CHEST PAIN EVALUATION TOOL

Chest pain or discomfort is one of the commonest causes for presentation to the Emergency Room (ER) or physicians' office. There are many causes for chest discomfort. The serious causes need to be excluded before less serious causes can be considered. Serious causes for chest pain include:

- Acute Coronary Syndromes (ACS): New onset angina, accelerating or crescendo angina and prolonged angina or coronary insufficiency, non ST elevation myocardial infarction (NSTEMI) and ST elevation myocardial infarction (STEMI). CHRONIC: stable angina.
- Aortic dissection (sudden, tearing chest or interscapular back pain with weakness, dizziness, diaphoresis, pallor, new aortic regurgitation, cerebral ischaemia or pulse deficits)
- Pulmonary embolism (sudden pleuritic chest discomfort with dyspnea, hypoxemia)
- Pericarditis (sharp, retrosternal chest discomfort. Worse with breathing or lying down)
- Pleurisy/pneumonia/pneumothorax (sharp thoracic discomfort associated with viral or pulmonary symptoms: fever, cough, sputum or spontaneously occurring in young people).

Less serious causes include:

- Chest wall pain (costochondritis, pleurodynia)
- Referred pain from cervical disc disease, brachial plexus (neuritis, scalenus anticus syndrome, cervical rib)
- Gastro-esophageal reflux disease (reflux esophagitis or esophageal spasm)
- Referred abdominal pain (biliary colic, gastritis, perforated ulcer or other viscus)
- Zoster or shingles

Causes of chest pain or discomfort are best identified by a careful medical history. First establish the acuity or chronicity of symptoms. Acute chest pain is best evaluated in the ER to rule out **ACS, NSTEMI, STEMI** or other serious causes. Less acute chest pain should be evaluated using three **CARDINAL FEATURES** to classify the chest discomfort and establish the likelihood of angiographically significant (>70% luminal stenosis) coronary artery disease. Ischaemic chest pain or discomfort may present with typical or atypical features. Typical features include:

1. Retrosternal location of discomfort (in whole or in part)
2. Provocation by activity or stress
3. Relief by rest or nitroglycerin

If all three features are present the chest pain or discomfort is classified as **TYPICAL ANGINA**. If two of three features are present the chest discomfort is classified as **ATYPICAL ANGINA**. If only one of three features are present the chest discomfort is classified as **NON ANGINAL CHEST PAIN**. The angiographic likelihood of significant CAD can be derived from these three cardinal features as well as the **AGE** and **GENDER** of the patient as presented in the table at the top of the chest pain algorithm on the next page. In **WOMEN**, ischaemic symptoms may present atypically such as unusual fatigue, sleep disturbance and shortness of breath. Only 30% of women report chest discomfort prior to heart attack. The most frequent acute symptoms in women are shortness of breath (57.9%), weakness (54.8%), and fatigue (42.9%). Acute chest pain was absent in 43%. Evaluation of chest discomfort in women must be tempered by a lower pre-test likelihood of CAD and the atypical symptom presentation.

CHEST PAIN ASSESSMENT ALGORITHM

STABLE SYMPTOMS – ASSESS PRE-TEST LIKELIHOOD CAD

UNSTABLE SYMPTOMS
- New onset angina
- Accelerating angina
- Prolonged resting angina

Prevalence of CAD (%) in Symptomatic Patients According to Age and Sex

	Typical angina		Atypical angina		Non anginal chest pain	
AGE	Men	Women	Men	Women	Men	Women
30-39	69.7	25.8	21.8	4.2	5.2	0.8
40-49	87.3	55.2	46.1	13.3	14.1	2.8
50-59	92.0	79.4	58.9	32.4	21.5	8.4
60-69	94.3	90.6	90.6	54.6	28.1	18.6
	3 of 3 criteria		2 of 3 criteria		1 of 3 criteria	

1)Retrosternal discomfort.2)Provoked by exercise or stress.3)Relieved by rest or NTG

 .....bridging the care gap

Low Likelihood
CAD < 10% risk
Consider no test

Intermediate Likelihood
CAD 10-90% risk

High Risk
CAD > 90% risk
Consider non-invasive assessment to determine severity and extent of CAD or cardiac catheterization based on severity of symptoms.

Patient **able** to exercise

Patient **unable** to exercise

ECG Normal

ECG Abnormal

Exercise Stress Test

Exercise Myocardial Perfusion Scan*

Exercise Stress Echo

Persantine** Myocardial Perfusion Scan*

Dobutamine Stress Echo

*Avoid in women of child-bearing years **Persantine may be contra-indicated in asthma

Test Results: If suspected false + Exercise Stress Test (EST) — consider Stress Echo or Stress Nuclear study. If inconclusive EST — consider Persantine Nuclear study.

