UW Health
University of Wisconsin Hospital and Clinics

Division of Nuclear Medicine Procedure / Protocol

MYOCARDIAL STRESS TEST PROCEDURES **CPT CODE: N/A**
UPDATED: MARCH 2012

This protocol is an outline for only the stress portion of a myocardial stress test. The goal of the stress portion of the test is to dilate the coronary arteries either by exercising the patient or by the use of a pharmacologic agent.

PATIENT PREP PRIOR TO THE EXAM: See the myocardial stress test patient prep protocol.

EXAM PREP: The following will be completed once the patient enters the nuclear medicine department for the stress test.

1. A signed consent form will be obtained for the test. See the **STRESS TESTING CONSENT** form.
2. Male patients will have certain areas of chest hair shaved off for the placement of 10 EKG patches.
3. The patient will have 10 EKG patches placed on various areas of the chest by the exercise physiologist or the EKG technician. 10 leads will then be attached.
4. The patient will be asked to lie down on the bed. A baseline EKG will be obtained by the exercise physiologist or the EKG technician. A baseline blood pressure will also be obtained either by the exercise physiologist or the physician present.
5. The patient is now ready for the stress portion of the test.

MYOCARDIAL STRESS TEST INDICATIONS

Indications for Exercise Stress:

1. Detection of obstructive coronary artery disease (CAD) either with high risk factors or intermediate pretest probability of CAD based on age, gender and symptoms.
2. Risk stratification of post-myocardial infarction in patients not revascularized.
3. Risk stratification of patients with chronic stable CAD for medical management or patients for consideration of revascularization.
4. Risk stratification of low-risk acute coronary syndrome patients within 6-12 hours and intermediate risk acute coronary syndrome at 1-3 days.
5. Risk stratification before non-cardiac surgery in patients with known CAD or those with high-risk factors for CAD.
6. To evaluate the efficacy of therapeutic interventions and tracking subsequent risk based on serial changes in myocardial perfusion in patients with known CAD.
7. Abnormal or non-diagnostic standard ETT alone.
8. Resting ECG characteristics that would result in a non-diagnostic ETT (i.e. LBBB, paced rhythm, WPW).

Absolute Contraindications for Exercise Stress:

1. High-risk unstable angina.
2. Decompensated or inadequately controlled congestive heart failure.
3. Uncontrolled hypertension (>200/110 mm Hg).
4. Uncontrolled cardiac arrhythmias (causing hemodynamic compromise or symptoms).
5. Severe symptomatic aortic stenosis.
6. Acute pulmonary embolism.
7. Acute myocarditis or pericarditis.
8. Acute aortic dissection or large aortic aneurysm.
9. Severe pulmonary hypertension.
10. Acute myocardial infarction (<4 days).
11. Acutely ill for any reason.

Relative Contraindications for Exercise Stress:

1. Known left main coronary artery stenosis.
2. Moderate aortic stenosis.
3. Hypertrophic obstructive cardiomyopathy or other forms of outflow tract obstruction.
4. Significant tachyarrhythmias or bradyarrhythmias.
5. High-degree atrioventricular (AV) block.
6. Mental or physical impairment leading to inability to exercise adequately.
7. Patients with left bundle branch block (LBBB), permanent pacemakers, and ventricular pre-excitation (Wolff-Parkinson-White syndrome).

Indications for Early Termination of Exercise Stress:

1. Moderate to severe angina pectoris.
2. Marked dyspnea or fatigue.
3. Ataxia, dizziness or near syncope.
4. Signs of poor perfusion (cyanosis and pallor).
5. Patient's request to terminate the test.
6. Excessive ST segment depression (>2 mm).
7. ST Elevation (>1mm) in leads without diagnostic Q waves (except for leads V1 or aVR).
8. Sustained supraventricular or ventricular tachycardia.
9. Development of LBBB or intraventricular conduction delay that can not be distinguished from ventricular tachycardia.
10. Drop in systolic blood pressure of >10 mm Hg from baseline, despite an increase in workload, when accompanied by other evidence of ischemia.
11. Hypertensive response (systolic blood pressure >250 mm Hg and /or diastolic pressure >115 mm Hg).
12. Technical difficulties in monitoring the electrocardiogram or systolic blood pressure.

Indications for Regadenoson Stress:

1. Patients who are unable to undergo adequate exercise stress.
2. Patients with LBBB, permanent pacemakers, and ventricular pre-excitation (Wolff-Parkinson-White syndrome).

