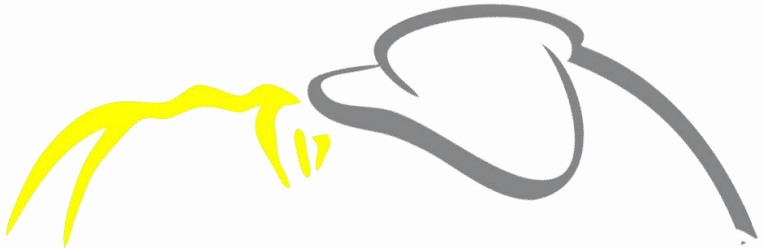
Anesthesia monitoring systems



433
ANAESTHESIA

Objectives:

- Not given

Please go back to the lecture, because not all slides are included here, deletion was due to: "It’s not important” Doctor said.

Patient Monitoring and Management:

- **Things you measure** (physiological measurement, such as BP or HR)
- **Things you observe** (e.g. observation of pupils)
- **Planning to avoid trouble** (e.g. planning induction of anesthesia or planning extubation)
- **Referring diagnoses** (e.g. unilateral air entry may mean endobronchial intubation)
- **Planning to get out of trouble** (e.g. differential diagnosis and response algorithm formulation). Need to solve the complications

Monitoring in the Past:

- Visual monitoring of respiration and overall clinical appearance
- Finger on pulse
- Blood pressure (sometimes)

Why anesthesia monitoring is important:

- The most important and serious side effect of anesthetic drugs is depression of respiration and the cardiovascular system.
- Occur at "therapeutic" doses
- Severe depression of either respiration or the cardiovascular system is life-threatening.

Standardized basic monitoring requirements (guidelines) from the ASA (American Society of Anesthesiologists):

STANDARD I	STANDARD II
Qualified anesthesia personnel shall be presented in the room throughout the conduct of all general anesthetics, regional anesthetics and monitored anesthesia care.	During all anesthetics, the patient's oxygenation, ventilation, circulation and temperature shall be continually evaluated. Oxygenation: cellular level, gas exchange. Ventilation: lung inflation.

Basic Monitoring:

Oxygenation, ventilation, circulation, temperature: should be preform for all patients

- **Cardiac:** Blood Pressure, Heart Rate, ECG
  - *ECG: Rate, ST Segment (ischemia), Rhythm*
- **Respiratory:** Airway Pressure, Capnogram, Pulse Oximeter, Spirometry, Visual Cues
- **Temperature** [pharyngeal, axillary, esophageal, etc.]
- **Urine output** (if Foley catheter has been placed)
- **Nerve stimulator** [face, forearm] (if relaxants used)
- **ETT cuff pressure** (keep < 20 cm H_2O). Because pressure ischemia.
- **Auscultation** (esophageal or precordial stethoscope)
- Visual surveillance of the anesthesia workspace and some exposed portion of the patient

Visual Surveillance:

- Anesthesia machine / workspace checkout
- Patient monitor numbers and waveforms
- Bleeding/coagulation (e.g., are the surgeons using a lot of suction or sponges?
- Diaphoresis / movements / grimaces

  Excessive sweating means MI
- Line quality (is my IV reliable?)
- Positioning safety review like pressure ulcer
- Respiratory pattern (e.g. tracheal tug, accessory muscle use etc.)

Low Tech Patient Monitoring:

In areas have no adequate monitoring devices

- Manual blood pressure cuff
- Finger on the pulse and forehead
- Monaural stethoscope (heart and breath sounds)
- Eye on the rebreathing bag (spontaneously breathing patient)
- Watch respiratory pattern
- Watch for undesired movements
- Look at the patient's face
  - color OK?
  - diaphoresis present?
  - pupils

Special Monitoring:

Alarms: Purpose: Alarms serve to alert equipment operators that some monitored variable or combination of variables is outside some region

- Pulmonary artery lines (Swan Ganz)
- Transesophageal echocardiography
- Intracranial pressure (ICP) monitoring
- Electrophysiological CNS monitoring
- Renal function monitoring (indices)
- Coagulation monitoring (e.g. ACT, TEG)
- Acid-base monitoring (ABGs)
- Monitoring depth of anesthesia

Cardiac monitoring:

✓ **Arterial blood pressure:** direct and indirect or invasive or non invasive

-Non invasive: blood pressure cuff

-Invasive: use cannula, radial artery is most cannulated, It allows continuous beat-to-beat blood pressure measurements.

