# Electrocardiograph

**Type your name here**

# Overview

- Test equipment/supplies
- Clinical applications
- ECG strips
- Lead placement
- Operation
- PM
- Calibration
- Questions

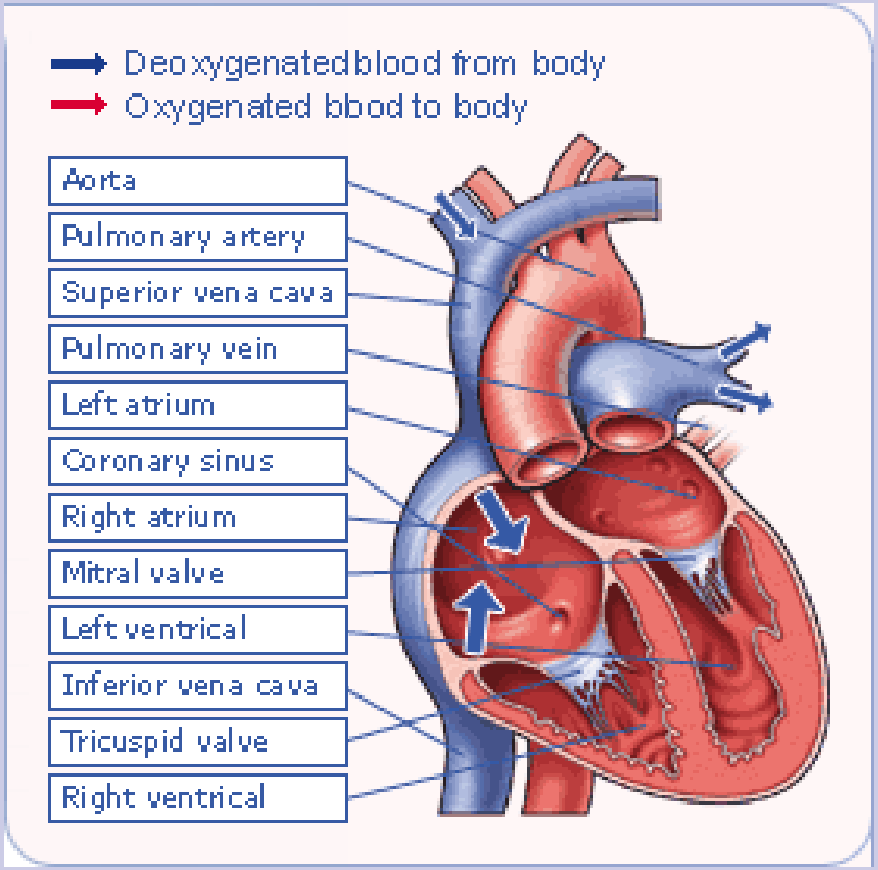
# Test equipment/supplies

- The following test equipment is used for safety and calibration tests for any ECG devices.
  - ECG simulator
  - Electrical safety tester
  - Canned air
  - Nonabrasive cleaner/soap and water

# Electrocardiograph (ECG) and the Heart

***clinical applications***

An ECG diagnoses heart function and conditions by recording the electrical voltage in the heart in the form of a continuous strip graph called an electrocardiogram.

