



RUBIDIUM-82 REST-STRESS MYOCARDIAL PET PERFUSION PROTOCOL

1) Patient preparation:

- No caffeinated products or medications for 12-24 hrs. (**ASNC – no caffeinated products for at least 12 hrs.**)
- No Theophylline containing medications for 3 days. (Theophylline is an antidote of Dipyridamole). (**ASNC – No Theophylline for 2 days**)
- No nitrates (i.e. Isordil (Isosorbide Dinitrate) or Nitrogl) for 12 hrs. You may use sub-lingual (SL) nitrates up to 1 hour before the test.
- Nitro patch (Nitrodur) off for 12hrs (minimum 2hrs UOHI).
- Continue cardiac medication unless otherwise directed by physician.
- 4 hr fast exception of water intake. (**ASNC – 6 hours fasting exception of water intake.**)
- No Viagra, Aggrenox or Persantine for 24 hr prior to test.
- Assess patients > 300 lbs for NH3 or when Rb generator activity is low. (Calculate the activity/kg to assess which tracer: activity > 7-12 MBq/kg use Rb, activity < 7 MBq/kg use NH3).
- Weight limit of camera 500 lbs.
- Patients < 200 lbs give carbonated water 10 – 15 minutes prior to scanning. Patients > 200 lbs give regular water. Also observe patient body weight distribution to determine whether to give water or carbonated water.
- Female patients of childbearing potential (up to 55 yrs). Proceed with urine pregnancy test.

2) Patient positioning:

- Arms-up (above head) out of the cardiac FOV produces the best image quality.
- Arms-down only in occasional patients who cannot tolerate arms-up position.
- Scout scan to confirm heart is centered in the FOV. Landmark at xyphoid process.
- Patient orientation: head first.
- Patient position: supine.
- kV 120, mA 10

3) Rest CT Attenuation Correction Scan (CTAC):

- Low-dose X-ray CT (<1mSv).
- Fast helical scan (0.4s) at normal mid-to-end expiration.
- Smart mA: Automatic Exposure Control – combines both z axis and angular tube current modulation to adjust the dose to the size and shape of individual patients – accounting for all three dimensions. Prior to scanning, the user selects the desired image quality, or noise index. Based on a single scout scan, the system adjusts the exposure during the CT scan to achieve that level of acceptable noise across the region of interest. The system increases and decreases the mA as it encounters various anatomy thicknesses and asymmetries. Compared with using fixed mA, Smart mA can reduce patient dose by as much as 32.5% while maintaining consistent image quality.
- Reference noise index: 12.35 (dose steps: -60.97, noise index: 50).
- mA range 20 – 210, kV 140.
- Scan type – helical, Rotation time – 0.4 sec, Rotation length – full, Detector coverage – 40 mm, Helical thickness – 3.75 mm, Coverage speed – 98.42 mm/sec, Coverage time – 2.0 sec, Interval – 3.27 mm, SFOV – large body, Pitch & Speed (mm/rot) – 0.984:139.37,

DFOV – 70 mm, Recon type – std wide view, Matrix size 512, Recon mode – full, Window width – 400, Window level – 40, Cardiac filter – none, Number of images 47.

4) Rest Scan Infusion:

- Dose: 10 MBq/kg for 3D or 20 MBq/kg for 2D (<2200MBq (60 mCi) maximum). Minimum dose 1000MBq (UOHI). (**ASNC – 1110 - 1480MBq; Max. 2200MBq**).
- Check blood pressure and heart rate pre and post Rb infusion.
- Infusion over 30 seconds (The standard for quantitative studies). (**ASNC – bolus injection \leq 30 seconds**).
- Use Constant time/Constant Activity.

5) Rest Scan Acquisition:

- Dynamic scan duration 8 minutes (UOHI 3D acquisition). (**ASNC 6-8 minutes**).
- Start time: at start of infusion.
- Rest imaging performed before stress imaging to prevent residual stress effects (i.e. stunning, steal). Due to the short half-life of Rb-82 (76 sec), longer acquisition time is meaningless (**ASNC recommends 3-6 min, explaining that 80% of useful counts are obtained in the first 3 min, 95% at 5 min, and 97% at 6 min standard; 3-10 minutes optional**).

6) Waiting time:

- Not required because of short half-life (76 sec).
- Check rest images (CTAC alignment) before proceeding with stress.
- Use static image with iterative reconstruction (8 mm) with CT std.