Contraindications for Regadenoson Stress:

1. Patients with 2nd or 3rd degree heart block or sinus node dysfunction unless these patients have a functioning artificial pacemaker.
2. Patients with severe bronchospasm.
3. Patients with systolic blood pressure <90mm Hg.
4. Recent use of Dipyridamole, Dipyridamole containing medications in the last 48 hrs, Aminophylline in the last 24 hrs or food and/or beverages with caffeine in the last 12 hrs.
5. Known hypersensitivity to Regadenoson.

Relative Contraindication for Regadenoson Stress:

1. Profound sinus bradycardia (<40 bpm).
2. Patients with a history of seizure disorders and/or antiepileptic medications. See the attached document for antiepileptic medications.

Indications for Reversal of Regadenoson Stress:

1. Severe hypotension (systolic blood pressure <80 mm Hg).
2. Development of symptomatic, persistent second degree or complete heart block.
3. Wheezing. See the last page of this policy for the procedure in the event the patient goes into respiratory distress.
4. Severe chest pain associated with ST depression of 2 mm or greater.
5. Signs of poor perfusion (pallor, cyanosis and cold skin).
6. Technical problems with the monitoring equipment.
7. Patient's request to stop.

Indications for Adenosine Stress:

1. Patients with left bundle branch block (LBBB), permanent pacemakers, and ventricular pre-excitation (Wolff-Parkinson-White syndrome), and permanent ventricular pacing.
2. Risk stratification of clinically stable patients into low and high-risk groups very early after acute myocardial infarction (greater or equal to one day).

Indications for Early Termination of Adenosine Stress:

1. Severe hypotension (systolic blood pressure <80 mm Hg).
2. Development of symptomatic, persistent second degree or complete heart block.
3. Wheezing.
4. Severe chest pain associated with ST depression of 2 mm or greater.
5. Signs of poor perfusion (pallor, cyanosis and cold skin).
6. Technical problems with the monitoring equipment.
7. Patient's request to stop.

Contraindications for Adenosine and Dipyridamole Stress:

1. Patients with 2nd or 3rd degree heart block or sinus node dysfunction unless these patients have a functioning artificial pacemaker.
2. Patients with severe bronchospasm.
3. Patients with systolic blood pressure <90mm Hg.
4. Recent use of Dipyridamole, Dipyridamole containing medications in the last 48 hrs, Aminophylline in the last 24 hrs or food and/or beverages with caffeine in the last 12 hrs.
5. Known hypersensitivity to Adenosine or Dipyridamole respectively.
6. Unstable acute myocardial infarction or acute coronary syndrome.

Relative Contraindication for Adenosine and Dipyridamole Stress:

1. Profound sinus bradycardia.

Indications for Dobutamine Stress:

1. Recommended only in patients who cannot undergo exercise stress and who also have contraindications to pharmacologic vasodilator stressors.

Contraindications to Dobutamine Stress:

1. Patients with idiopathic hypertrophic subaortic stenosis.
2. Patients with know hypersensitivity to Dobutamine.
3. Recent myocardial infarctions (<1 week).
4. Unstable angina.
5. Hemodynamically significant left ventricular outflow tract obstruction.
6. Severe aortic stenosis.
7. Atrial tachyarrhythmias with uncontrolled ventricular response.
8. Prior history of ventricular tachycardia.
9. Uncontrolled hypertension (>200/110 mm Hg).
10. Patients with aortic dissection or large aortic aneurysm.
11. Patients who are on beta-blockers where the cardiac response will be stunned.

STRESS TEST PROCEDURES

EXERCISE TREADMILL OR AIRDYNE STRESS TEST

1. The patient will take their place on the treadmill or the Airdyne bicycle. An IV drip of 0.9% Normal Saline in water will be attached. This is to ensure that the radiopharmaceutical can be rapidly injected when indicated.
2. The exercise physiologist or the physician present will obtain an upright blood pressure. An upright EKG will be obtained by the exercise physiologist or the EKG technician.
3. The stress test will begin. Blood pressures will be obtained at various times during the stress test. Optimally, the patient will be exercised to maximum tolerance.