Normal

Equivocal or Mild Symptoms

Abnormal Low/ Moderate Risk

Abnormal High Risk

ACS Protocol

High Risk

Indeterminate Risk

Optimal Medical Therapy

CT Angiogram

Cardiac Catheterization

Non-Invasive Risk Stratification

NON-INVASIVE CARDIAC INVESTIGATIONS AND PROCEDURES: *PATIENT INFORMATION*

Treadmill Exercise Stress Testing

Stress testing is also known as treadmill testing or graded exercise testing. During the test you will be asked to walk on a treadmill which gradually increases the speed and slope. Your electrocardiogram (ECG), blood pressure and symptoms will be continuously monitored. The test will be stopped when your symptoms warrant it or if a strongly positive result or arrhythmia occurs. Treadmill testing is useful to assess the presence and severity of coronary artery disease, and if present to indicate the prognosis and to guide therapy or intervention. Treadmill testing may show changes in the ECG which could the blood supply to your heart is reduced. Chest pain or shortness of breath may accompany these changes. Unfortunately treadmill testing is not perfect. About 30% of the time false positive results may be obtained. This may make further testing necessary to rule out coronary disease or assess its severity.

Stress Echocardiography

Stress echocardiography combines stress testing with an echocardiogram (cardiac ultrasound) obtained before and immediately after exercise. Exercise is usually carried out on a treadmill. Alternatively a bicycle (either upright or lying down) may be used to provide the exercise stress. This measures the pump function of the heart under stress and can be used to prove or disprove the presence of coronary artery disease. Stress echo may also be useful to evaluate the functional significance and severity of angiographically identified coronary narrowing. Sometimes a medication, dobutamine, is used to accelerate the heart rate in patients who are unable to exercise. Echocardiography is used to measure the pump function of the heart before and during this pharmacologic (medication induced) stress test and identify lack of blood supply to the heart muscle. Side effects of dobutamine include angina and cardiac arrhythmias. Sometimes if image quality is poor, echo contrast is given intravenously. This helps to better see the walls and pump function of the heart.

Stress Nuclear Testing (Exercise Myocardial Perfusion Imaging)

Stress nuclear testing is a form of stress test that may provide added useful information about your prognosis. A nuclear material is injected into your blood stream while you exercise on the treadmill. If unable to exercise, a medication called Persantne may be used as an alternative-see below. The material is safe and medically approved. Similar nuclear materials are used to obtain bone scans, brain scans, thyroid scans etc. The nuclear material is taken up by your heart and is distributed through the heart muscle according to blood flow. Areas of the heart that are supplied by narrowed arteries will have reduced blood flow that will show up on scanning as reduced areas of radioactivity. These techniques are more accurate than routine treadmill testing in finding coronary disease and determining its severity. Scanning agents include the isotopes thallium and Technetium 99m. Technetium 99m is bound to carrier molecules (MIBI or Myoview®; tetrafosmin or Cardiolyte®). Technetium 99m-based scanning has the added advantage of providing information on the pump function of the heart. Both stress and persantine nuclear stress tests are useful in excluding falsely abnormal treadmill stress tests and carry 90-95% accuracy.

MPI is a widely used and safe non invasive test that has been well validated for more than 30 years. As with many non invasive tests, it results in a small radiation exposure. By appropriate selection of patients, the very small risk associated with the radiation exposure is far outweighed by the benefits of the test. In relative quantitative terms the exposure from a MPI test (8-10 mSv) is roughly 3 times the naturally occurring annual background radiation (approximately 3 mSv).

Persantine Nuclear Stress Testing (Pharmacologic Stress Myocardial Perfusion Imaging)

In patients who cannot exercise due to vascular or musculoskeletal problems (e.g. back pain, arthritis, etc.) an injection of intravenous persantine may be used to “stress” the heart. Persantine dilates blood vessels in the heart. If a vessel is narrowed or blocked it cannot dilate. That is why we can see a difference in blood flow across the heart when we inject the nuclear scanning agent. Nuclear isotopes are then administered and the heart scanned with a special camera to identify areas of reduced coronary artery blood flow. Persantine may not be given to patients with asthma or who are on asthma medications or to patients with unstable symptoms. Side effects of persantine include headaches, flushing, chest pain and shortness of breath. These effects are readily reversed with the antidote, aminophylline.

