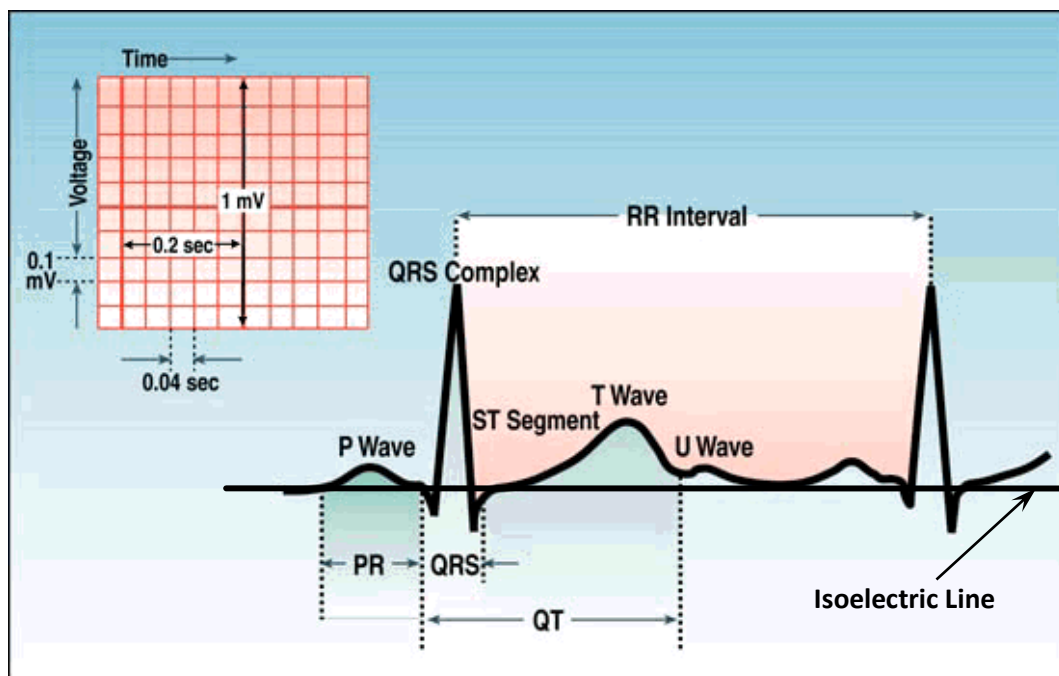


M3. Electrical activity of the heart. Electrocardiography. Determination of the heart's electrical vector.

Problems to be prepared:

- Fundamentals of the electrostatics, electric charge [1] – Chap. 21-2, conductors and insulators – Chap. 21-3, Coulomb's law – Chap. 21-4, the electric field – Chap. 22-2 and the electric potential – Chap. 24-3
- Fundamentals of the electric current [1] – Chaps. 26-2 and 26-3 and Ohm's law – Chap. 26-5
- Fundamentals of the electric circuit [1] – Chaps. 27-2 through 27-6
- Heart Electrical Activity. The Einthoven triangle. The cardiac vector.
- Electrocardiography: the methods of registration, the electrocardiogram.

The ECG is the most commonly performed cardiac test. An electrocardiogram is a test that measures the electrical activity of the heartbeat. As the heart undergoes depolarization and repolarization, the electrical currents that are generated spread not only within the heart, but also throughout the body. This electrical activity generated by the heart can be measured by an array of electrodes placed on the body surface. An ECG gives two major kinds of information. First, by measuring time intervals on the ECG, a doctor can determine how long the electrical wave takes to pass through the heart. Second, by measuring the amount of electrical activity passing through the heart muscle, a cardiologist may be able to find out if parts of the heart are too large or are overworked.



