Basic Patient Monitoring Setups

Heart Rate (HR)

Measures number of heartbeats per minute (beats/min)

Indicates cardiac activity and circulation status

Normal adult range: 60–100 bpm

Abnormal values may indicate arrhythmia, shock, or cardiac issues

2. Blood Pressure (BP)

Measures force of blood against artery walls

Expressed as Systolic / Diastolic (e.g., 120/80 mmHg)

Shows circulatory health and organ perfusion

Low BP → shock risk

High BP → cardiac stress risk

3. Respiratory Rate (RR)

Number of breaths per minute

Reflects lung function and oxygen demand

Normal adult range: 12–20 breaths/min

High RR → respiratory distress

Low RR → respiratory depression

4. Oxygen Saturation (SpO_2)

Percentage of oxygen carried by hemoglobin

Measured using pulse oximeter

Normal range: 95–100%

Low SpO_2 indicates hypoxia

5. Body Temperature

Indicates metabolic and infection status

Normal range: 36.5–37.5°C

High temp → fever/infection

Low temp → hypothermia

6. Electrocardiogram (ECG)

Records electrical activity of the heart

Detects arrhythmias and ischemic changes

Continuous waveform monitoring

7. Urine Output

Indicates kidney function and fluid balance

Normal: ~0.5–1 mL/kg/hour

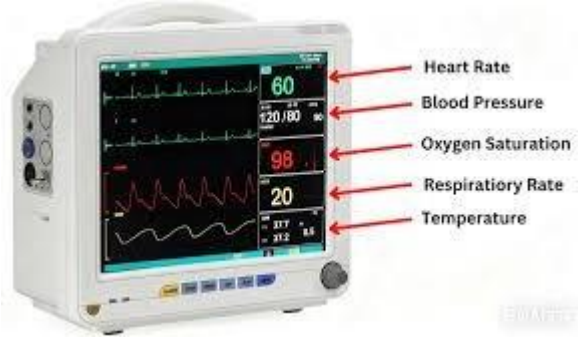
Low output may signal renal failure or shock

2. Advanced Monitoring parameters

ROHINI COLLEGE OF ENGINEERING
DEPARTMENT OF BIOMEDICAL ENGINEERING

24BM402 Biomedical Sensors and Data Acquisition Systems

UNIT V – REAL-WORLD BIOMEDICAL DAQ APPLICATIONS AND STANDARDS



1. Invasive Blood Pressure (IBP)

Continuous, real-time blood pressure monitoring Measured using an arterial catheter

More accurate than cuff method

Used in unstable and surgical patients

2. Central Venous Pressure (CVP)

Measures pressure in central veins near the heart Indicates blood volume and venous return

Helps guide fluid therapy and shock management

3. Cardiac Output (CO)

Amount of blood pumped by heart per minute Indicates overall heart performance

Important in heart failure and critical illness

4. End-Tidal Carbon Dioxide ($EtCO_2$) Measures CO_2 concentration at end of exhalation Assesses ventilation efficiency

Used in ventilated and anesthesia patients

5. Arterial Blood Gas (ABG) Analysis

Measures oxygen, carbon dioxide, and blood pH
Evaluates respiratory and metabolic function Helps manage ventilation and acid-base balance

6. Intracranial Pressure (ICP)

Measures pressure inside the skull
Used in brain injury, stroke, and neurosurgery Prevents brain damage due to high pressure

7. Electroencephalogram (EEG) Records brain electrical activity Detects seizures and brain dysfunction Used in neurocritical care

8. Mixed Venous Oxygen Saturation (SvO_2) Measures oxygen remaining after tissue use Indicates tissue oxygen delivery and consumption

9. Pulmonary Artery Pressure (PAP) Measures pressure in pulmonary artery Assesses lung circulation and heart function

10. Lactate Monitoring

Measures lactic acid in blood
Indicates tissue hypoxia and shock severity

3. ICU Monitoring Equipment

Multiparameter Patient Monitor

- Core monitoring device at each ICU bed
- Displays ECG, heart rate, BP, SpO_2, respiratory rate, temperature
- Provides real-time waveforms and alarms

2. Ventilator

- Supports or replaces spontaneous breathing
- Supplies oxygen and removes carbon dioxide
- Used in respiratory failure and critical illness

3. Infusion Pumps

- Deliver precise amounts of fluids and medications
- Ensures controlled drug dosage Types:
- Syringe pump
- Volumetric infusion pump

4. Defibrillator

- Restores normal heart rhythm during cardiac arrest
- Delivers controlled electric shock

5. Bedside Monitor

- Continuous monitoring and alarm system
- Easy access Placed near the patient for nurses and doctors

6. Central Monitoring Station

- Displays data from multiple patients
- Located at nursing station

- Allows remote observation

7. Pulse Oximeter

- Measures oxygen saturation (SpO_2)
- Non-invasive finger probe
- Detects hypoxia