Appropriate Use of Non-invasive Cardiac Testing

- Evaluate pre test likelihood of angiographically significant CAD with chest pain algorithm. Choose to test or not based on risk level.
- In low risk patients (<10 % risk of angiographically significant CAD) consider no testing.
- Choose the test with the lowest risk to the patient.
- Cost should be a consideration in choosing the appropriate test.
- Avoid repeated radiation exposure unless the value of the information derived exceeds the incremental radiation risk.
- Factor in lifetime radiation exposure from background radiation and other radiologic tests and procedures.
- In high risk patients (> 90% risk of angiographically significant CAD) consider imaging the coronary arteries directly.

MEDICAL RADIATION SAFETY

What are x-rays and what do they do?

- X-rays are forms of radiant energy, like light or radio waves. Unlike light, x-rays can penetrate the body, which allows a cardiologist or radiologist to produce pictures of internal structures.
- X-ray examinations provide valuable information about your health and play an important role in helping your doctor make an accurate diagnosis and prognosis.

Measuring radiation dosage

- The scientific unit of measurement for radiation dose, commonly referred to as effective dose, is the millisievert (mSv). Because different tissues and organs have varying sensitivity to radiation exposure, the actual radiation risk to different parts of the body from an x-ray procedure varies. The term effective dose is used when referring to the radiation risk averaged over the entire body.
- The effective dose accounts for the relative sensitivities of the different tissues exposed. More importantly, it allows for quantification of risk and comparison to more familiar sources of exposure that range from natural background radiation to radiographic medical procedures.

Naturally-occurring “background” radiation exposure

- We are exposed to radiation from natural sources all the time. According to recent estimates, the average person in the U.S. receives an effective dose of about 3 mSV per year from naturally occurring radioactive materials and cosmic radiation from outer space. These natural “background” doses vary throughout the country.
- People living at higher altitudes receive about 1.5 mSv more per year than those living near sea level. The added dose from cosmic rays during a coast-to-coast round trip flight in a commercial airplane is about 0.03 mSv. Altitude plays a big role, but the largest source of background radiation comes from radon gas in our homes (about 2 mSv per year). Like other sources of background radiation, exposure to radon varies widely from one part of the country to another.
- To explain it in simple terms, we can compare the radiation exposure from one chest x-ray as equivalent to the amount of radiation exposure one experiences from our natural surroundings in 10 days.

Safety in nuclear medicine procedures

- Nuclear medicine is a branch of medical imaging that uses small amounts of radioactive material to diagnose and determine the severity of or treat a variety of diseases, including many types of cancers, heart disease and certain other abnormalities within the body.
- Depending on the type of nuclear medicine exam, the radioactive material, or radiotracer, may be injected into a vein, swallowed or inhaled as a gas. The radiotracer will accumulate in the organ or area of the body being examined, where it gives off energy in the form of gamma rays, allowing the radiologist or nuclear medicine physician to view structural and functional information about organs or tissues within the body.
- During nuclear medicine exams, patients are exposed to some radiation from the radiotracer and may be exposed to additional radiation, depending on the imaging method used during the procedure. Though the exact amount of radiation exposure can vary, based on the patient’s physical dimensions and the part of the body being examined, radiologists and nuclear medicine physicians will use the lowest dose possible in order to obtain the highest quality images.
- Nuclear imaging exams can be performed safely on children and pregnant women as long as the benefits outweigh the small associated radiation risk. When performing such exams, careful evaluation should be done to ensure proper/optimal dosage is given. Women should always inform their physician or technologist if there is any possibility that they are pregnant or if they are breastfeeding.

Comparisons of effective radiation dose with background radiation exposure for cardiac radiology and nuclear procedures

HEART			
For this Procedure	***Your appropriate effective radiation dose is:**	**Comparible to natural background radiation for:**	****Additional lifetime risk of fatal cancer from examination:**
Myocardial perfusion imaging with EF	16 mSv	5 years	Low
Cardiac blood pool imaging (MUGA)	8 mSv	32 months	Low
Cardiac CT for calcium scoring	3 mSv	1 year	Low
Coronary Computer Tomography Angiography (CTA)	16 mSv	5 years	Low
PET scan	4 mSv	16 months	Low
Cardiac catheterization	7 mSv	28 months	Low
Coronary angioplasty	15 mSv	5 years	Low
CHEST			
Computed Tomography (CT)-Chest	7 mSv	2 years	Low
Computed Tomography (CT)-Chest Low Dose	1.5 mSv	6 months	Very Low
Radiography-Chest	0.1 mSv	10 days	Minimal

CANCER RISK	
Risk Level	**Approximate additional risk of fatal cancer for an adult from examination:**
Negligible	Less than 1 in 1,000,000
Minimal	1 in 1,000,000 to 1 in 100,000
Very Low	1 in 100,000 to 1 in 10,000
Low	1 in 10,000 to 1 in 1000
Moderate	1 in 1000 to 1 in 500
Note: These risk level represent very small additions to the 1 in 5 chance we all have of dying from cancer.	