- Direct blood pressure measurement involves placing a catheter in an artery and connecting it to a transducer via a fluid-filled line.
- Tubing should be narrower and stiffer. no bubbles in the system. The transducer is connected to an amplifier and display unit
- shows the waveform , systolic/diastolic/mean pressures calculated from the waveform.
- The shape of the waveform gives useful information about the state of the circulation, in particular the peripheral resistance
- Indirect blood pressure involves inflating a cuff around the limb and monitoring the blood flow in the limb distal to the artery

Indications :

elective hypotension anticipation of wide intra-operative blood pressure swings and blood gases

(ENT surgery and neurosurgery), aortic aneurysm, frequent ABG

Contraindications:

Catheterization should be avoided in arteries without documented adequate collateral blood flow

indirect: best to be avoided in patient vascular abnormalities(A-V fistula)

✓Electrocardiogram:

- The electrocardiogram only monitors the electrical activity of the heart and the heart rate
- Tell nothing about the mechanical function of the heart or the state of the circulation
- Essential for diagnosis and treatment of arrhythmias .

Artifacts in ECG Monitoring:

- Loose electrodes or broken leads
- Misplaced leads
- Wrong lead system selected
- Emphysema, pneumothorax, pericardial effusion
- Shivering or restlessness
- Respiratory variation and movement
- Monitor Pulse Oximetry, Invasive ABP

Central venous catheterization:

- Indicated for monitoring CVP for fluid management (Hypovolemia , shock)
- Infusion of drugs
- Infusion of TPN
- Aspiration of air embolism
- Insertion of pacemaker
- Giving venous access in pt with poor peripheral vein
- Access for insertion of pulmonary artery catheter
- Usually we choose the right internal jugular vein

■ **Contraindicated in :**

1. Renal cell tumor extended to RT ventricle
2. PT with anticoagulation
3. Ipsilateral carotid end-arterectomy

■ **Complications :**

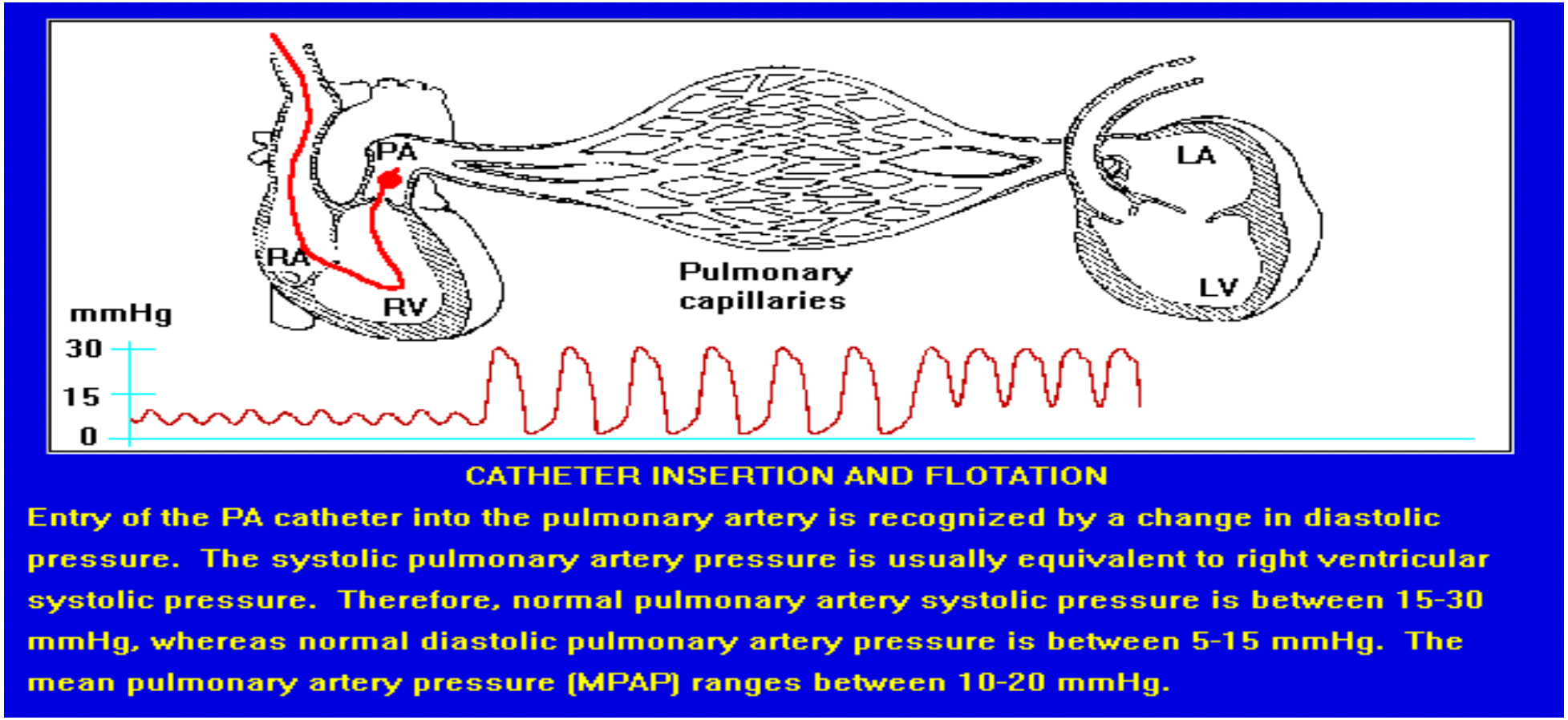
1. Air embolism
2. Infection
3. Thrombus embolism
4. Dysrhythmia
5. Hematoma
6. Pneumothorax , hemothorax
7. Cardiac tamponade
8. Trauma to nearby tissue