Absolute indication to stop exercise:

Drop in SBP > 10mm H from baseline with other signs of ischemia.
Moderate to severe angina
Severe dizziness, ataxia
Sign of poor perfusion, i.e. pallor or cyanosis
Loss of ability to monitor the patient
Patient desire to stop
Sustained VT
ST elevation > 1mm leads **without** Q waves excludes aVR and V1
The patient has achieved maximum exercise

Relative indication to stop exercise:

Drop in SBP > 10mm Hg without other ischemic signs
ST-T wave changes > 2mm ST depression or axis shift
Other arrhythmias multifocal PVC's, triplets, SVT, heart block or bradycardia
Severe patient fatigue
Development of wide complex tachycardia that can't be differentiated from VT
Increasing chest pain
Hypertensive response > 250/114 mmHg

4. The nuclear medicine technologists will inject the radiopharmaceutical when indicated by either the exercise physiologist or the physician present, optimally 90 seconds before the termination of the stress portion of the test.
5. Once the stress test is complete, the IV drip will be disconnected. The IV will either be capped and left in or discontinued as requested by the exercise physiologist or the physician present. The patient will be monitored for the appropriate amount of time depending on which radiopharmaceutical was injected.
6. The patient will be asked to wait in the cardiac waiting room (if injected with Technetium 99m) or imaged immediately (if injected with Thallium 201).

REGADENOSON STRESS TEST

1. The stress portion of this test may be performed with an IV drip of 0.9% Normal Saline in water. If so, the IV drip is connected to the IV site on the patient. If not, proceed to step two.
2. One syringe of Regadenoson is obtained either from the cabinet in the lab or from the radiopharmacy.
3. The exercise physiologist or the physician in charge may ask for a pre-drawn syringe of 100mg Aminophylline to be on hand. This is located in the fridge in the radiopharmacy.
4. When all parties are ready, the Regadenoson is infused over 10 seconds.
5. Rapidly flush the IV with a 0.9% sodium chloride 10mL pre-drawn syringe or with the existing IV drip.
6. At 30 seconds from the start of the Regadenoson, inject the radiopharmaceutical.
7. Rapidly flush the IV with a 0.9% sodium chloride 10mL pre-drawn syringe or with the existing IV drip.
8. Blood pressures will be obtained by the exercise physiologist or the physician present.
9. If the Aminophylline is needed, it is to be administered by the exercise physiologist or the physician in charge of the stress test.
10. It is ***NOT*** recommended to use Aminophylline on seizing patients.
11. Upon completion of this protocol, the patients IV is capped and left in until after images are complete.
12. The patient will be asked to wait in the cardiac waiting room (if injected with Technetium 99m) or imaged immediately (if injected with Thallium 201).

WALKING REGADENOSON STRESS TEST

1. An IV drip of 0.9% Normal Saline is hung; the IV tubing is primed and hooked up to the IV site on the patient.
2. One syringe of Regadenoson is obtained either from the cabinet in the lab or from the radiopharmacy.
3. The exercise physiologist or the physician in charge may ask for a pre-drawn syringe of 100mg Aminophylline to be on hand. This is located in the fridge in the radiopharmacy.
4. The patient is moved to the treadmill. The exercise physiologist or the physician present will obtain an

upright blood pressure. An upright EKG will be obtained by the exercise physiologist or the EKG technician.

5. The patient will walk for 2 minutes at a slow pace as determined by the exercise physiologist or the physician in charge of the exam.
6. The Regadenoson is infused over 10 seconds while the patient is walking.
7. Rapidly flush the IV with a 0.9% sodium chloride 10mL pre-drawn syringe or with the existing IV drip.
8. At 30 seconds from the start of the Regadenoson, inject the radiopharmaceutical.
9. Rapidly flush the IV with a 0.9% sodium chloride 10mL pre-drawn syringe or with the existing IV drip. The patient will continue to walk for at least one minute after the radiotracer has been injected.
10. Blood pressures will be obtained by the exercise physiologist or the physician present.
11. The patient will now recover sitting on the bed, treadmill portion is now complete.
12. If the Aminophylline is needed, it is to be administered by the exercise physiologist or the physician in charge of the stress test.
13. It is ***NOT*** recommended to use Aminophylline on seizing patients.
14. Upon completion of this protocol, the patients IV is capped and left in until after images are complete.
15. The patient will be asked to wait in the cardiac waiting room (if injected with Technetium 99m) or imaged immediately (if injected with Thallium 201).