7) Pharmacologic stress:

- Dipyridamole infusion 0.142 mg/kg/min for 5 min, max dose 110 mg.
- History of severe asthma, COPD or patient presents with wheezing that persists after ventolin. Doctor/Nurse to reassess for Dobutamine protocol.
- Continuous ECG and regular BP monitoring.
- It has been shown that the ordinary dose of 0.56 mg/kg over 4 min cannot achieve maximal coronary vasodilatation.

8) Stress Scan Acquisition:

- Rb infusion and scan start at 8 min after start of Dipyridamole infusion.
- Dose and acquisition the same as rest scan.

9) Aminophylline:

- Start at 12 min after start of Dipyridamole infusion. (4 min after start of scan. Can shorten time to 3 min if patient in distress).
- Dose: < 50.9 kg 100 mg, 51-90 kg 150 mg, > 90 kg 200 mg (infusion rate: 50 mg/min).
- Routinely given to avoid adverse side effects of Dipyridamole.
- If ECG not back to baseline or chest pain persists proceed with sublingual nitro as per supervising physician.

10) Stress CT Attenuation Correction Scan (CTAC):

- Same as rest.
- Check CTAC alignment.

- Use static image with iterative reconstruction (8 mm) with CT std.

11) PET Recon/Replay:

- **Static image:** Prescan delay 2 min 30 sec, Scan time 5 min 30 sec, Number of phases 1, Number of images 47.
- Low EF or poor uptake summed at later time frame.
- **ASNC recommends starting static acquisition at 70-90 sec (if LVEF>50%) or 90-130 sec (if LVEF<50%) after end of infusion.** Our later time (2 min) allows patients with poor cardiac functions to have their myocardial uptakes stabilized.
- **Gated image:** Prescan delay 2 min, Scan time 6 min, Number of phases 1, Number of images 376.
- Gated binning mode: Binning type – percent, Trigger rejection – cycle rejection + next, Pre-phase delay (ms) – 0, Number of bins – 8, 12.5% per bin, Percent per phase – 100, Ave. trig/min 80; Percent deviation allowed 50 (HR range 120-40) * May have to change according to patients HR (i.e. Dobutamine).
- **Dynamic image:** Prescan delay 0 min, Scan time 8 min, Number of phases 4, Number of images 705.
- Frame times: 9x10s, 3x30s, 1x60s, 2x120s.
- Scan direction – towards feet.
- Number of bed positions 1.
- DFOV 50 cm (static, gated), 40 cm (dynamic).
- R/L centre (mm) R 0.0, A/P centre (mm) A 0.0 (static, gated).
- R/L centre (mm) R 0.0, A/P centre (mm) A 5.0 (dynamic).
- Matrix size 128 x 128 (static, gated, dynamic).
- **Recon Option:** (static, gated, dynamic), Attenuation type: measured, CTAC type – image set, CTAC series – CT std, Contrast compensation – automatic, Correction:

Well counter – sensitivity and activity (WCC file: default), Normalization – default, Randoms – singles, Scatter – ON (scatter correction mandatory for 3D systems due to high scatter fraction (45% quoted, probably 60% in patients)), Deadtime: ON, DMPR – N (static, gated, dynamic).

12) Reconstruction Type:

- **Static # 1:** Recon method: VUE Point HD, Filter type: Hanning with filter cutoff 8 mm, subsets 24, iterations 4, cardiac 3D - on, Z axis filter – none.
- **Static # 2:** Recon method: VPFX (**Time of Flight**), Filter type: Hanning with filter cutoff 4 mm.
- **Static # 3:** Recon method: VUE Point HD, Filter type: Hanning with filter cutoff 12 mm.
- **Gated:** Recon method: VUE Point HD, Filter type: Hanning with filter cutoff 16 mm, subsets 24, iterations 4, cardiac 3D – on, Z axis filter – none.
- **Dynamic:** Recon method: FORE – FBP, Filter type: Hanning with filter cutoff 12 mm, subsets 24, iterations 4, cardiac 3D – on, Z axis filter – none. (**ASNC – iterative recon method**).



