CARDIAC TESTS

- Chest X-ray
    - X-rays are a form of electromagnetic radiation (like light); they are of higher energy, however, and can penetrate the body to form an image on film. There is low radiation exposure. X-rays are monitored and regulated to provide the minimum amount of radiation exposure needed to produce the image.
    - A chest X-ray may be ordered when an person's symptoms include a persistent cough, coughing up blood, chest pain, a chest injury, or difficulty in breathing. The test is also used when tuberculosis, lung cancer, or other chest or lung disease is suspected.
    - A serial chest X-ray (repeated or sequential) may be used to evaluate changes over time if an abnormality found on a chest X-ray (for example, an increase in the size of an abnormality over a period of weeks).
- EKG
    - What is it?
      An electrocardiogram – often abbreviated, as EKG or ECG – is a test that measures the electrical activity of the heartbeat. With each beat, an electrical impulse (or "wave") travels through the heart. This wave causes the muscle to squeeze and pump blood from the heart.
    - Why is it done?
      An EKG gives two major kinds of information.
        - 1st, find out how long a wave takes to travel from one part of the heart to the next shows if the electrical activity is normal or slow, fast or irregular.
        - Second, by measuring the amount of electrical activity passing through the heart muscle, a pediatric cardiologist may be able to find out if parts of the heart are too large or are overworked.
- HDP
    - Swan catheter
- Exercise Stress Test
    - Definition
        - An exercise stress test is a general screening tool to test the effect of exercise on your heart. The test gives a general sense of how healthy your heart is.
        - During the test, the electrical activity of the heart is measured while you walk on a treadmill or pedal a stationary bicycle. This measures the heart's reaction to your body's increased demand for oxygen. (See also sestimibi and thallium stress tests.)
    - How the test is performed
        - You will be asked to walk or pedal on an exercise machine. An electrocardiogram (ECG) is used to record the activity of your heart and blood pressure readings are taken. The response of the heart to this increased workload is monitored.
        - The test continues until you reach a target heart rate, unless complications such as chest pain or an exaggerated rise in blood pressure develop with activity. Monitoring continues after exercise for 10 to 15 minutes or until the heart rate returns to baseline.
- Thallium Stress Testing
    - Nuclear imaging methods that provide a view of the blood flow into the heart muscle. The thallium and sestamibi tests are also called "MIBI stress test" and "myocardial perfusion scintigraphy", and are used to evaluate how well your heart is perfused (supplied with blood) at rest as compared with activity.
    - During these tests, heart images can be obtained because the patient receives an injection of a substance that is labeled with a radioactive marker or radiotracer to make it visible in the bloodstream. These substances are also called radiopharmaceuticals, and include thallium-201 and technetium-99m MIBI or sestamibi.