EXERCISE BAILOUT REGADENOSON STRESS TEST

1. The patient exercises as in the standard exercise stress test protocol.
2. If the target endpoints for the stress are not reached, the exercise physiologist or the physician in charge of the stress test will ask for the Regadenoson to be given while the patient is still walking on the treadmill.
3. The speed and elevation of the treadmill will be decreased.
4. When all parties are ready, the Regadenoson is slowly infused over 10 seconds.
5. Rapidly flush the IV with a 0.9% sodium chloride 10mL pre-drawn syringe or with the existing IV drip.
6. At 30 seconds from the start of the Regadenoson, inject the radiopharmaceutical.
7. Rapidly flush the IV with a 0.9% sodium chloride 10mL pre-drawn syringe or with the existing IV drip. The patient will continue to walk for at least one minute after the radiotracer has been injected.
8. Blood pressures will be obtained by the exercise physiologist or the physician present.
9. The patient will now recover by sitting on the bed, the treadmill portion is now complete.
10. If the Aminophylline is needed, it is to be administered by the exercise physiologist or the physician in charge of the stress test.
11. It is ***NOT*** recommended to use Aminophylline on seizing patients.
12. Upon completion of this protocol, the patients IV is capped and left in until after images are complete.
13. The patient will be asked to wait in the cardiac waiting room (if injected with Technetium 99m) or imaged immediately (if injected with Thallium 201).

DOBUTAMINE STRESS TEST

1. The Dobutamine is obtained from the radiopharmacy. The syringe contains 125mg of Dobutamine in 10ml, diluted to a total volume of 25mL with 0.9% Sodium Chloride.
2. An IV drip of 0.9% Normal Saline is hung; the IV tubing is primed and hooked up to the IV site on the patient.
3. Follow the Dobutamine pump protocol (either pump) to prepare for the infusion.
4. The exercise physiologist or the physician charge of the stress test will indicate when to begin infusion of the Dobutamine by the nuclear technologist.
5. Blood pressures will be obtained either by the exercise physiologist or the physician present at their indicated times.
6. Follow the Dobutamine pump protocol for changing the stages upon indication by the physician present. This is usually done every 3 minutes. This is continued until one of the following indications is achieved:

    A. The patient has achieved a minimum of 85% of the age predicted maximal heart rate.
    B. The infusion has reached a maximum dose rate of 40 mcg/kg/min.
    C. The blood pressure has reached a maximum of > 250 mm Hg.

D. A 2 mm or more depression of the ST segments in 2 EKG leads has occurred.
E. A serious arrhythmia (as deemed by the physician present) has developed.
F. Severe angina as indicated by the patient.

7. Upon reaching the 30 mcg/kg/min dose rate of Dobutamine, the physician present may determine the administration of Atropine is necessary. The dose and administration will be performed by the physician present. This may again be repeated at the 40 mcg/kg/min dose rate as determined by the physician present.
8. The Dobutamine infusion will be stopped when instructed by the physician present.
9. The radiopharmaceutical will be injected by the nuclear medicine technologist when indicated by the physician present.
10. The patient will be monitored, blood pressures taken for the appropriate amount of time as determined by the radiopharmaceutical used and the physician present.
11. The patient will be asked to wait in the cardiac waiting room (if injected with Technetium 99m) or imaged immediately (if injected with Thallium 201).

ADENOSINE STRESS TEST

1. The Adenosine is obtained from the radiopharmacy. The syringe contains 3mg/mL of Adenosine adjusted for weight using the following calculations.

   IV Dose = 0.56mg/kg x patient weight in kg = _____mg
   Volume = Dose in mg / 3mg/mL = _____mL
   Volume dispensed = dose in mL + 1.5mL (accounts for the extension tubing) = _____mL
   The rate of infusion is set at 0.14 mg/kg/min.

2. The Adenosine is prepared using the pump protocol (as determined by which pump being used).
3. An IV drip of 0.9% Normal Saline in water is hung; the IV tubing is primed and hooked to the IV site on the patient.
4. The Adenosine extension tubing is hooked up to the IV drip tubing.
5. The nuclear medicine technologist will begin infusion of the Adenosine over a 4 minute period when indicated by the exercise physiologist or the physician present.
6. Blood pressures are obtained either by the exercise physiologist or the physician present at certain intervals during the test.
7. The radiopharmaceutical will be administered 1 minute prior to the completion of the Adenosine infusion. This infusion may exceed 4 minutes if the patient exceeds 200 kg.
8. Stop the infusion of Adenosine at 4 minutes or upon completion of infusion. Disconnect the Adenosine from the IV drip.
9. The patient will be monitored for the appropriate amount of time as determined by the radiopharmaceutical injected and the exercise physiologist or the physician present.
10. The patient will be asked to wait in the cardiac waiting room (if injected with Technetium 99m) until the imaging technologist is ready to image the patient or escorted directly to the imaging room (if injected with Thallium 201).

DIPYRIDAMOLE (PERSANTINE) STRESS TEST

1. The Dipyridamole is obtained from the radiopharmacy pre-drawn. The total dose is calculated as follows:

   IV Dose = 0.57 mg/kg x weight (kg) = _____mg
   Volume = Dose / 5 mg/mL = _____mL
   Volume dispensed = Volume + 1.5mL (accounts for the extension tubing) = _____mL
   The infusion rate is set at 0.14 mg/kg/min.

