

ROHINI COLLEGE OF ENGINEERING
DEPARTMENT OF BIOMEDICAL ENGINEERING
24BM402 Biomedical Sensors and Data Acquisition Systems
UNIT V – REAL-WORLD BIOMEDICAL DAQ APPLICATIONS AND
STANDARDS

ICU Monitoring

- Continuous Patient Observation

To monitor vital signs like heart rate, blood pressure, oxygen level, and respiration continuously without interruption.

- Early Detection of Complications

To identify sudden changes in a patient's condition such as cardiac arrest, respiratory failure, or organ dysfunction at an early stage.

- Support Clinical Decision-Making

To provide real-time data that helps doctors choose the correct treatment, medications, and interventions.

- Guide Treatment Effectiveness

To track how well treatments, ventilator support, and medications are working.

- Ensure Patient Safety

To reduce risks by triggering alarms when vital signs go beyond safe limits.

- Prevent Deterioration

To stop minor health issues from becoming life-threatening emergencies.

Improve Survival Outcomes

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To increase recovery chances through timely and accurate medical care.

3. Types of ICU Units

- Medical ICU (MICU)

Treats patients with severe medical conditions like infections, respiratory diseases, kidney failure, and sepsis.

- Surgical ICU (SICU)

For patients recovering from major surgeries such as abdominal, transplant, or emergency operations.

- Cardiac ICU (CICU)

Specialized care for serious heart conditions like heart attack, heart failure, arrhythmias, and post–cardiac surgery care.

- Neonatal ICU (NICU)

Dedicated to newborn babies, especially premature or low-birth-weight infants who need intensive monitoring and life support.

- Pediatric ICU (PICU)

Provides intensive care for critically ill infants, children, and adolescents.

- Neuro ICU

For patients with brain and nervous system disorders such as stroke, brain injury, seizures, and neurosurgery recovery.

- Trauma ICU

Handles patients with severe injuries from accidents, burns, fractures, or multiple organ trauma.

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- Coronary Care Unit (CCU)

Focuses specifically on acute coronary syndromes and advanced cardiac monitoring.



4. 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

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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 (SpO₂)

Percentage of oxygen carried by hemoglobin

Measured using pulse oximeter

Normal range: 95–100%

Low SpO₂ 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

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5. Advanced Monitoring parameters

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 (EtCO₂)

Measures CO₂ concentration at end of exhalation

Assesses ventilation efficiency

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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 (SvO₂)

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

6. ICU Monitoring Equipment

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Multiparameter Patient Monitor

- Core monitoring device at each ICU bed
- Displays ECG, heart rate, BP, SpO₂, 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

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- Displays data from multiple patients
- Located at nursing station
- Allows remote observation

7. Pulse Oximeter

- Measures oxygen saturation (SpO₂)
- 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

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7. 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

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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

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8. Advantages

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

9. Limitations

- Motion artifacts affect signals
- Requires correct electrode placement