AMMONIA (N-13) REST-STRESS MYOCARDIAL PET PERFUSION PROTOCOL

1) Patient preparation:

- No caffeinated products or medications for 12 - 24 hrs. (**ASNC no caffeinated products for at least 12 hrs**).
- No Theophylline containing medications for 3 days. (Theophylline is an antidote of Dipyridamole). (**ASNC – No Theophylline for 2 days**).
- No nitrates (i.e. Isordil (Isosorbide Dinitrate) or Nitrogl) for 12 hrs. You may use sub-lingual (SL) nitrates up to 1 hour before the test.
- Nitro patch (Nitrodur) off for 12hrs (minimum 2hrs).
- Continue cardiac medications unless otherwise directed by physician.
- 4 hr fast exception of water intake. (**ASNC- 6 hr fast exception of water intake**).
- No Viagra, Aggrenox or Persantine for 24 hr.
- NH₃ should be considered for patients > 300 lbs. (Calculate the activity/kg to assess which tracer: activity > 7-12 MBq/kg use Rb, activity < 7 MBq/kg use NH₃).
- Weight limit of camera 500 lbs.
- Female patients of childbearing potential (up to 55 yrs). Proceed with urine pregnancy test.

2) Patient positioning:

- Arms-up (above head) out of the cardiac FOV produces the best image quality.
- Arms-down only in occasional patients who cannot tolerate arms-up position.
- Scout scan to confirm heart is centered in the FOV. Landmark at xyphoid process.
- Patient orientation: head first.
- Patient position: supine.

- kV 120, mA 10

3) Rest CT Attenuation Correction Scan (CTAC):

- Low-dose X-ray CT (< 1mSv).
- Fast helical scan (< 0.4s) at normal mid-to-end expiration.
- Smart mA: Automatic Exposure Control – combines both z axis and angular tube current modulation to adjust the dose to the size and shape of individual patients – accounting for all three dimensions. Prior to scanning, the user selects the desired image quality, or noise index. Based on a single scout scan, the system adjusts the exposure during the CT scan to achieve that level of acceptable noise across the region of interest. The system increases and decreases the mA as it encounters various anatomy thicknesses and asymmetries. Compared with using fixed mA, Smart mA can reduce patient dose by as much as 32.5% while maintaining consistent image quality.
- Reference noise index: 12.35 (dose steps: -60.97, noise index: 50).
- mA range 20 – 210, kV 140.
- Scan type – helical, Rotation time – 0.4 sec, Rotation length – full, Detector coverage – 40 mm, Helical thickness – 3.75 mm, Coverage speed – 98.42 mm/sec, Coverage time – 2.0 sec, Interval – 3.27 mm, SFOV – large body, Pitch & Speed (mm/rot) – 0.984:139.37, DFOV – 70 mm, Recon type – std wide view, Matrix size 512, Recon mode – full, Window width – 400, Window level – 40, Cardiac filter – none, Number of images 47.

4) Rest Scan Infusion:

- Dose: 5 MBq/kg for 2D or 3D (< 750 MBq (20 mCi) maximum). (**ASNC – 370 – 740 MBq; larger patient 925 – 1110MBq**).
- Check blood pressure and heart rate pre and post NH₃ infusion.
- Infusion over 30 seconds (The standard for quantitative studies). Infuse the NH₃ dose using the Harvard Pump (set up 20 ml/minute, top up dose to 10 ml with saline).

5) Rest Scan Acquisition:

- Dynamic scan duration 20 min (Acquisition duration is limited by the half-life of NH₃ (10 min) and rising liver activity. **ASNC recommends 10-15 min, and states that longer than 20 min of limited value. Note that ASNC mentioned only half-life limitation and did not comment on the time course of liver activities.**
- Start time: at start of infusion.
- Rest imaging performed before stress imaging to prevent residual stress effects (eg stunning, steal). Due to the short half-life of NH₃ (10 min), longer acquisition time is meaningless.

6) Waiting time:

- 30 – 40 min
- Allow time for the NH₃ remaining inside the body to decay. The standard is 5 half-lives between scans, i.e. 50 min for NH₃. A waiting time of 40-45 min between injections, plus time for dipyridamole infusion, make up to about 50 min at time of starting acquisition.
- Check rest images (CTAC alignment) before proceeding with stress.
- Use static image with iterative reconstruction (8 mm) with CT std.

7) Pharmacologic stress:

- Dipyridamole infusion 0.142 mg/kg/min for 5 min, max dose 110 mg.
- History of severe asthma, COPD or patient presents with wheezing that persists after ventolin. Doctor/Nurse to reassess for Dobutamine protocol.
- Continuous ECG and regular BP monitoring.
- It has been shown that the ordinary dose of 0.56 mg/kg over 4 min cannot achieve maximal coronary vasodilatation.

8) Stress Scan Acquisition:

- NH₃ infusion and scan start at 8 min after start of Dipyridamole infusion.
- Dose and acquisition the same as rest scan.

