Monitoring of vital signs on a model system

Monitoring is continual visualization of measured and derived specific values of vital functions. The important part of monitoring is signalizing of marginal states of derived value, which immediately or the later activates an acoustic or a visual physiological alarm, if they exceeded the limits.

1. Monitoring of the electrical activity hear (ECG - electrocardiogram)

Instrumental oscilloscope monitoring of the electrical activity of the heart is the oldest electronic monitoring method whatsoever and today without ECG monitors is running of intensive care units and operating theaters practical unthinkable.

Monitoring of ECG usually requires to use of monitoring leads (the most common 12 leads). However, a number of electrodes of the monitoring cable is limited to 3, 4 or 5. A limited number of electrodes of monitoring cable is the cause for of investigation of their optimal location on the patient´s body to obtain the greatest possible likelihood of capture of starting myocardial ischemia and rhythm disorders of the heart. In assessment of arrhythmias it should be considered that monitoring leads serve only as a warning and as a basic orientation of abnormal heart rhythm, as well as monitoring the response of the electrical activity of the heart muscle for the acute treatment

For the detection of myocardial ischemia (ST segment depression) are sensitive unipolar chest leads V_1 – V_5 (V_5 is most sensitive of them) and less sensitive are standard lead II and lead VF.

A three-electrode monitoring cable usually allows to monitor of standard leads I, II and III. With a specific location of three electrodes on the patient´s body we get modified leads. These leads allow to simulate using 3 electrodes some of the unipolar chest leads. The modified monitoring leads are: MCL - Modified Chest Lead, CS_5 - Central Subclavicular Lead (it is suitable for detecting cardiac ischemia of the heart´s front wall), CB_5 - Central Back Lead (it is suitable for detection of ischemia and during open-chest surgery operation).

1.1 <u>Introduction of monitoring ECG electrodes</u>

1. Before placing the electrodes prepare the patient's skin and connect to the electrode terminals or snap fasteners of lead conductors and apply conductive paste on the electrodes, when the electrodes are not already supplied with conductive paste

2. Place the electrodes on the patient.

Electrode Placement (Fig.1):

- **Red** electrode – is located near the right shoulder – directly below the clavicle
- **Yellow** electrode – is positioned near the left shoulder, directly below the clavicle
- **Green** electrode – is placed on the left of hypogastrium (area below the stomach)

3. Plug the patient cable with electrode leads in the ECG connector on the side panel of the monitor

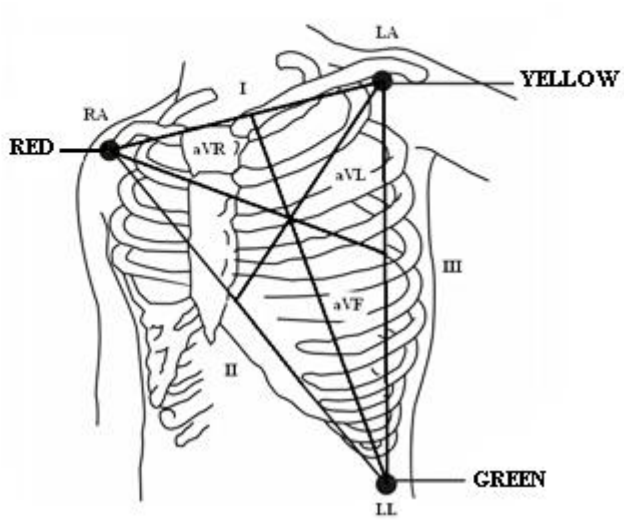

Fig. 1 Einthoven´s triangle and standard bipolar leads

ECG monitoring device shows a continuous curve of the cardiac electrical activity of the patient and allows an accurate assessment of its current physiological state (Fig. 2).

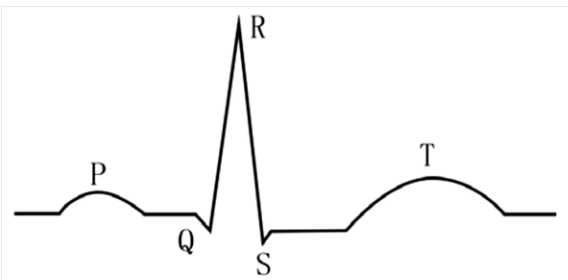

Fig. 2 Standard ECG waveform

2. Non-invasive monitoring of systemic arterial blood pressure (NIBP)

The use of automatic devices for measuring blood pressure has become a great asset for the needs of intensive care units and anesthesiology.