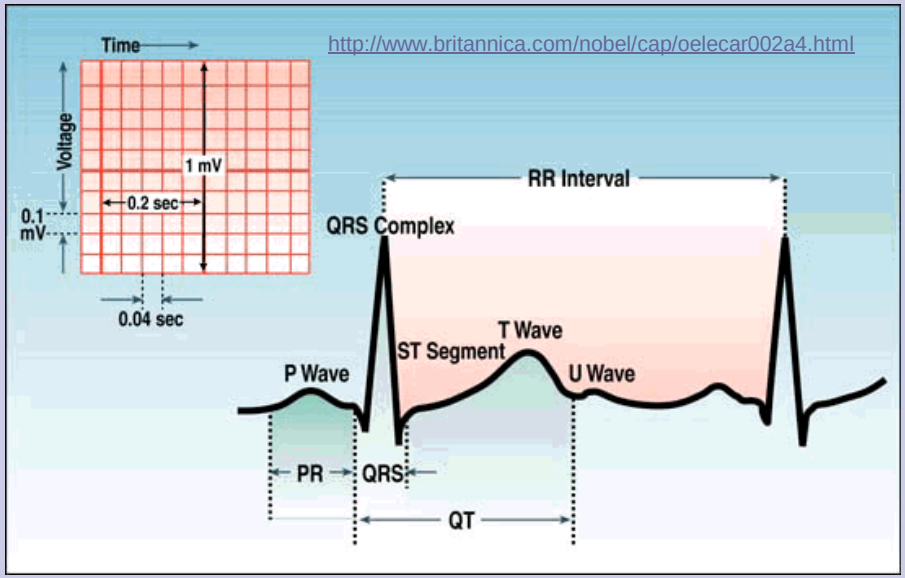



This measured cardiac cycle is a two-phase rhythm consisting of contraction (the systolic phase) and relaxation (the diastolic phase) stimulated and regulated by tiny electrical currents, each equivalent to a millionth of the current in a 100 watt light bulb. The muscular walls of the atria and ventricles, known as the myocardium, continuously produce these.

The whole cycle takes less than a second, so there are some 70 beats a minute when the body is at rest and up to 200 or more during extreme exercise. The fitter you are, the slower your heart rate. Some athletes have a pulse rate of only 35 beats a minute.

# ECG Waves and Intervals

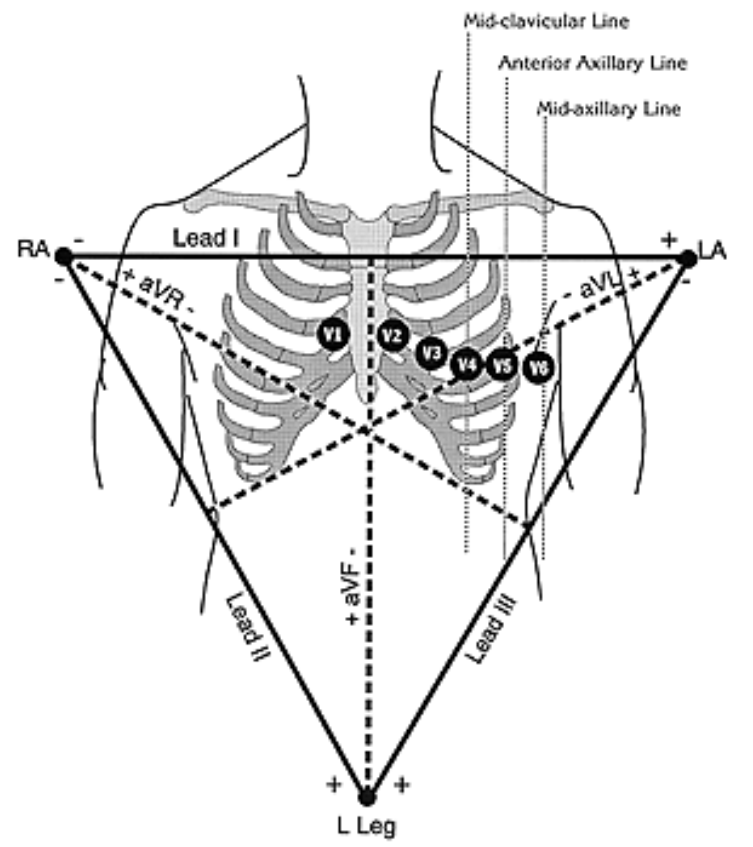
- P wave: depolarization of the right and left atria
- QRS complex: right and left ventricular depolarization (normally the ventricles are activated *simultaneously*)
- ST-T wave: ventricular repolarization
- U wave: origin for this wave is not clear - but probably represents "after-depolarizations" in the ventricles
- PR interval: time interval from onset of atrial depolarization (P wave) to onset of ventricular depolarization (QRS complex)
- QRS duration: duration of ventricular muscle depolarization
- QT interval: duration of ventricular depolarization and repolarization
- RR interval: duration of ventricular cardiac cycle (an indicator of ventricular rate)
- PP interval: duration of atrial cycle (an indicator of atrial rate)