    - In comparison to the standard treadmill stress test, thallium and sestamibi stress tests are more accurate and provide additional information.
    - How the test is performed
        - Exercise as hard as you can on a treadmill or bicycle
        - When you reach your maximum level of exercise, a nurse will inject in your vein a small amount of a radioactive substance (radiotracer), either thallium or sestamibi
        - The radiotracer will travel in the bloodstream and, through the coronary arteries, will enter into the heart muscle as you complete your exercise session.
        - After you finish exercising, you will lie down on a special table under a bulky camera called a gamma camera. The gamma camera can scan your heart and detect the radiotracer in it.
        - The distribution of the radiotracer in your heart will be processed by a computer to create pictures of your heart. The first pictures are made shortly after the exercise test, to show the circulation of blood to your heart during exercise. This is the part considered "a stress test" and is the most challenging for your heart.
        - Then you will need to lie quietly for 2-3 hours, and at that point the scanner will make another series of pictures of your heart. These images will show the circulation of blood through your heart muscle at rest.
- Myoview or Cardiolite Stress Testing; Sestamibi
    - Advantage
        - Technetium instead of Thallium which is brighter and better
        - Used for women w/ large breasts or men with big guts
        - Fewer false positive than Thallium, better for screening
        - Specificity is 96% (Thallium is 85%)
        - Good screening tool
    - Disadvantage
        - Not as good for viability as Thallium
        - Not as good for people who have had an infarct
- Persantine Stress Test
    - What is an IV Persantine-Thallium Stress Test?
        - This test is an alternative procedure for patients with coronary artery disease who can not exercise on a treadmill.
        - An IV line is started to administer the persantine and the thallium.
        - Persantine helps to expand the coronary arteries increasing the blood flow to the area. This effect is similar to what happens during vigorous exercise.
        - Thallium (a radioactive isotope) is detected by X-rays and shows which parts of the heart muscle are receiving enough oxygen.
        - EKG used to moniter.
        - A special camera takes pictures of the heart.
        - 2 phases, with each phase lasting 30-60 minutes
    - Why is a Persantine Stress Done?
        - This test will help the doctor to evaluate the patient's cardiac condition related to:
        - Irregular heart rhythms
        - Which areas of the heart are not getting enough blood and oxygen.
        - How quickly the heart recovers after exercise.
    - Good area dilates more to Persantine and shows up as bright, bad area is dull.
    - Steal can be created, but only occurs w/ very high grade stenosis, pt will become symptomatic w/ chest pain
- Multigated Acquisition Wall Motion Scan (MUGA)
    - During the MUGA test, a radioactive isotope (Technetium) is injected into the vein
    - Radioactive isotopes attach to red blood cells and pass through the heart in the circulation
    - The isotopes can be traced through the heart using special cameras or scanners. Ejection fraction (normal=55%, 30% after one MI, <30% major risk) can be measured by observing volumes during systole and diastole.

    - The test is often given at rest, then repeated with exercise, or after administering certain medications. The test is performed to detect certain heart conditions.
    - Easily done and reproducible
- First-pass radionuclide angiocardiography
    - Nuclear imaging, same information as MUGA, but harder to do
    - Injection of a bolus of a technetium-99m-labelled RBCs
    - Nuclear scan images acquired in rapid sequence during the injection
    - Images recorded allow the calculation of the ventricular ejection fraction (EF), the determination of shunt volumes and wall motion abnormalities
    - First-pass radionuclide angiocardiography is less frequently used nowadays, as gated blood pool scanning yields much better results. Gating of the data to the cardiac cycle permits addition of the five or so cardiac cycles observed during the first pass of the radionuclide, thereby improving the statistical accuracy of the EF determination.
- Spect
    - Single photon emission computed tomography (SPECT) is a noninvasive technique for creating very clear, three-dimensional pictures of a major organ (e.g., the heart)
    - Uses radionuclide imaging – a technique that involves the injection of very small amount of a radionuclide substance called a tracer. Energy from the tracer in the body is detected by a gamma ray camera, which then takes the pictures. A tracer is not a dye (contrast medium)
- Gated Spect
    - In addition to aquiring images, you play them back like a movie??
    - You get wall motion
- Echo Doppler
    - You get ejection fraction, wall motion
    - An instrument that transmits high-frequency sound waves called a transducer is placed on your ribs near the breast bone and directed toward the heart. The transducer picks up the echoes of the sound waves and transmits them as electrical impulses. The echocardiography machine converts these impulses into moving pictures of the heart.
    - Best test to test DYASTOLIC DYSFUNCTION
    - This test is performed to evaluate the valves and chambers of the heart in a noninvasive manner for
        - heart murmurs
        - check the pumping function of the heart
        - evaluate patients who have had heart attacks
    - It is a very good screening test for heart disease in certain groups of patients.
- TEE
    - Swallow a probe
    - Sedate patient, use Lidocaine
    - You get a better view of the heart
    - Sometimes you can't see the Left Atrium too well
    - Use on pts:
        - Suspected descending aortic dissection
        - Endocarditis
        - Need a closer look
- Non-Invasive Vascular Testing
    - Plethysmography (Pulse Volume Recording w/ Segmental blood pressures)
        - A test is performed by placing blood pressure cuffs on the extremities to measure the systolic pressure
        - The cuffs are then attached to a pulse volume recorder (plethysmograph) that displays each pulse wave.
        - Compares the systolic blood pressure of the lower extremity to the upper extremity, to help rule out disease that blocks the arteries in the extremities.
        - Use for diabetic pts over 70, non-healing ulcers, cellulitis, claudication Sx, reduced pulses