2. If Aminophylline is requested to be on hand, a pre-drawn 100mg syringe can be obtained from the fridge in the radiopharmacy.
3. Prepare the Dipyridamole in the pump per the pump protocol (this depends on which pump is being used).

4. An IV drip of 0.9% Normal Saline in water is hung; the IV tubing is primed and then attached to the IV site on the patient.
5. The nuclear medicine technologist will begin the infusion of Dipyridamole as indicated by the exercise physiologist or the physician present.
6. Blood pressures will be obtained at various times throughout the test by the exercise physiologist or the physician present.
7. The nuclear medicine technologist will stop the pump at 4 minutes or when the infusion is complete (this will be longer for patients in excess of 200 kg). Disconnect the Dipyridamole tubing from the IV drip.
8. The radiopharmaceutical is injected 4 minutes after the completed Dipyridamole infusion.
9. The exercise physiologist or the physician present may administer the Aminophylline two minutes after the administration of the radiopharmaceutical if necessary.
10. The IV site is to be capped and left in place until after the stress images are complete.
11. The patient will be monitored for the appropriate amount of time as determined by the radiopharmaceutical injected and the exercise physiologist or the physician present.
12. The patient will be asked to wait in the cardiac waiting room (if injected with Technetium 99m) until the imaging technologist is ready to image the patient or escorted directly to the imaging room (if injected with Thallium 201).

DRUG INDUCED RESPIRATORY DISTRESS FORMER QA POLICY
UPDATED: JULY 2007

If a patient is having respiratory distress during an adenosine drug study, the following steps should be taken:

1. A "puffer" of **ALUPENT** is located in the orange drug box.

2. If this does NOT provide relief, then by order of physician the following action is undertaken:

   A. Place a stat call to Respiratory Therapy **beeper 7596** and state,

   "Please call 3-_____ stat, please call 3-_____ stat."

   Keep the phone clear for the return call.

   B. When RT responds, state **"We need a small volume nebulizer kit immediately in room E1/3___ Nuclear Medicine. We have the drug albuterol."**

   C. Get the albuterol from the radiopharmacy and have ready for use when RT arrives. Also have an oxygen line ready and available for RT.

3. If any stat pages are needed dial **2-0000 and order the page with chimes.**

Epilepsy medications: Generic medications with common brand names

Carbamazepine
- Atretol
- Carbagen SR
- Epitol
- Mazepine
- Tegretol
- Tegrital
- Teril
- Timonil

Carbemazepine-XR
- Carbatrol
- Tegretol XR

Clobazam
- Frisium
- Novo-Clobazam
- Onfi

Clonazepam
- Epitril
- Klonopin
- Rivotril

Diazepam
- Diastat
- Diazepam
- Valium

Divalproex Sodium
- Depacon
- Depakote
- Epival

Divalproex Sodium-ER
- Depakote ER

Eslicarbazepine Acetate
- Aptiom

Ethosuximide
- Zarontin

Ezogabine
- Potiga

Felbamate
- Felbatol

Gabapentin
- Neurontin

Lacosamide
- Vimpat

Lamotrigine
- Lamictal

Levetiracetam
- Keppra

Levetiracetam XR
- Keppra XR

Lorazepam
- Ativan

Oxcarbazepine
- Oxtellar
- Oxtellar XR
- Trileptal

Perampanel
- Fycompa

Phenobarbital
- Phenobarbital

Phenytoin
- Dilantin
- Epanutin
- Phenytek

Pregabalin
- Lyrica

Primidone
- Mysoline

Rufinamide
- Banzel
- Inovelon

Tiagabine Hydrochloride
- Gabitril

Topiramate
- Topamax

Topiramate XR
- Qudexy XR
- Trokendi XR

Valproic Acid
- Convulex
- Depakene
- Depakine
- Orfiril
- Valporal
- Valprosid

Vigabatrin
- Sabril

Zonisamide
- Zonegran

Reviewed By: S. Perlman, D. Fuerbringer, S. Knishka, M. Zasadil

Updated By: K. Kopacz

Scott B. Perlman, MD, MS
Chief, Nuclear Medicine

Derek Fuerbringer, CNMT
Manager, Nuclear Medicine

Scott Knishka, RPh, BCNP
Radiopharmacist

Mary L. Zasadil, MD
Director, Nuclear Cardiology