**This diagram illustrates ECG waves and intervals as well as standard time and voltage measures on the ECG paper.**

# Electrode Placement

- The 12-lead ECG provides information about the heart's electrical activity in 3 approximate right-angled directions : Right-Left, Superior-Inferior, Anterior-Posterior
- Each of the 12 leads represents a particular orientation in space:

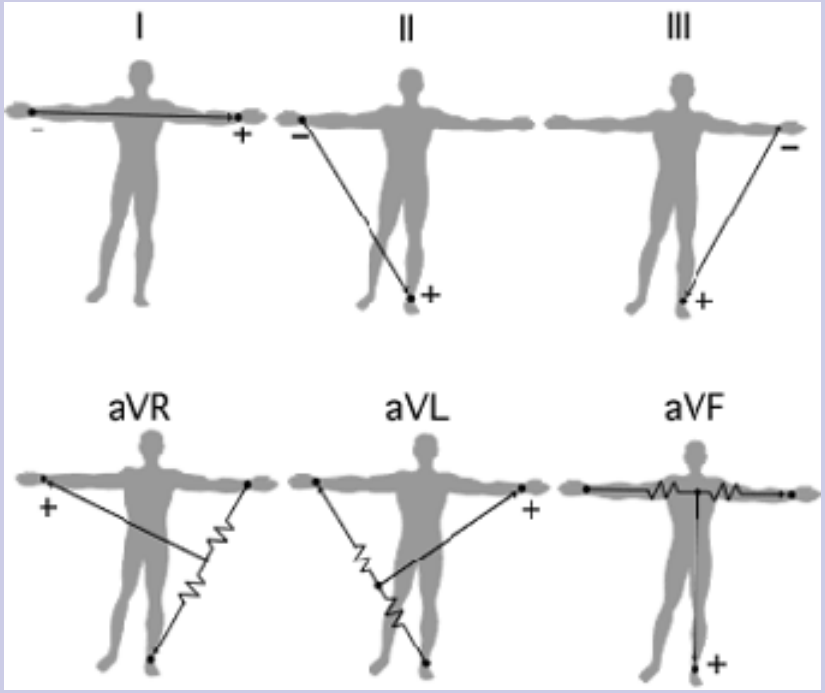



RA = right arm
LA = left arm
LF = left foot
RF = right foot (not shown on diagram)
V1 = 4th intercostal space, just to the right of the sternum.
V2 = 4th intercostal space, just to the left of the sternum.
V4 = On the mid clavicular line & 5th intercostal space.
V6 = On the mid axillary line, horizontal with V4.
V5 = Between V6 & V4.
V3 = Between V4 & V2.

The monitor combines two electrodes together to use as a focal point for some of the electrical tracings. This is why only ten electrodes are used.

# Lead Placement

- The stretch between two limb (arm or leg) electrodes is called a Lead. Mr. Einthoven named the Leads between the three limb electrodes "Standard Lead I, II and III" referring to the two arm electrodes and the left leg electrode. He studied the relationship between these electrodes, forming a triangle where the heart electrically constitutes the null point. The relationship between the Standard Leads is called Einthoven's Triangle. Einthoven's Triangle is used when determining the electrical axis of the heart.




The Standard Leads (top) and the Augmented Leads (bottom) reflect the limb electrodes (left arm, right arm, left leg) used to record the heart's electrical axis in the frontal plane.

A bit of history…**Willem Einthoven** was a Dutch doctor and physiologist. He invented the first practical electrocardiogram (ECG or EKG) in 1903 and received the Nobel Prize in Medicine in 1924 for it.

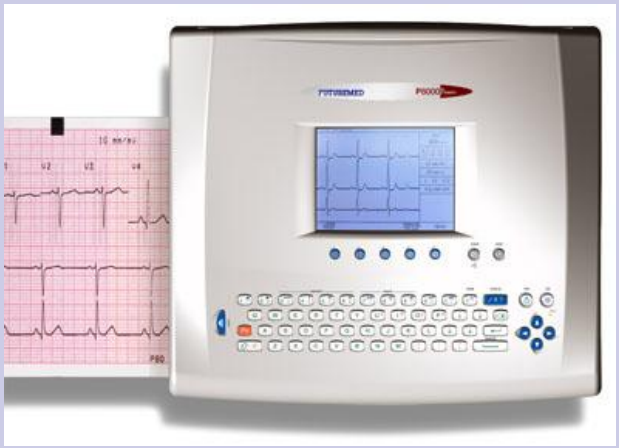
Illustration by Urban Frank.