Adapted from RadiologyInfo.org (http://www.radiologyinfo.org/en/safety/index.cfm?pg=sfty_xray)

Stress Echocardiography versus Stress Myocardial Perfusion Imaging (MPI)

In general stress echocardiography is more specific in ruling out CAD. Stress nuclear myocardial perfusion imaging is more sensitive in identifying CAD. Stress echocardiography is also more operator and laboratory dependent and subject to technical limitations. The advent of contrast stress echo will help to overcome some of these limitations.

CHOOSE STRESS ECHOCARDIOGRAPHY IF:	CHOOSE MYOCARDIAL PERFUSION IMAGING IF:
Younger < 50	Older > 50
Low – Intermediate pre-test likelihood of CAD	Intermediate to hight pre-test likelihood of CAD
Female in childbearing years	Male > Female
Good echo image quality	Poor image quality
Able to exercise	Unable to exercise (Persantine stress)
Repeated tests expected	Infrequent evaluation
Prior multiple radiologic/nuclear exposure	Low cumulative radiation exposure
LAD is primary vessel of interest	Need to evaluate significance of known coronary stenosis other than LAD
Single vessel CAD likely	Multi-vessel CAD likely; prior PCI/CABG
Normal resting LV function	Multiple wall motion abnormalities
Normal QRS on resting ECG	LBBB or Paced Rhythm (Persantine stress)

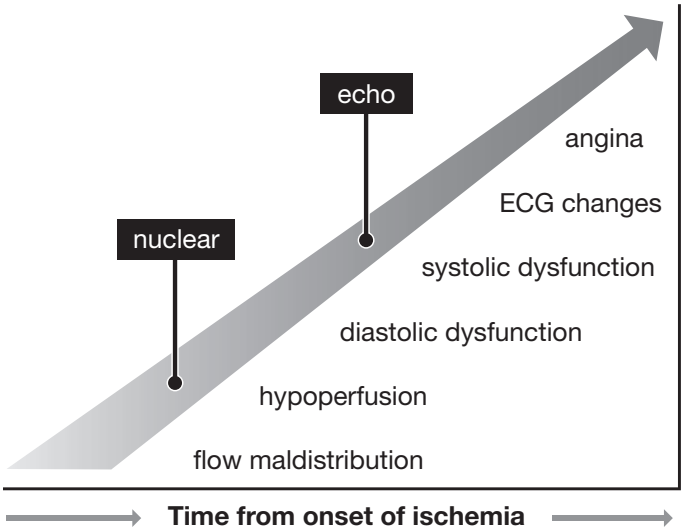

Fig. 1. The ischaemic cascade represents a sequence of pathophysiologic events caused by coronary artery disease. Nuclear imaging probes an earlier event hypo-perfusion) in the ischaemic cascade than stress echocardiography (systolic dysfunction).

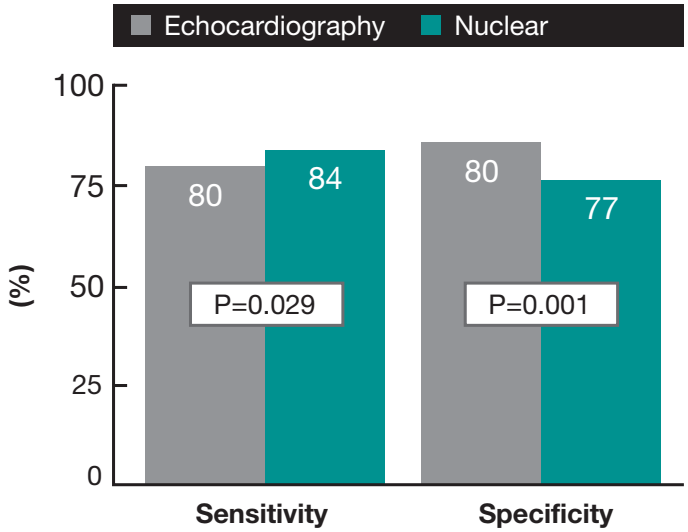

Fig. 2. Sensitivity and specificity of stress echocardiography and nuclear imaging for the detection of coronary artery disease (data based on Refs. 1-17).

Noninvasive evaluation of ischaemic heart disease: myocardial perfusion imaging or stress echocardiography? Schinkel el al. European Heart Journal (2003) 24, 789–800.