9) Aminophylline:

- Start at 12 min after start of Dipyridamole infusion. (4 min after start of scan. Can shorten time to 3 min if patient in distress).
- Dose: < 50.9 kg 100 mg, 51-90 kg 150 mg, >90 kg 200 mg (infusion rate: 50 mg/min).
- Routinely given to avoid adverse side effects of Dipyridamole.
- If ECG not back to baseline or chest pain persists proceed with sublingual nitro as per supervising physician.

10) Stress CT Attenuation Correction Scan (CTAC):

- Same as rest.
- Check CTAC alignment.
- Use static image with iterative reconstruction (8 mm) with CT std.

11) PET Recon/Replay:

- **Static image:** Prescan delay 2 min, Scan time 18 min, Number of phases 1, Number of images 47.
- Increased liver uptake sum frames at earlier time frames.
- **ASNC recommends starting static acquisition at 1.5 – 3 min after end of infusion. Our later time (3 min) allows patients with poor cardiac functions to have their myocardial uptakes stabilized.**
- **Gated image:** Prescan delay 2 min, Scan time 18 min, Number of phases 1, Number of images 376.
- Gated binning mode: Binning type – percent, Trigger rejection – cycle rejection + next, Pre-phase delay (ms) – 0, Number of bins – 8, 12.5% per bin, Percent per phase – 100, Ave. trig/min 80; Percent deviation allowed 50 (HR range 120-40) * May have to change according to patients HR (i.e. Dobutamine).
- **Dynamic image:** Prescan delay 0 min, Scan time 20 min, Number of phases 6, Number of images 705.
- Frame times: 9x10s, 3x30s, 1x60s, 1x120s, 1x240s, 2x300s.
- Scan direction – towards feet.
- Number of bed positions 1.
- DFOV 50 cm (static, gated), 40 cm (dynamic).
- R/L centre (mm) R 0.0, A/P centre (mm) A 0.0 (static, gated).
- R/L centre (mm) R 0.0, A/P centre (mm) A 5.0 (dynamic).
- Matrix size 128 x 128 (static, gated, dynamic).
- **Recon Option:** (static, gated, dynamic), Attenuation type: measured, CTAC type – image set, CTAC series – CT std, Contrast compensation – automatic, Correction: Well counter – sensitivity and activity (WCC file:

default), Normalization – default, Randoms – singles, Scatter – ON (scatter correction mandatory for 3D systems due to high scatter fraction (45% quoted, probably 60% in patients)), Deadtime: ON, DMPR – N (static, gated, dynamic).

12) Reconstruction Type:

- **VPFX (Time of Flight):** turned off until problems resolved. Will be done in the future.
- **Static # 1:** Recon method: VUE Point HD, Filter type: Hanning with filter cutoff 8 mm, subsets 24, iterations 4, cardiac 3D - on, Z axis filter – none.
- **Static # 2:** Recon method: FORE – FBP, Filter type: Hanning with filter cutoff 12 mm.
- **Static # 3:** Recon method: VUE Point HD, Filter type: Hanning with filter cutoff 12 mm.
- **Gated:** Recon method: VUE Point HD, Filter type: Hanning with filter cutoff 16 mm, subsets 24, iterations 4, cardiac 3D – on, Z axis filter – none.
- **Dynamic:** Recon method: FORE – FBP, Filter type: Hanning with filter cutoff 12 mm, subsets 24, iterations 4, cardiac 3D – on, Z axis filter – none.



CONTRAINDICATIONS FOR DIPYRIDAMOLE

1) Patient preparation:

- No caffeinated/de-caffeinated products or medications for 12 – 24hrs.
- No Theophylline containing medications for 3 days. (Theophylline is an antidote of Dipyridamole).
- No nitrates (i.e. Isordil (Isosorbide Dinitrate) or Nitrogl) for 12 hrs. You may use sub-lingual (SL) nitrates up to 1 hour before the test.
- Nitro patch (Nitrodur) off for 12 hrs (minimum 2 hrs).
- Continue cardiac medication unless otherwise directed by physician.
- 4 hr fast.
- No Viagra, Aggrenox or Persantine for 24 hr prior to test.
- Weight limit of camera 500 lbs.