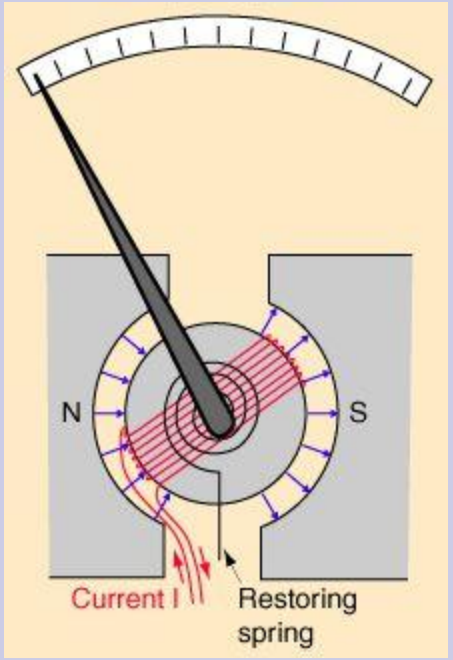
# Electrocardiograph Operation

An electrocardiograph is just a really fancy galvanometer.  A galvanometer is an electromechanical transducer. It produces a rotary deflection, through a limited arc, in response to electric current flowing through its coil. Each electrocardiograph electrode sends an electrical impulse to the machine, producing an electrocardiograph, which is a representation of voltage versus time.