Oscillometric method (non-invasive measurement of blood pressure) uses the fact that when you press the artery with the cuff arise the pneumatic pulsations in cuff, similar to the Korotkov´s sounds (Fig. 3). Suppose that the cuff is inflated above the patient's systolic pressure. In subsequent slow deflation of the cuff, the onset of pulsations in the cuff correlates with the systolic pressure of the patient. The maximum amplitude of pulsations is corresponding to the mean arterial pressure and the disappearance of pulsations in the cuff is correlated with diastolic pressure. In addition to systolic and diastolic blood pressure values is also measured the mean arterial pressure and the heart rate.

The value of systolic and diastolic pressure is not determined from the onset and disappearance of pneumatic pulsations, but systolic and diastolic value is derived mathematically, when on the basis of the detection of maximum pulsations and evaluation of increase in speed and decrease of pulsations, are by the mathematical approximation set distances from the maximum (mean) value, which corresponding to systolic and diastolic pressure.

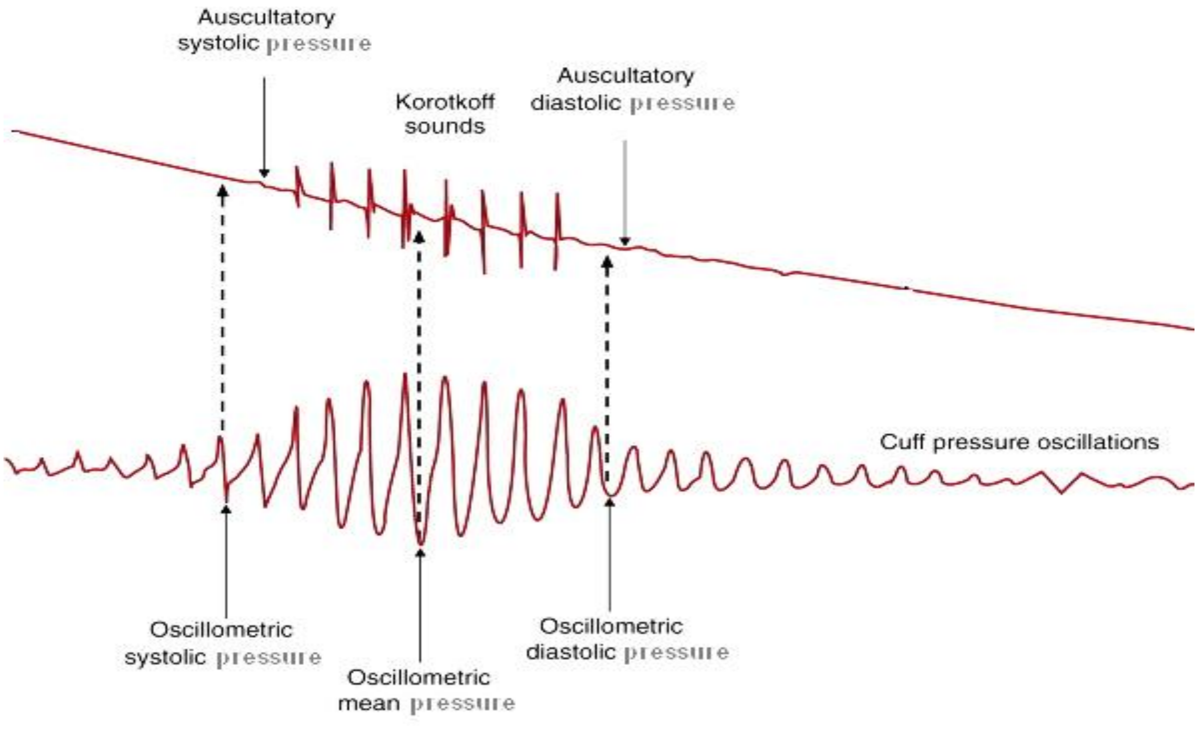

Fig. 3 Measurement of systemic arterial pressure according to oscillometric method

2.1 <u>Introduction of monitoring NIBP cuff</u>

1. Plug the air hose in the NIBP cuff connector of the monitor
2. Apply a cuff of proper size to the upper arm (Fig. 4)
3. Connect the cuff with the air hose

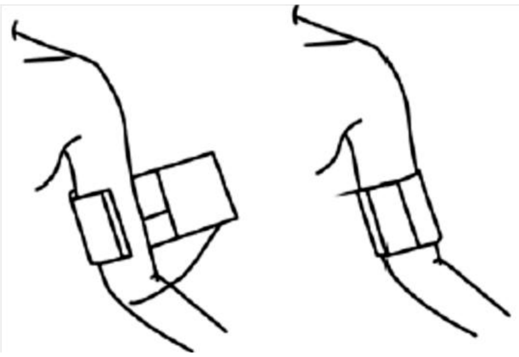

Fig. 4 Application of the cuff

3. Non-invasive monitoring of oxygen saturation of the hemoglobin – pulse oximetry (SpO_2)

The method of pulse oximetry (pletyzmographic pulse oximetry) is a standard method of estimating oxygenation of patient by measuring the saturation of hemoglobin by oxygen in arterial blood.