Pulmonary artery catheter:

- Indicated to monitor CO, PAP , SVR , mixed venous oxygenation
- Contraindicated :

1. Complete LBBB
2. Sever arrhythmia

IMP: numbers



CATHETER INSERTION AND FLOTATION

Entry of the PA catheter into the pulmonary artery is recognized by a change in diastolic pressure. The systolic pulmonary artery pressure is usually equivalent to right ventricular systolic pressure. Therefore, normal pulmonary artery systolic pressure is between 15-30 mmHg, whereas normal diastolic pulmonary artery pressure is between 5-15 mmHg. The mean pulmonary artery pressure (MPAP) ranges between 10-20 mmHg.

Respiratory system.

- **Pulse oximeter:**
  - ✓ combines the principles of oximetry and plethysmography to noninvasively measure oxygen saturation in arterial blood.
  - ✓ The pulse oximeter probe contains two light emitting diodes at wavelengths of 940nm and 660 nm.
  - ✓ Oxygenated and reduced hemoglobin differ in light absorption (940 and 660 nm respectively).
  - ✓ Thus the change in light absorption during arterial pulsation is the basis of oximetry determination.
  - ✓ The ratio of the absorption at the two wavelengths is analyzed by a microprocessor to record the oxygen saturation.
- Pulse Oximeter Wavelengths: Red (660 nm)
  - absorbed by unoxygenated hemoglobin
- Near infrared (940 nm)
- absorbed by oxygenated hemoglobin

False Readings:

- Nail polish
- Intravenous dyes
- Diminished pulse
- Movement of finger
- Ambient light

Abnormal Hemoglobin:

- Carboxyhemoglobin:

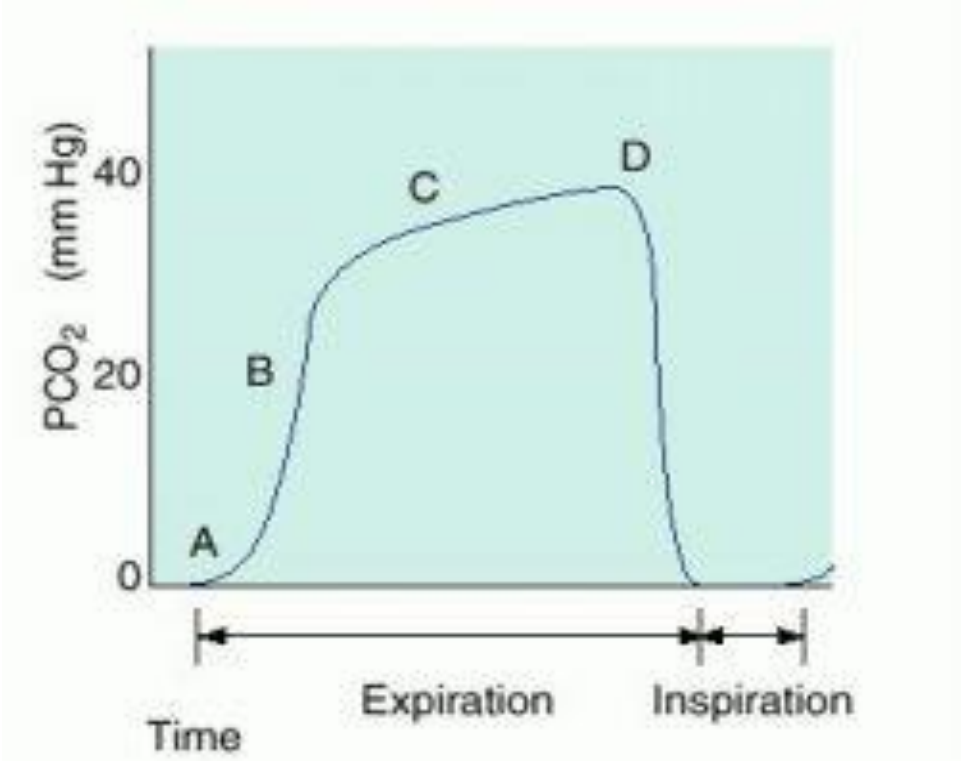
false high reading in carbon monoxide patients

- Methemaglobin:

reads 85% regardless of actual saturation

- Fetal hemoglobin:

little effect on pulse oximetry



- A normal capnography demonstrating the three phases of expiration:
  - phase A—dead space. No gas exchange
  - Phase B—mixture of dead space and alveolar gas.
  - Phase C—alveolar gas plateau.

Capnometry:

- Is the measurement of end-tidal carbon dioxide tension.
- This provides valuable information to the anesthesiologist.
- The presence of end tidal CO2 aids in confirming endotracheal intubation.
- Alteration in the slope of the graph can give clues to the presence of airway obstruction.
- A rapid fall in reading may signify extubation, air embolism or low cardiac output with hypovolemia.

Monitoring ETCO2:

- Confirms the movement of air in and out of the lungs
- Assumed to reflect alveolar CO2
- Assumed to indicate adequacy of ventilation and cardiac output
- Better indicator of ventilation
- Measures high point of the expiratory plateau
- Normally less than the PaCO2
- Normal gradient about 5-8

CO_2 Increases with:

- Hypoventilation
- Malignant hyperthermia
- Sepsis and fever
- Rebreathing
- Bicarbonate administration
- Insufflation of CO_2 . In laparoscopic surgeries

CO_2 Decreases with:

- Hyperventilation
- Hypothermia
- Low cardiac output
- pulmonary embolism
- Circuit disconnect
- Cardiac arrest

Clinical Uses of Capnography:

✓ Detection of untoward events
✓ Maintenance of normocarbia
✓ Weaning from mechanical ventilation
✓ Evaluating effectiveness of CPR

