# BASICS OF BIOMEDICAL INSTRUMENTATION

#### UNIT IV MEASUREMENT OF NON-ELECTRICALPARAMETERS

# IV UNIT

 UNIT IV MEASUREMENT OF NON-**ELECTRICALPARAMETERS** Temperature, respiration rate and pulse rate measurements. Blood Pressure: indirect methods - Auscultatory method, direct methods: electronic manometer, Systolic, diastolic pressure, Blood flow and cardiac output measurement: Indicator dilution, and dye dilution method, ultrasound blood flow measurement.

#### Temperature measurement

 Body temperature is a measure of your body's ability to make and get rid of heat. If you tell your doctor about your temperature reading, be sure to say where it was taken: on the forehead or in the mouth, rectum, armpit, or ear. Normal: The average normal temperature is 98.6°F (37°C).  The average normal body temperature is generally accepted as 98.6°F (37°C). Some studies have shown that the "normal" body **temperature** can have a wide **range**, from 97°F (36.1°C) to 99°F (37.2°C). A temperature over 100.4°F (38°C) most often means you have a **fever** caused by an infection or illness

#### Systematic temperature

- Summary. Systematic errors in temperature measurement are inevitable because of finite heat transfer rate between the system whose temperature is being measured and the sensor that is interrogating
  - it. Systematic errors are situation dependent.

... **Temperature** error is essentially due to conduction along the lead wires

## thermistor

 A thermistor is a resistance thermometer, or a resistor whose resistance is dependent on temperature. The term is a combination of "thermal" and "resistor". It is made of metallic oxides, pressed into a bead, disk, or cylindrical shape and then encapsulated with an impermeable material such as epoxy or glass.

## Thermocouple

• A **Thermocouple** is a sensor used to measure temperature. Thermocouples consist of two wire legs made from different metals. The wires legs are welded together at one end, creating a junction. This junction is where the temperature is measured. When the junction experiences a change in temperature, a voltage is created.

#### Skin temperature

Skin temperature is the temperature of the outermost surface of the body. Normal human skin temperature on the trunk of the body varies between 33.5 and 36.9 °C (92.3 and 98.4 °F), though the skin's temperature is lower over protruding parts, like the nose, and higher over muscles and active organs.

#### thermometer

 A thermometer is a device that measures temperature or a temperature gradient A thermometer has two important elements: (1) a temperature sensor (e.g. the ...Dimension measured:

#### thermometer

• Determine agreement between three different types of temperature-measuring instruments: the temporal artery scanner, the digital oral thermometer, and the **infrared** tympanic thermometer calibrated to an oral setting, in pediatric patients who are febrile and afebrile.

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## **Types of pulses**

The **pulse** felt on the neck is called the carotid **pulse**. When felt on the groin, it is called the femoral **pulse**. The **pulse** at your wrist is called the radial **pulse**. The pedal **pulse** is on the foot, and the brachial **pulse** is under the elbow

#### pulse rate vs heartbeat

 The pulse rate is exactly equal to the heartbeat, as the contractions of the heart cause the increases in blood pressure in the arteries that lead to a noticeable pulse. Taking the pulse is, therefore, a direct measure of heart rate.

#### factors affect our heart rat

 Myriad factors affect our heart rate, including our age, medical conditions, medications, diet, and fitness level. Today, we're even more aware of our heart rate, thanks to devices such as smartwatches that can measure every beat during rest and exercise

## Healthy pulse rate

• A **normal** resting **heart rate** for adults ranges from 60 to 100 beats per minute. Generally, a lower heart rate at rest implies more efficient heart function and better cardiovascular fitness. For example, a welltrained athlete might have a **normal** resting **heart rate** closer to 40 beats per minute.

#### Pulse rate measurements

 A pulse oximeter is a small, lightweight device used to monitor the amount of oxygen carried in the body. This noninvasive tool attaches painlessly to your fingertip, sending two wavelengths of light through the finger to measure your pulse rate and how much oxygen is in your system.

#### Pulse rate measurements

 A heart rate monitor (HRM) is a personal monitoring device that allows one to measure/display heart rate in real time or record the heart rate for later study.

## pulse oximeter

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#### pulse rate

 Your pulse rate is the number of times your heart beats per minute. A normal resting heart rate should be 60–100 beats per minute, but it can vary from minute to minute.

## Methodes

- 1. transmittnane methodes
- 2.Reflectance metodes

## Respiration rate-Methodes Impedance pneumography

 Impedance pneumography is a technique for measuring instantaneous lung aeration changes (breathing) as changes in the thoracic electrical impedance through skin electrodes

#### Principle of operation

• There are various kinds of pneumographic devices, which have different principles of operation. In one mechanism, a flexible rubber vessel is attached to the chest. The vessel is equipped with sensors. Others are impedance based. In these methods, a high frequency (tens to hundreds of kHz) low amplitude current is injected across the chest cavity. The voltage resulting from this current injection is measured and the resistance is derived from the application of Ohm's law (R = V/I). Current flows less easily through the chest as the lungs fill, so the resistance rises with increasing lung volume.