Schiller AT-10
Electrocardiograph

P8000 Power
Electrocardiograph

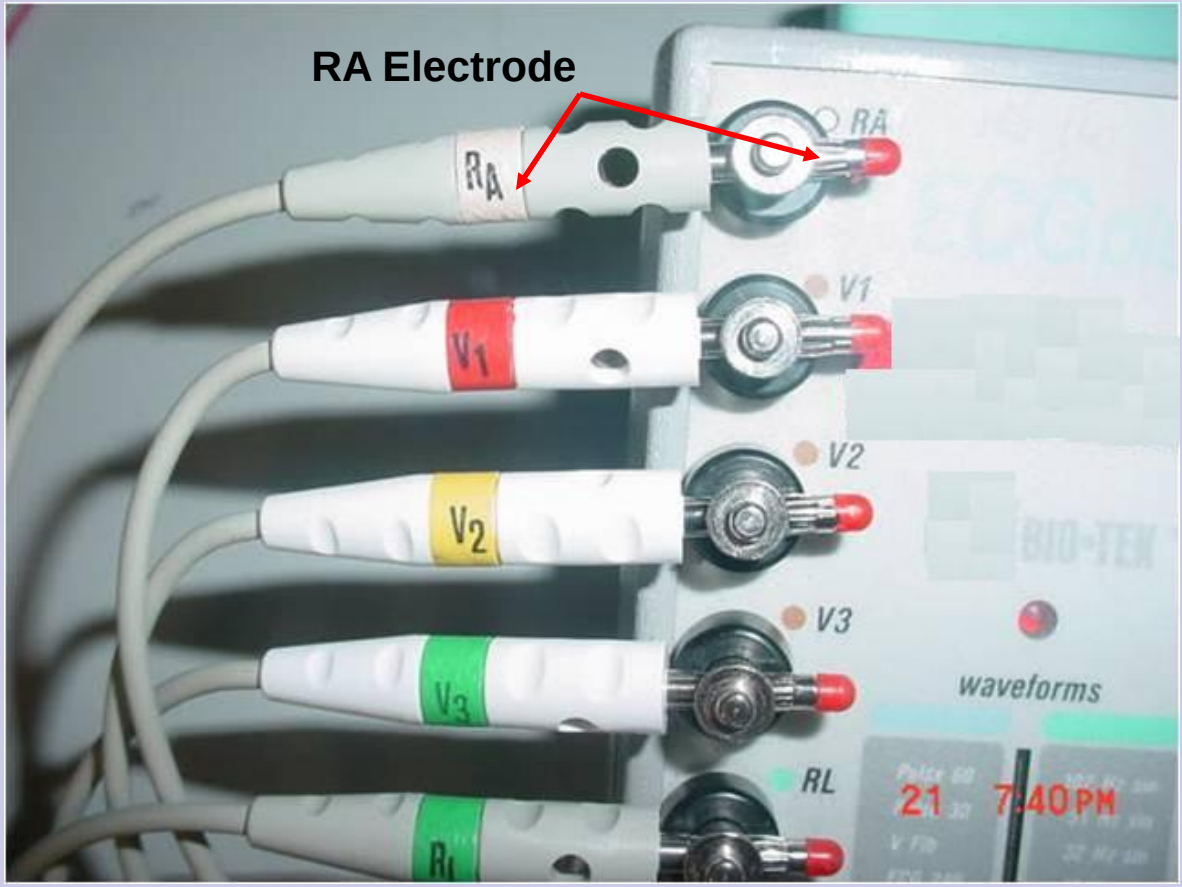





Galvanometer

# Electrode Placement

- The electrodes are connected to the simulator by placing the RA electrode on the connector for RA, the LA electrode on the connector for LA, etc.



# ECG Simulator Operation

- Turn the simulator on. You will be able to measure pulse rates and waveforms. Depending on which leads you connect, you will see specific waveforms. The number of waveforms should equal the number of leads you have connected (with the exception of 10 leads and 12 waveforms). The waveforms are also different from each other and should be labeled on the graph.


# Preventive Maintenance (PM)

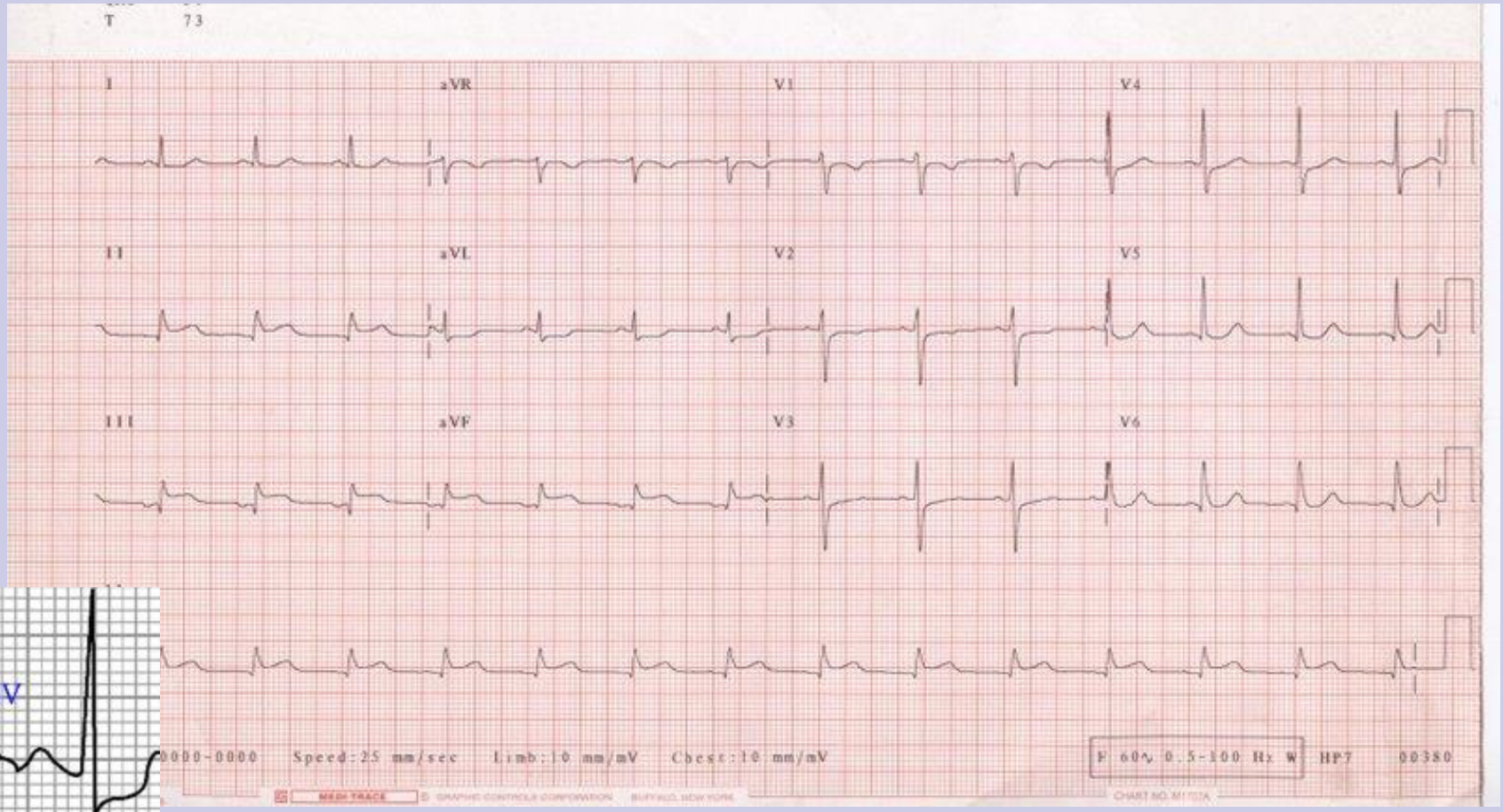
- There are various types of “qualitative (calibration) tests” that can be performed. A recvommend3ed source is E*CRI's* Health Devices Inspection and *Preventive Maintenance* (IPM) System. These may include with recommended tolerances within parenthesis ().  Please check for…
  - Cracked chassis/housing
  - AC Plugged
  - Broken receptacle
  - Cut or frayed strain reliefs
  - Cut or frayed power cord
  - Blown fuses
  - Tripped circuit breakers
  - Frayed or worn cables/connectors
  - Expired accessories dates
  - Worn/dried up electrodes or gel pads
  - Damaged controls/switches
  - Low or dead battery pack
  - No battery charger lights
  - No lights/LEDs/sounds
  - Can’t see or read CRT display
  - Printer doesn’t print characters
  - Unable to read the manufacturer Labels
  - Rubbed off or missing Biomed Stickers