It measures how much light (which is sent out a light source on the one side of the sensor) goes through patient tissue (such as a finger or ear) to a receiving element on the other side of the sensor. The amount of light transmitted depends on several factors, most of which are constant. However, one of these factors „arterial blood flow“ changes over time because he is pulsating. Measuring the absorption of light during the pulsations can be derived oxygen saturation in arterial blood. Detection of pulsations creates pletyzmographic curve [PLETH] and signal of pulse frequency (plethysmography - shows the activity of blood vessels, measurement of their pulse volume).

3.1 <u>Introduction of monitoring SpO_2 sensor</u>

- according to task in practical exercise – pulse oxymetry (Fig. 5)

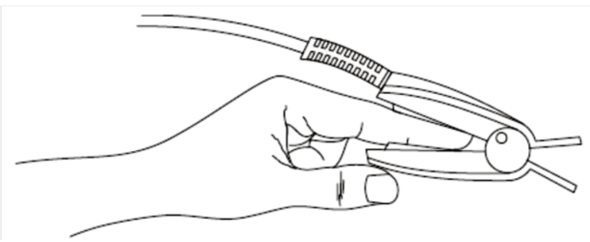

Fig. 5 Location of the SpO_2 sensor

4. Monitoring of respiratory activity - Impedance method for monitoring of chest excursions (RESP)

By monitoring the impedance changes (electrical resistance) of the chest during breathing excursions are used the ECG electrodes. Between the two ECG electrodes, outside the frequency band of ECG, passes through the patient's chest the high frequency alternating current of low intensity (100 uA/100 kHz). This passing current allows to assess impedance of the tissue between these two electrodes. Impedance of the chest is changed depending on the excursions during breathing. It is assumed that the change in impedance of the chest during connected mainly with the movement and the change in volume of an interpleural fluid and with the change in volume of a gas mixture in the airways.

Some patients due to their clinical condition expand the chest laterally (sideways) and so they create a negative intrathoracic pressure. In these cases, it is better for optimalization of the respiratory curve to place two RESP electrodes laterally to the right armpit and on the left side of the chest to the place with the maximum respiratory motion.

4.1 Introduction of respiratory monitoring electrodes

1. Before placing the electrodes prepare the patient's skin and connect to the electrode terminals or snap fasteners of lead conductors.

2. Place the electrodes on the patient. Before placing apply conductive paste on the electrodes, when the electrodes are not already supplied with conductive paste.

Electrode placement (Fig. 6):

- Place the RA and LL electrode diagonally. Try to avoid placing the electrodes so the liver area and the ventricles of the heart are in path between the electrodes used for respiration, to avoid cardiac artifact to overlay on the ECG.

3. Plug the patient cable with electrode leads in the ECG connector on the side panel of the monitor.

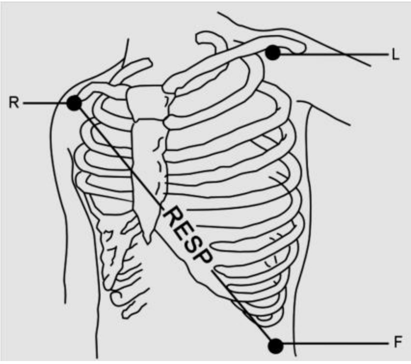

Fig. 6 Placement of the electrodes for monitoring of respiration

5. Monitoring of body temperature (TEMP)

The body temperature of the patient belongs to basic monitoring parameters. Current status of monitoring of this important parameter is not too favorable in common practice when is administered the anesthesia and during resuscitation or on the intensive care unit in an adult patient. It is caused partly due to technical problems and due to lack of aids for proper monitoring of this parameter, and partly due to lack use of means to ensure patient´s normotherms during surgery (heating mattresses, heaters of infusion fluids, thermal humidifier).