8. Capnograph

- Measures carbon dioxide in exhaled air
- Monitors ventilation status

9. Suction Apparatus

- Removes mucus, blood, or secretions
- Maintains clear airway

10. Oxygen Delivery System

- Supplies medical oxygen to patients
- Includes oxygen cylinders and pipeline supply

11. ECG Machine

- Records electrical activity of heart
- Detects arrhythmias and cardiac abnormalities

12. Crash Cart (Emergency Trolley)

- Contains emergency drugs and equipment
- Used during cardiac or respiratory emergencies

4. ECG Monitoring System

1. Introduction

An ECG monitoring system continuously records the electrical activity of the heart. It helps detect heart rhythm abnormalities and cardiac emergencies in ICU patients.

2. Purpose of ECG Monitoring

- Detects arrhythmias (irregular heartbeat)
- Identifies myocardial infarction (heart attack)
- Monitors heart rate and rhythm
- Assesses effectiveness of cardiac treatment
- Provides early warning of cardiac arrest

3. Basic Principle

- The heart generates electrical impulses during contraction
- Electrodes placed on the body detect these signals
- Signals are amplified and displayed as waveforms

4. Main Components

a) Electrodes

- Attached to chest and limbs
- Detect electrical signals from the heart

b) Lead Wires

- Connect electrodes to monitor

c) Amplifier

- Increases weak electrical signals

d) Signal Processor

- Filters noise and interference

e) Display Unit

- Shows ECG waveform on monitor screen

f) Alarm System

- Alerts abnormal heart rhythms

5. ECG Leads Used in ICU

- 3-Lead ECG

Basic rhythm monitoring

Used for general ICU observation

- 5-Lead ECG

More detailed cardiac monitoring Detects ischemia and arrhythmias

- 12-Lead ECG

Complete heart electrical view Used for detailed diagnosis

6. ECG Waveform Components

- P wave – Atrial depolarization
- QRS complex – Ventricular depolarization
- T wave – Ventricular repolarization

7. Applications in ICU

- Continuous cardiac monitoring
- Post-surgery heart observation
- Drug effect monitoring
- Emergency cardiac care

8. Advantages

- Non-invasive and continuous
- Early detection of cardiac issues
- Real-time monitoring

9. Limitations

- Motion artifacts affect signals
- Requires correct electrode placement

Limited structural heart information

5. Blood Pressure Monitoring

Introduction

Blood Pressure (BP) monitoring measures the force exerted by circulating blood on artery walls. It is a vital parameter used to assess cardiovascular health and organ perfusion in critically ill patients.

2. Importance in ICU

- Detects shock and circulatory failure
- Guides fluid and drug therapy
- Monitors heart performance
- Ensures adequate blood supply to organs

3. Types of Blood Pressure Monitoring

A. Non-Invasive Blood Pressure (NIBP)

- Measured using an inflatable cuff
- Common and painless method Working

Principle:

- Cuff inflates to stop blood flow
- Gradual deflation detects arterial pulsations
- Uses oscillometric technique

Advantages:

- Simple and safe
- No risk of infection
- Easy to use

Limitations:

- Not continuous
- Less accurate in unstable patients

B. Invasive Blood Pressure (IBP)

- Direct measurement from artery
- Uses arterial catheter and pressure sensor Working

Principle:

Catheter inserted into artery (radial/femoral)

- Pressure transmitted through fluid line
- Converted into electrical signal by transducer

Advantages:

- Continuous real-time monitoring
- Highly accurate
- Useful in critical and surgical patients

Limitations:

- Risk of infection and bleeding
- Requires skilled professionals

4. Normal BP Values (Adults)

- Systolic: ~90–120 mmHg
- Diastolic: ~60–80 mmHg

5. Applications in ICU

- Monitoring trauma patients
- Managing shock and sepsis
- Major surgery monitoring
- Cardiac patient care

6. Equipment Used

- BP cuff
- Pressure transducer
- Monitor display
- Connecting tubing

6. Oxygen Monitoring

Pulse Oximeter

- Non-invasive
- Uses infrared light
- Attached to finger/earlobe

Arterial Blood Gas (ABG)

- Measures oxygen and CO2 in blood
- Lab-based analysis

7. Respiratory Monitoring

- Respiratory rate sensors
- Capnography
- Spirometry
- Airway pressure monitoring

8. Hemodynamic Monitoring

- Blood flow and circulation status
- Invasive and non-invasive methods
- Used in shock and heart failure

9. Neurological Monitoring

- Glasgow Coma Scale (GCS)
- EEG monitoring
- Intracranial pressure
- Brain oxygen monitoring

10. ICU Bedside Setup

Typical ICU bed includes:

- Patient monitor
- Ventilator
- Infusion pumps
- Suction apparatus
- Oxygen supply
- Emergency crash cart