P Waves - atrial depolarization

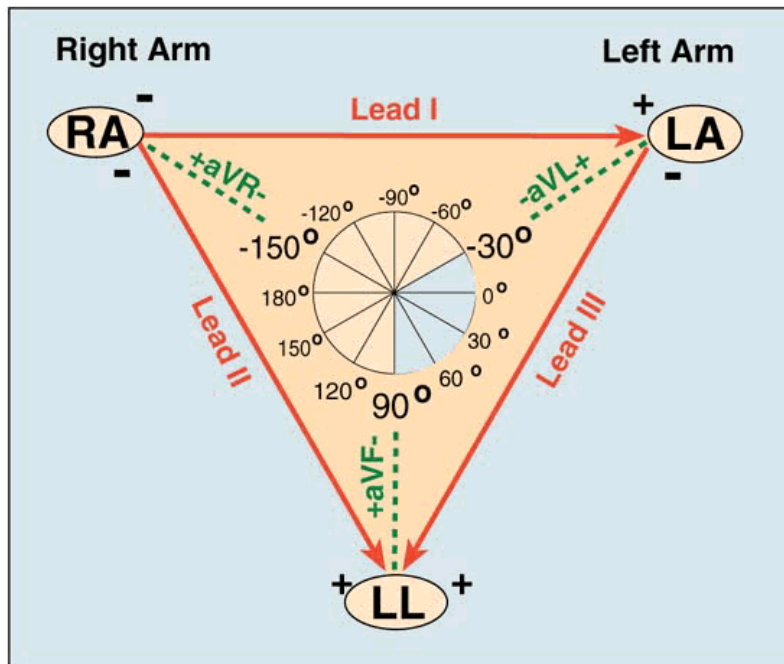
QRS Complex – ventricular depolarization

T Wave – repolarization of ventricles

U Wave – repolarization of Purkinje fibers

Isoelectric Line – baseline voltage of the electrocardiogram

The cardiac vector indicates the direction of the depolarization in time. The ECG measured from any one pair of the bipolar leads is a time variant, single dimensional projection of the cardiac vector and could be represented using the Einthoven triangle



Einthoven's triangle provides a way to understand the amplitude of the ECG waves. One way to verify that your data is correct is to plot the cardiac vector into the Einthoven triangle. For this:

- 1) construct an equilateral triangle with the base on top. Top will be lead I, right = lead III and left = lead II
- 2) from the middle point of each side, plot on the corresponding lead (triangle side) a segment of magnitude proportional to the amplitude of the QRS complex.
- 3) trace a line perpendicular to the segment at each end of the segment.

The perpendicular lines corresponding to the initial point of the vectors will intersect in the center of the triangle; the perpendiculars traced from the end of the vector should also intersect at one point. The line between the two intersections shows the orientation of the heart.

Instruction

1. Measure the pressure of the blood of examined patient using the Korotkow's method; (look the instruction)
2. Perform the standard, resting ECG. You should to undress to the waist and lie down on a bed. Please stuck onto your arms, legs and chest a number of sticky patches called electrodes.

The electrodes are attached to a recording machine by wires. When your heart beats, it produces electrical signals which are picked up by the electrodes and transmitted to the recording machine. The machine then prints a record of your heartbeat onto a paper strip. You should lie still when the recording is being taken as moving can affect the reading