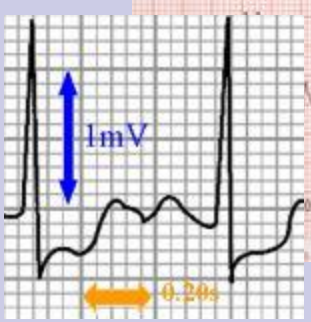
# Calibration

- There are various types of “quantitative (calibration) tests” that can be performed. A recvommend3ed source is E*CRI's* Health Devices Inspection and *Preventive Maintenance* (IPM) System. These may include with recommended tolerances within parenthesis ().
  - Milivolt response at different internal pulses such as 2.5 5, 10, and 20 mm/mv (%% or .5mm).
  - Paper speed set at 100 mm (2mm).
  - Frequency response from .5 – 40 Hz. Checking for irregularities on the waveforms
  - Safety Inspection or lead leakage testing.
  - If performing acceptance or initial inspection testing please check for “crosstalk” between the ;leads or electromagnetic interference of the cables.

# Calibration example

- With sensitivity at 20mm/mV, depress the 1 millivolt button.
- Check to see that the stylus is deflecting 19-21 mm, or 9-11 small squares.



# Sources


- The Alan E. Lindsay ECG Learning Center: http://medstat.med.utah.edu/kw/ecg/
- Healthy Heart Programme: http://www.heartpro.co.uk/human-heart-p-32.html
- Bellingham Fire Department/Whatcom Medic One: http://www.cob.org/fire/Education/ekg_leads.htm
- Wikipedia Encyclopedia: http://en.wikipedia.org/wiki/Image:ECG_001.jpg
- Health Devices Inspection and Preventative Maintenance Systems Procedure/Checklist 410-0595 by ECRI.

# Questions