    - Venous Duplex
        - Use when there is a venous problem
            - Vericous veins
            - Edema
            - Venous stasis
            - Stasis ulcers
- Carotid Doppler
    - Carotid duplex is an ultrasound procedure performed to assess blood flow through the carotid artery to the brain. High-frequency sound waves are directed from a hand-held transducer probe to the area. These waves "echo" off the arterial structures and produce a 2-dimensional image on a monitor, which will make obstructions or narrowing of the arteries visible.
    - Carotid duplex is a procedure that uses ultrasound to look for
        - Plaques (Intimal thickness)
        - Blood clots
        - Aneurisms
        - Other problems with blood flow
    - Predict TIAs and strokes (CVAs) and if pt would benefit from stent
- Holter
    - Definition: 24 hours of ECG recordings
    - Used to check for
        - Arrythmias (tachy, brady, V-tach)
        - Post MI
        - Palpataions, dizziness
        - Sudden death risk
- Signal Average ECG
    - Non-invasive
    - Identifying risks for potentially fatal heart rhythm problems
    - The procedure involves obtaining electrocardiograph signals from the heart, amplifying them, and then filtering and averaging them by computer
    - The procedure may detect "**late potentials**," low amplitude signals associated with serious rhythm abnormalities, which can lead to sudden cardiac death.
    - Useful in same pts as holter
- HRV (Heart Rate Variability) Test
    - High variability is good (HR quickens as you run up stairs, for instance, and slows as you nap)
- T Wave Alterans
    - Low level stress test (bring hear to 110)
    - Look at T wave
        - If they are stable → good
        - If they invert, change → bad
    - Helps predict risk of sudden death
    - Used in same pts as holter
- Transtelephonic monitering
    - Holter through the telephone
    - Loop recorder records heart beat for 30 days
    - Used in same pts as holter
- Pacemaker Testing
    - Monitor function of pacemaker over the phone
- Ambulatory Blood Pressure and HR
    - Monitor blood pressure for white coat syndrome pts
- EPS
    - Intracardiac electrophysiology study (EPS) involves placing wire electrodes within the heart to find the location of a known arrhythmia and determine the best therapy

- Abnormal electrical activity can occur anywhere along the conduction system, including in the muscle cells of either the atria or ventricles. The electrodes inserted during EPS will map the type of arrhythmia you have and where the problem arises in your heart.
- Allows for determination of the severity of the problem (including whether you are at risk for sudden cardiac death) as well as appropriate treatment.
- Good for pts w/ syncope, posts MI, arrhythmias

- Ablation
  - Nonsurgical method
  - Insert a thin tube (catheter) through a blood vessel (in the upper thigh, wrist or arm) and all the way up to the heart
  - At the tip of the tube is a small wire, which can deliver radiofrequency energy to burn away the abnormal areas of the heart
  - Success rate over 90 percent
  - Treats
    - Tachycardia
    - Wolff-Parkinson-White syndrome: episodes of tachycardia caused by abnormal electrical pathways (circuits) in the heart
    - V-tach w/ normal ventricle (Not good for people post MI)
    - A-fib
      - Most you can't burn b/c its due to stretch fibers
      - Some you can burn b/c it's from one irritable focus
- Pacemakers
  - Biventricular pacemaker
    - New type of artificial pacemaker designed to treat heart failure
    - In many heart failure patients, the walls of the left ventricle are no longer synchronized, these pacemakers resynchronize
    - Standard pacemakers pace either the lower-right chamber of the heart (single chamber pacemaker) or both the lower-right and the upper-right chambers (dual chamber pacemaker). In contrast, biventricular pacemakers pace both of the lower chambers of the heart (the ventricles).This enables the device to stimulate the left and right ventricles simultaneously, which can enable the left ventricle to pump blood more efficiently
    - Used to treat heart failure
    - Used for pts w/
      - Stage 3 / 4 heart failure (sx w/ rest or minimal activity)
      - Ejection fractions <30%
      - Have an IVCD?
      - QRS interval >130 msec
    - Buy stock in Guidance?
- ICDs
  - An implantable cardioverter defibrillator (ICD) is a device that is implanted in the chest to monitor for and, if necessary, correct episodes of rapid heartbeat.
  - If the heartbeat gets too fast (ventricular tachycardia), the ICD will stimulate the heart to restore a normal rhythm (anti-tachycardia pacing).
  - In cases where the heartbeat is so rapid that the person may die (ventricular fibrillation), the ICD will also give an electric shock (defibrillation) to "reset" the heartbeat.
  - Similar to an artifical pacemaker, which is another type of device that corrects an abnormal heart rhythm. However, pacemakers are usually chosen to correct a heart rhythm that is too slow (bradycardia), whereas ICDs are used to correct a heart rhythm that is too fast (tachycardia). And there are patients who need both bradycardia pacing and anti-tachycardia pacing. In these patients, an ICD will be used to pace the heart.
  - Minor surgical procedure (not open-heart surgery)
- AEDs

