In ACR Practice Guideline; 439-447.

American College of Sports Medicine, comp. Resource Manual for Guidelines for Exercise Testing and Prescription. Philadelphia: Lea & Febiger, 1988.

Guidelines for Exercise Testing and Prescription. Philadelphia: Lea & Febiger, 1986.

Ritchie JL, Bateman TM, Bonow RO, et al. Guidelines for the clinical use of cardiac radionuclide imaging. J Am Coll Cardiol 1995; 25:521-547.

Strauss HW, Miller DD, Wittry MD, et al. Society of Nuclear Medicine Procedure Guideline for Myocardial Perfusion Imaging. In: Society of Nuclear Medicine Procedure Guidelines Manual 1997. Reston, VA: Society of Nuclear Medicine; 1997:1-8.

Written: _____	Date: _____
Revised: _____	Date: _____
Reviewed: _____	Date: _____
_____	Date: _____

Attachment A

CONSENT FOR EXERCISE MYOCARDIAL PERFUSION SCAN

I, _____ authorize Dr. _____ and his assistants to administer and conduct an exercise stress test. This test is designed to determine the presence or absence of clinically significant heart disease; to evaluate the effectiveness of my current therapy; and/or to measure my fitness for work or sport.

I understand that I will walk on a treadmill at a specific speed and grade and at three-minute intervals the speed and elevation will increase. While walking on the treadmill, my electrocardiogram and blood pressure will be monitored. Exercise will be progressively increased until I attain a predetermined end point corresponding to moderate exercise stress, or become distressed in any way or develop any abnormal response the physician considers significant, whichever of the above occurs first. Just before the test is terminated an injection of radioisotope (Tc99M Myoview) is given through an intravenous site and I am required to walk an additional minute on the treadmill to allow significant circulation and accumulation of the isotope in my heart.

Every effort will be made to conduct the test in such a way as to minimize discomfort and risk. However, I understand that just as with other types of diagnostic tests there are potential risks (approximately 2 to 3 per 10,000) associated with an exercise test. These include episodes of lightheadedness, fainting, chest discomfort, leg cramps and very rarely heart attacks or sudden death. There is no risk or side effects associate with the radioisotope injection. I further understand that the laboratory is properly equipped for such situations and that its professional personnel are trained to administer any emergency care necessary. I voluntarily accept the risks associated with the above procedures.

Signature of Patient

Signature of Witness

Date

Attachment B

Pre-Stress Test Cardiac History

Patient Name: _____ Date: _____
Age: _____ Gender: _____ Height: _____ Weight: _____
Referring MD: _____

Reason your doctor ordered the test: _____

What medications do you take? _____

Do you ever get chest pain or discomfort? Yes or No If yes, please describe: _____

Where is the discomfort located?
How long does it last?
What were you doing when you got the discomfort?
Does anything make the discomfort better (i.e. rest, burping, deep breaths etc.)?
Do you get nausea or shortness of breath when you get the discomfort?

Have you ever had a heart attack? Yes or No If yes, when? _____

Have you ever had heart surgery? Yes or No If yes, when? _____

Have you had an angioplasty or balloon? Yes or No If yes, when? _____

Do you get cramps in your legs when you walk? Yes or No If yes, describe? _____

Do you have high blood pressure? Yes or No If yes, how long? _____

Are you a diabetic? Yes or No If yes, how long? _____

Do you have high cholesterol? Yes or No If yes, how long? _____

Do you smoke? Yes or No If yes, how long? _____

Does anyone in your family have heart disease? Yes or No If yes, who? _____

If you are a female, do you take hormone replacement? Yes or No _____

Do you ever get heart palpitations? Yes or No If yes, describe _____

Do you ever get dizzy, light headed or pass out? Yes or No If yes, describe _____

Do you get shortness of breath? Yes or No If yes, describe _____

Attachment C

EXERCISE TREADMILL REPORT

Patient: _____ Date: _____

Age: _____ Max HR: _____ 85% _____ Pred Ex Time: _____

The patient exercised for _____ min and _____ sec of a [Bruce/Modified/Individualized] protocol achieving _____ METS. The peak heart rate achieved was _____ bpm which is _____ % of the age predicted maximum. The test was terminated due to [fatigue/dyspnea/leg fatigue/_____]. The pt [denied/complained of] chest discomfort which developed at [_____ min of/ peak] [exercise/recovery] and persisted through _____ mins of [recovery/exercise]. This discomfort was relieved by [rest/NTG]. The blood pressure response was [appropriate/ inappropriate] with peak exercise blood pressure of _____ mm Hg. There were [no/significant] exercise-induced arrhythmias which consisted of _____

The baseline ECG was [normal/ abnormal] and showed _____. There were [no] significant ST segment changes consisting of _____ mm maximal [upsloping/ downsloping/ horizontal] [depressions/elevations] in leads _____ which developed at [_____ minutes of peak][exercise/recovery] and resolved by/gradually returned (to/ towards) baseline/ persisted] [through/by] _____ minutes of [recovery/exercise]. 30 mCi of Tc99m [cardiolite/ myoview] was injected at peak exercise.

Impression:

1. [Symptom limited/ Maximal/ Submaximal] exercise treadmill test which is electrocardiographically [negative/positive/non-diagnostic/indeterminate/suggestive of, but not diagnostic] for myocardial ischemia [due to resting ECG abnormalities/ baseline artifact/ submaximal heart rate]. However, [the patient's (good/excellent) exercise tolerance/ lack of associated chest pain / rapid resolution of ECG changes in recovery] reduce the positive predictive value of this test result.
2. [No] exercise induced chest discomfort [as described above].
3. [Appropriate / inappropriate hypertensive / hypotensive] blood pressure response.
4. [No] significant exercise induced arrhythmias [as described above].
5. [Excellent / Good / Fair / Poor] exercise tolerance.