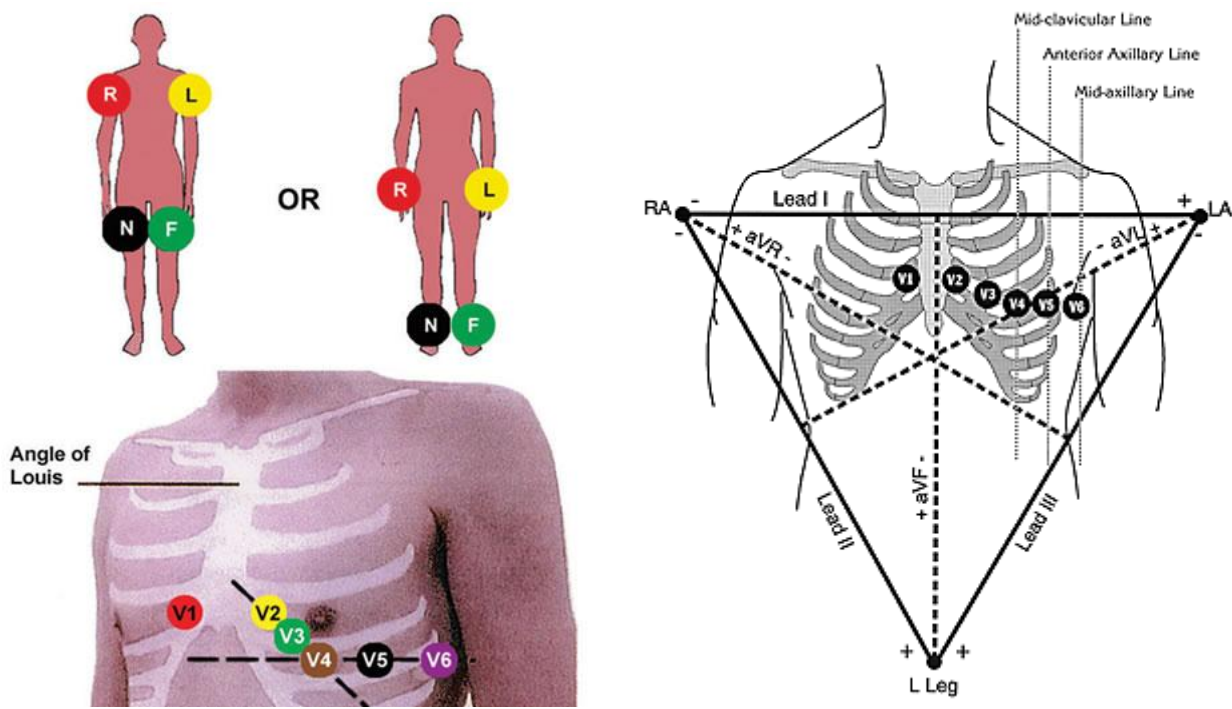
The electrocardiograph AsCARD is equipped with a 10-electrodepatient's cable. In order to receive 12 standard leads of Einthoven, Goldberger, Wilson, the electrodes should be attached in the following way (in parentheses electrode label in the USA):

Limb electrodes:


- R (RA) – red On the right arm, avoiding bony prominences.
- Y (LA) – yellow In the same location that R was placed, but on the left arm this time.
- F (LL) – green On the left leg, avoiding bony prominences
- N (RL) – black In the same location that F was placed, but on the right leg this time.

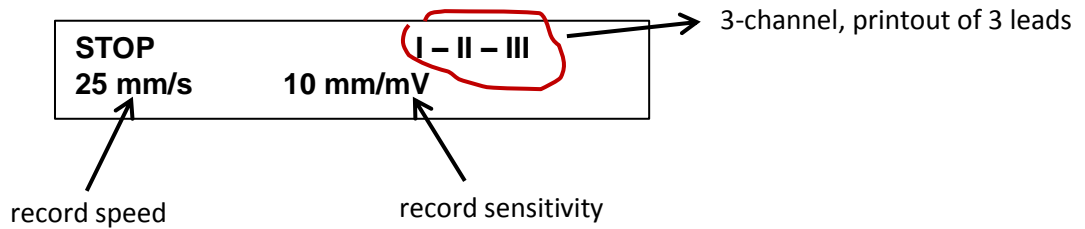
Precardiac electrodes:

- C1 (V1) white-red in the fourth intercostal space just to the right of the sternum
- C2 (V2) white-yellow in the fourth intercostal space just to the left of the sternum
- C3 (V3) white-green half way between C2 (V2) and C4 (V4)
- C4 (V4) white-brown the fifth intercostals space in the mid-clavicular line (the imaginary line that extends down from the midpoint of the clavicle).
- C5 (V5) white-black Horizontally even with V4, but in the anterior axillary line. (The anterior axillary line is the imaginary line that runs down from the point midway between the middle of the clavicle and the lateral end of the clavicle; the lateral end of the collarbone is the end closer to the arm.)
- C6 (V6) white-violet Horizontally even with V4 and V5 in the midaxillary line. (The midaxillary line is the imaginary line that extends down from the middle of the patient's armpit.)