    - A defibrillator is a device that attempts to restore a normal heart rhythm by delivering an electrical shock to the heart. A defibrillator is used when the heartbeat is dangerously fast due to ventricular tachycardia or ventricular fibrillation. Either of these conditions can be life-threatening, because the heart may abruptly stop pumping blood to the body (cardiac arrest). Some defibrillators are external (e.g., defibrillator paddles in an emergency room), and some are surgically implanted in the patient's chest (e.g., an implantable cardioverter defibrillator).
    - Recent advances in technology have allowed people with little training to use automatic external defibrillators (AEDs) in an emergency when medical professionals are not present.
    - The American Heart Association estimates that 20,000 lives would be saved every year in the United States if AEDs were more widely available. The chance of surviving cardiac arrest decreases by 10 percent with every minute that ticks by without defibrillation.
- Cardiac Catheterization
    - Used to study the various functions of the heart or to obtain diagnostic information about the heart or its vessels
    - A small incision is made in an artery or vein in the arm, neck, or groin. The catheter is threaded through the artery or vein into the heart. X-ray images called fluoroscopy are used to guide the insertion.
    - When the catheter is in place, dye is injected to visualize the structures and vessels within the heart.
    - Using different techniques, the coronary arteries can be viewed by injecting dye or opened using balloon angioplasty. The oxygen concentration can be measured across the valves and walls (septa) of the heart and pressures within each chamber of the heart and across the valves can be measured. The technique can even be performed in small, newborn infants.
- PTCA (POBA)
    - Balloon angioplasty is one of three standard treatments for coronary artery disease (CAD) — a disease in which the blood flow to the heart and the body is restricted due to hardened arteries (atherosclerosis). The other standard treatments for CAD are medication and bypass surgery.
    - The goal of balloon angioplasty is to push the fatty plaque back against the artery wall to make more room for blood to flow through the artery. This improved blood flow reduces the risk of heart attack and sudden cardiac death.
    - Physician uses an artery into which a thin tube with an uninflated balloon at the tip (balloon-tipped catheter) will be inserted. He inserts the balloon-tipped catheter through the femoral artery all the way up to the heart
    - Once the balloon-tipped catheter is at the site of the blockage, the balloon at the tip of the catheter is inflated, pushing the plaque in the artery back against the wall of the artery
    - The balloon-tipped catheter is then removed or replaced with a stent (a wire mesh tube used to hold the artery open). The patient is then given time to recover
    - Most patients are free to go home after about 24 hours.
- Stents
    - w/ PTCA
    - everybody gets them
    - The artery must be <2 mm
- Heart Surgery
    - Off pump, better to do surgery this way (let the heart beat naturally)
    - Annuloplasty: Reconstruction of the ring (or annulus) of an incompetent cardiac valve.
- <u>INDICATIONS for doing an ECG</u>
    - Class I You have to do the tests
    - Class 2A You should do the tests
    - Class 2B You don't have to
    - Class 3 You cannot do the tests