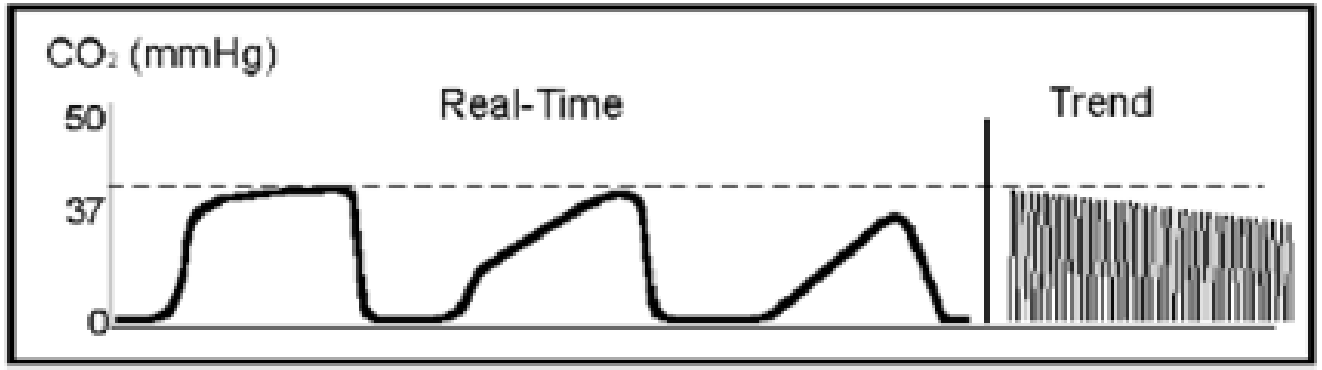
Describe Wave Forms representing the following:

- Normal wave form
- COPD
- Inadequate neuromuscular relaxation
- Unequal lung emptying Restrictive lung disease
- Esophageal intubation
- Malignant hyperthermia
- Cardiac arrest
- Pulmonary embolism

Mass Spectrometry:

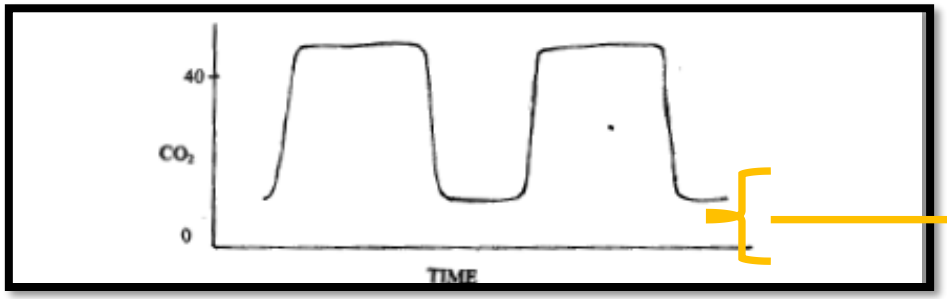
- Gas enters high vacuum area
- Bombarded by electron beam
- Charged particles passed over strong magnet
- Different components are deflected according to their chemical composition
- Specific collectors measure composition

Obstruction in Airway or Breathing Circuit

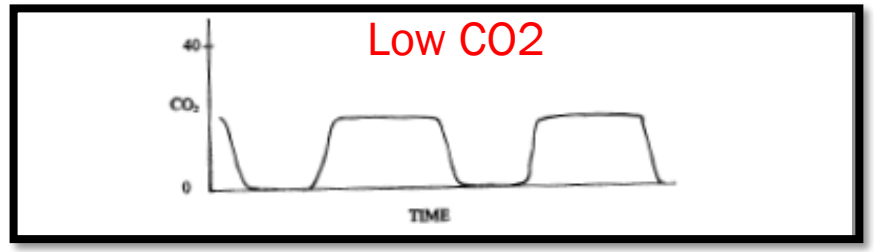


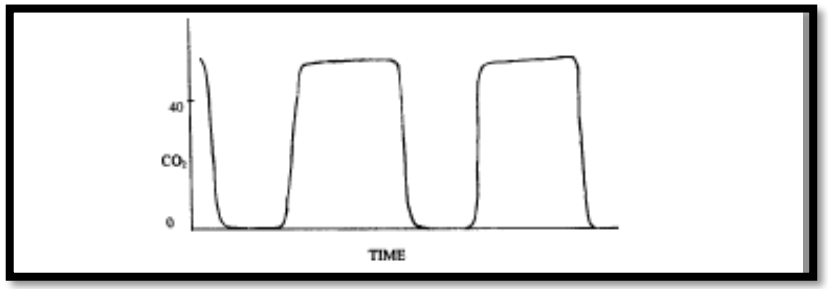
Possible Causes:

- Partially kinked or occluded artificial airway
- Presence of foreign body in the airway
- Obstruction in expiratory limb of breathing circuit
- Bronchospasm