In terms the temperature gradients of tissue are distinguished: a core body temperature, an intermedia temperature (average) and a skin temperature. In terms of monitoring we deemed the core body temperature of the eardrum temperature (tympanic membrane), the temperature in the pulmonary artery, the temperature of the lower third of the stomach and the temperature in the nasopharynx are considered as the core body temperature, too. With the exception of major disorders of thermoregulation in common practice can be considered as the core body temperature also the oral and the axillary temperature.

Temperature variation of the electrical resistance of the electronic element is a principle used and applied for monitoring of body temperature using electronic monitors. As an electronic device it is the most commonly useda thermistor, which electrical resistance decreases with increasing temperature. The advantage of the thermistor is relatively fast response to temperature changes and the possibility of miniaturization of this element. Thermistor can be widely used in the construction of electronic monitoring temperature probes for all modes and options monitoring of body temperature. Using a thermistor is smooth measurement of temperature in body cavities. When measuring the temperature on the surface of the skin (axillary) poses the problem of ensuring the thermistor surface area in contact with the surface of the skin and this problem may also be the cause of incorrect data about the measured temperature.

5.1 Introduction of monitoring temperature probe

1. Plug the temperature probe cable in the temperature probe connector on the side panel of the monitor.
2. Attach the temperature probe to the patient properly

Portable Multi-parameter Patient Monitor MEC-1200

Portable Multi-parameter Patient Monitor MEC-1200 is designed for inpatient monitoring of vital functions in adults, children and newborns.

This monitor is capable of monitoring the following parameters:

Electrocardiogram (ECG)	- Heart rate (HR)
	- ECG waveform(s)
	- S-T segment analysis
	- Arrhytmia analysis
Respiratory frequency (RESP)	- Respiratory rate (RR)
	- Respiration waveform
Pulse oxymetry (SpO_2)	- Oxygen saturation (SpO_2), Pulse rate (PR)
	- SpO_2 plethysmogram
Non-invasive blood pressure (NIBP)	- Systolic pressure (NS), diastolic pressure (ND), mean pressure (nM)
Temperature (TEMP)	- Temperature

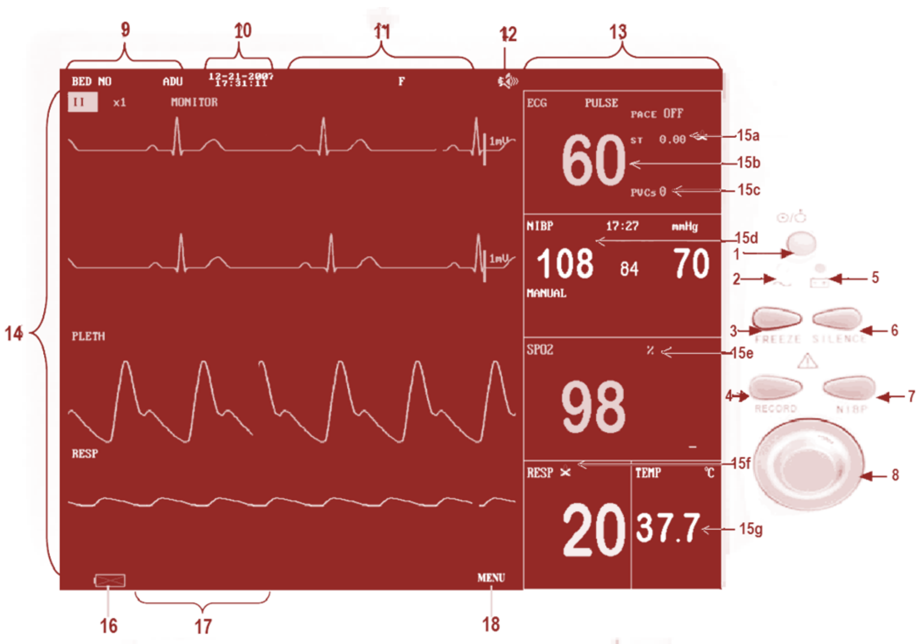

Fig. 7 Portable Multi-parameter Patient Monitor MEC-1200

Control panel:

1 Power switch, **2** AC power indicator, **3** FREEZE, **4** RECORD, **5** Battery indicator, **6** SILENCE, **7** NIBP, **8** Control Knob,

Display:

9 Patient information area, **10** System time, **11** Technical alarms area, **12** Sound icon, **13** Physiological alarms area, **14** Waveforms area. **15** Parameter Windows (**15a** ST analysis, **15b** HR n. PR, **15c** PVC, **15d** NIBP, **15e** SpO_2, **15f** RESP, **15g** TEMP) **16** Battery symbol, **17** Prompt information area, **18** MENU label