2) Patient condition:

- Asthma/COPD assess for Dobutamine.
- Patients allergic to Dipyridamole/Aminophylline proceed with Dobutamine.
- Hypotensive (systolic BP < 90), check with physician before proceeding.
- Hypertensive (systolic > 200, diastolic > 110), check with physician before proceeding.
- Claustrophobic patients.
- Female patients of childbearing potential (up to 55 yrs). Proceed with urine pregnancy test.
- Atrial fibrillation – controlled A-fib proceed with test. (60 – 100 bpm). Uncontrolled A-fib – 120 bpm or greater, check with physician before proceeding.

- 1st degree AV block check with physician before proceeding. 2nd or 3rd degree AV blocks proceed with Dobutamine.

DOBUTAMINE STRESS MYOCARDIAL PET PERFUSION PROTOCOL

1) Patient preparation:

- Same as Dipyridamole.
- Withhold beta blockers for 24 hrs unless contraindicated by physician.

2) Procedure:

- The infusion solution is prepared by mixing 100 mg of Dobutamine in 5% dextrose and water to a total volume of 100 ml. In large patients the concentration should be doubled, that is, 200 mg of Dobutamine should be mixed with 5% dextrose and water to a total volume of 100 ml.
- Dobutamine is infused intravenously by pump with a starting dose of 5 micrograms/kg/min.
- The dose of Dobutamine is increased in 3 minute intervals to 10, 20, 30, and 40 micrograms/kg/min.
- Blood pressure and heart rate are obtained every 3 minutes prior to increasing the dose of Dobutamine.
- If an endpoint is reached, the infusion may be terminated before reaching the maximum dose.
- If maximal heart rate at 40 micrograms/kg/min is within 15 beats per minute of 85% maximal age predicted heart rate, the infusion dose can be increased to 50 micrograms/kg/min for another 3 minutes provided that another endpoint has not been reached. (We have not had success with 50 micrograms/kg/min, usually go directly to atropine).
- If peak heart rate is more than 15 beats per minute below 85% maximal age predicted heart rate at peak dose of infusion (40 micrograms/kg/min), Atropine 0.6 mg is given intravenously to increase the heart rate

response. Another dose of 0.2 to 0.4 mg can be repeated at 1 minute to a maximum dose of 1 mg. (we start at 0.2 mg up to 0.6 mg of Atropine depending on patient response).

3) Stress Acquisition Scan:

- Inject radiotracer at peak heart rate.
- Follow Rubidium/Ammonia imaging protocol.
- Stop Dobutamine infusion at 3 minutes into the scan.

4) End points of study:

- Target heart rate at 85% age predicted maximal heart rate, or 70% age predicted heart rate in patients with recent myocardial infarction less than 6 weeks.
- Peak infusion dose is reached.
- Development of ventricular tachycardia or sustained supraventricular tachycardia.
- Development of hypertension, systolic blood pressure greater than 220 mmHg or diastolic blood pressure greater than 110 mmHg.
- Development of hypotension by < 20 mmHg compared to the previous stage. Infusion can be continued despite this drop in blood pressure at the discretion of the supervising physician.
- Development of intolerable symptoms.

5) Contraindications:

- Recent (< 1 week) myocardial infarction.
- Unstable angina.
- Atrial tachyarrhythmias with uncontrolled ventricular response.
- Ventricular tachycardia.
- Uncontrolled hypertension.

- Patients with aortic dissections or large aortic aneurysms (>5 cm).
- Severe aortic stenosis.
- 2 mm ST decrease in one lead.
- Patients with glaucoma and receiving medications for glaucoma will not receive atropine.
- Relative contraindications include: significant arrhythmia and previous psychiatric history.
- Do not use atropine if hypertrophic prostate.

UNSTABLE PATIENT – PERSANTINE PERFUSION PET SCAN

If chest pain/ECG changes persist after given aminophylline to the patient, you may give up to 3 nitro sprays. If the patient is pain free and ECG is back to baseline post 2 nitro sprays (i.e. ST changes > 1mm during stress), the patient can go home at the end of the test. If the patient is pain free and ECG is back to baseline post 1 to 3 nitro sprays (i.e. ST changes > 2mm during stress), patient may go get coffee; however, the patient must come back to PET unit. Show the PET images to the physician covering the PET unit and he/she will decide whether the patient can go or not. However, if the chest pain persists after the persantine perfusion PET scan (post aminophylline and nitro spray), you must keep the patient in the area, call the physician in charge of the PET unit, and discuss the condition of the patient. Patient must be monitored and redo the ECG to determine whether the ECG is back to baseline or not. Show the PET images to the physician and the physician in charge will take over. If there is no physician in charge in the area, you must call the CCU resident and the Nursing Care Coordinator (NCC).