#### blockdiagram



#### Co2 methodes



#### Apnoea detectors



Figure 2.24 Block diagram of apnoea monitor

#### Blood Pressure: indirect methods

• Blood pressure is measured in millimeters of mercury (mm Hg). A blood pressure measurement has two numbers: The top number (systolic) is the **pressure** of the **blood** flow when your heart muscle contracts, pumping **blood**. The bottom number (diastolic) is the **pressure** measured between heartbeats

#### Blood Pressure: indirect methods

 What are normal blood pressure numbers? A normal blood pressure level is less than 120/80 mmHg. No matter your age, you can take steps each day to keep your blood pressure in a healthy range

#### Blood Pressure: indirect methods



Indirect Blood Pressure Measurement - Sphygmomanometer

#### Know your blood pressure readings

BLOOD PRESSURE	SYSTOLIC mm HG (top number)		DIASTOLIC mm HG (bottom number)
Normal	<120	AND	<80
Elevated	120–129	AND	<80
<b>High blood pressure</b> (Stage 1 hypertension)	130–139	OR	80-89
<b>High blood pressure</b> (Stage 2 hypertension)	>140	OR	>90
Hypertensive crisis (Seek medical attention)	>180	AND/ OR	>120

Source: American Heart Association

INSIDER



#### Blood Pressure: direct methods

#### **Blood Pressure**

- An Individuals blood pressure is a standard clinical measurement
- Is considered a good indicator of the status of the cardiovascular system.
- Blood pressure values in the various chambers of the heart and in the peripheral vascular system help the physician determine the functional integrity of the cardio vascular system.

#### **Blood Pressure Measurement**

- Direct (invasive)
  - 1. Extravascular Method
    - The vascular pressure is coupled to an external sensor element via a liquid filled catheter.

[Catheter – is a long tube introduced into the heart or a major vessel by way of a superficial vein or artery.]

#### 2. Intravascular

 A sensor is placed into the tip of a catheter that is placed in the vascular system.

#### Indirect (non invasive)

#### Sphygmomanometer

Consists of an inflatable pressure cuff and a manometer to measure the pressure in the cuff.



#### Direct Measurement Intravascular

- The sensor is placed at the tip of the catheter.
- Enables the physician to obtain a high frequency response in detection of pressures at the tip of the catheter.
- Types of sensors
  - 1. Strain-gage systems
    - bonded onto a flexible diaphragm at the catheter tip.
  - 2. Fibre-optic device
    - Measures the displacement of the diaphragm optically by varying reflection of light from the back of the deflecting diaphragm.

#### Direct Measurement Extra Vascular

- The extra vascular sensor system is made up of a catheter.
- The catheter is connected to a three way stopcock and then to a pressure sensor
- It is filled with a saline-heparin solution.
- It must be flushed with solution every few minutes to prevent blood clotting at the tip.

## Systolic, diastolic pressure

 The top number refers to the amount of pressure in your arteries during the contraction of your heart muscle. This is called systolic pressure. The bottom number refers to your blood pressure when your heart muscle is between beats. This is called diastolic pressure.

### Systolic, diastolic pressure

 Blood pressure is measured using two numbers: The first number, called systolic blood pressure, measures the pressure in your arteries when your heart beats. The second number, called diastolic blood pressure, measures the pressure in your arteries when your heart rests between beats.

## difference

 Blood pressure readings are given in two numbers. The top number is the maximum pressure your heart exerts while beating (systolic pressure). The bottom number is the amount of pressure in your arteries between beats (diastolic pressure)

#### What are Systolic and Diastolic Blood Pressures?





#### Blood flow measurement:

 The most commonly employed techniques for the in vivo measurement of arterial blood flow to individual organs involve the use of flow probes or sensors. Commercially available systems for the measurement of in vivo blood flow can be divided into two categories: ultrasonic and electromagnetic. The total volume of **blood** that passes a certain point in the vascular tree within a given period of time is known as the bulk **flow** and is expressed in units of cm<sup>3</sup>/sec. The average **blood** velocity (V) equals the bulk **flow** (Q) divided by the cross-sectional area (A) of the vessel: V = О/А.

#### INTRODUCTION

- Blood flow is the one of the important physiological parameter and the most difficult to measure accurately.
- The average velocities of blood flow vary over a wide range depending on diameter of blood vessel.
- There are many techniques for measuring the blood flow and velocity.
- They are categorized into 1.invasive(surgical).

2.non invasive(through the skin).

#### Magnetic blood flow meter





#### **Ultrasonic Blood Flow Meters**

• A beam of ultrasonic energy is used to measure the velocity of flowing blood.

. Lead zirconate titanate is a crystal that has the highest conversion efficiency.

- Two types:
  - Transit time flow meters
  - Doppler type.

#### Doppler type

**Doppler Type Ultrasonic Flow Meters** 



#### cardiac output measurement

 Cardiac output (CO) is the product of the heart rate (HR), i.e. the number of heartbeats per minute (bpm), and the stroke volume (SV), which is the volume of blood pumped from the ventricle per beat; thus, CO = HR × SV. Values for cardiac output are usually denoted as L/min.  Cardiac output is calculated by multiplying the stroke volume by the heart rate. Stroke volume is determined by preload, contractility, and afterload. The normal range for cardiac output is about 4 to 8 L/min, but it can vary depending on the body's metabolic needs.