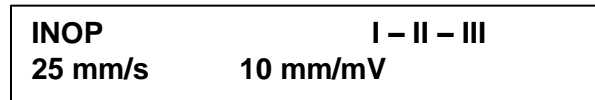


3. Check if the power cord is plugged into an electric socket and turn power on using the switch on back site of ECG recorder.

4. Switch on electrocardiograph by pressing . On the screen you will see:





The unit control the electrodes contact with the patient's body and signalizes poor contact with INOP.



When INOP is signalized, the ECG Leads are printed as a straight lines. It doesn't matter which electrode is badly connected. Check the contact on each electrode.


5. The device enables to input your data (name, age, sex, blood pre, etc.). In order to do it press ENTER key. Exit from data insertion mode is performed by pressing ESC key.


6. Choose record speed by pressing . Please set up the record speed for 25 mm/s.


7. Choose record sensitivity by pressing . Please set up the record sensitivity for 10 mm/mV.

8. It is possible to make ECG examination in below given modes:


- 1-chanel printout of 1 lead
- 3-chanel printout of 3 leads
- 6-chanel printout of 6 leads

To change the mode use the  key. Please set up the unit for 6-channel mode.

9. Chose leads to record by pressing . When you are working in 6-chanel mode it is possible to chose 2 different groups of ECG leads: I-II-III, aVR-aVL-aVF, and V1-V2-V3, V4-V5-V6.

10. Pres the key . The unit starts electrocardiogram registration. During the electrocardiogram record please change ECD leads. Every parameter's change is automatically described on the display and registered on the electrocardiogram.

11. Perform a short recording at a speed of 25 mm/s and sensitivity 10 mm/mV for groups of ECG leads I-II-III, aVR-aVL-aVF, and V1-V2-V3, V4-V5-V6.

12. Press the  key – than registration is stopped.

13. After test examined person is asked to take physical exercise (e.g. squats, the intense jumps, runs a corridor ...). Next measure the blood pressure and perform the ECG test one more time.

In the report:

- determine the duration of particular phenomena in the heart (complete the Tables)
- calculate frequency of impulses in the heart on the basis of RR interval
- plot on graph paper the instantaneous cardiac vector using the R wave. Mark on the electrocardiogram position from which data were taken. Graph and recorded ECG attach to the report.
- make the conclusions.

	Resting ECG		After exercise	
	Length (mm)	Duration (s)	Length (mm)	Duration (s)
RR Interval				
PR Interval				
QRS Duration				
QT Interval				

	systolic pressure	diastolic pressure
At rest		
After exercise		

Blood pressure measurement using the Korotkow's method

1. Please seat at a table in a relaxed but not slouched position, with feet flat on the floor. Place your right arm on the table. Your arm should be slightly bent so that it is at the same level as your heart.
2. Wrap the blood pressure cuff snugly around your upper arm, positioning it so that the lower edge of the cuff is 1 inch above the bend of the elbow.
3. Place the head of the stethoscope below the cuff on the inside of the elbow.



4. Palpate the radial pulse with the index and middle fingers near the base of the thumb on the anterior surface of the wrist.
4. Close the valve on the rubber inflating bulb and then squeeze it rapidly to inflate the cuff until the indicating needle reads 30 mmHg higher than the pressure at which the radial pulse disappeared. Do not exceed 180 mmHg.
5. Set the valve on the rubber bulb so that the pressure leaks out slowly (about 5 mm per second).
6. The pressure at which the sound was first heard is recorded as systolic blood pressure. Allow the pressure to continue to fall. As the air continues to be let out, the sounds will disappear. The point at which the sound disappears is recorded as diastolic pressure.
7. The results write down in the table.

[1] Walker J., Halliday and Resnick, *Principles of physics : international student version*, 9 th ed., extended, Hoboken : John Wiley & Sons, Inc., 2011. , ISBN 978-0-470-56158-4