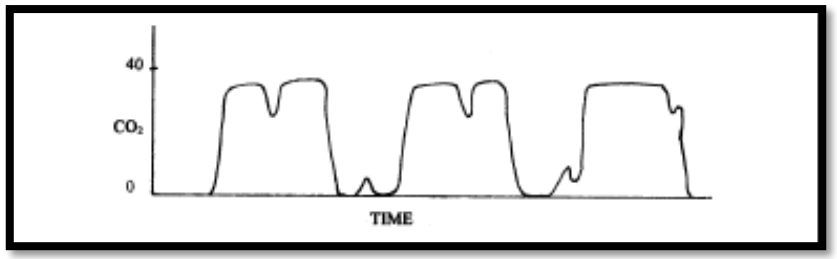


Reabsorption of CO2





Malignant hyperthermia , first sign



The effect of muscle relaxant start to decrease IMP

Peripheral Nerve Stimulation:

- ✓ Neuromuscular blockade is monitored during surgery to guide repeated doses of muscle relaxants and to differentiate between the types of block.
- ✓ All techniques for assessing neuromuscular blockade use a peripheral nerve stimulator (PNS) to stimulate a motor nerve electrically.
- ✓ A peripheral nerve stimulator delivers a current of variable frequency and amplitude to a pair of either ECG silver chloride pads or subcutaneous needles placed over a peripheral motor nerve.
- ✓ The evoked mechanical or electrical response of the innervated muscle is observed.
- ✓ Ulnar nerve stimulation of the adductor pollicis muscle and facial nerve stimulation of the orbicularis oculi are most commonly monitored.

Neurological monitoring:

Depth of Anesthesia :

- Clinical Signs:
  - eye signs
  - respiratory signs: tachypnea
  - cardiovascular signs: tachycardia
  - CNS signs
- EEG monitoring
- Facial EMG monitoring (experimental)
- Esophageal contractility (obsolete)

CNS Monitoring:

- Clinical: *sensorium, reflexes, "wake up test"*
- Electroencephalography, BIS
- Evoked potentials *(esp. somatosensory EPs)*
- Monitoring for venous air emboli
- Intracranial pressure (ICP) monitoring
- Transcranial doppler studies

Bispectral index :

- Anew two channeled EEG
- Bispectral data takes the data generated EEG, through number of steps calculate single number correlate with depth of anesthesia
- BIS value 65-85 advocated a measure of sedation
- BIS value 40-65 recommended for general anesthesia
- Measure : depth of anesthesia

Temperature Monitoring:

Rationale for use

- detect/prevent hypothermia
- monitor deliberate hypothermia
- adjunct to diagnosing MH
- monitoring CPB cooling/rewarming

Sites:

- Esophageal
- Nasopharyngeal
- Axillary
- Rectal
- Bladder

Wake-up Test:

- Test neurologic function following reversible surgical manipulation
- Movement must not cause damage
- Patient is allowed to awaken
- Amnesia must be maintained
- After awakening, patient follows verbal commands
  - *Evaluates corticospinal tracts (thoracic)*
- Response to painful stimuli
  - **Lumbar cord function**
- Measuring ICP:
- Ventricular catheter
- Subdural bolt
- Lumbar CSF catheter
- Scanning techniques

Electrolyte / Metabolic Axis:

- Fluid balance
- Sugar
- Electrolytes
- Acid-base balance
- Nutritional status

Coagulation Monitoring:

- Clinical signs
- PT / PTT / INR
- ACT
- Platelet counts
- Factor assays
- TEG

Detecting Mishaps Using Monitors:

1. Disconnection
2. Hypoventilation
3. Esophageal intubation
4. Bronchial intubation
5. Circuit hypoxia
6. Halocarbon overdose
7. Hypovolemia
8. Pneumothorax
9. Air Embolism
10. Hyperthermia
11. Aspiration
12. Acid-base imbalance
13. Cardiac dysrhythmias
14. IV drug overdose

تم بحمد الله

Done and Reviewed by

Afaf Almutairi

Leader

Yasmine Alshehri

Color reference:
Black-slids
Green-Notes
Blue-Book
Red-important

Contact us:
Anesthesia433
@gmail.com