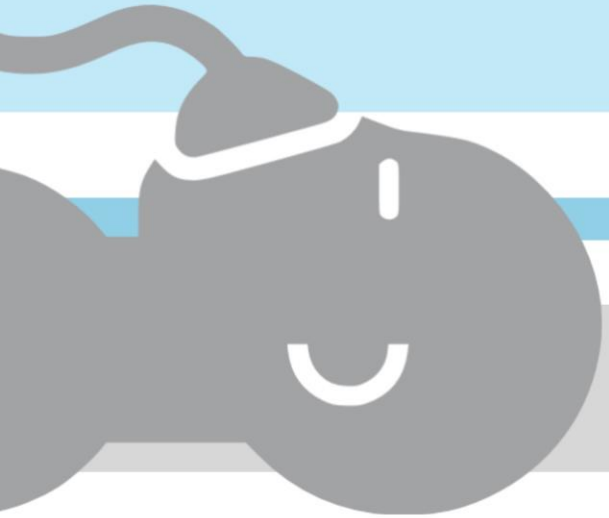


ANESTHESIA

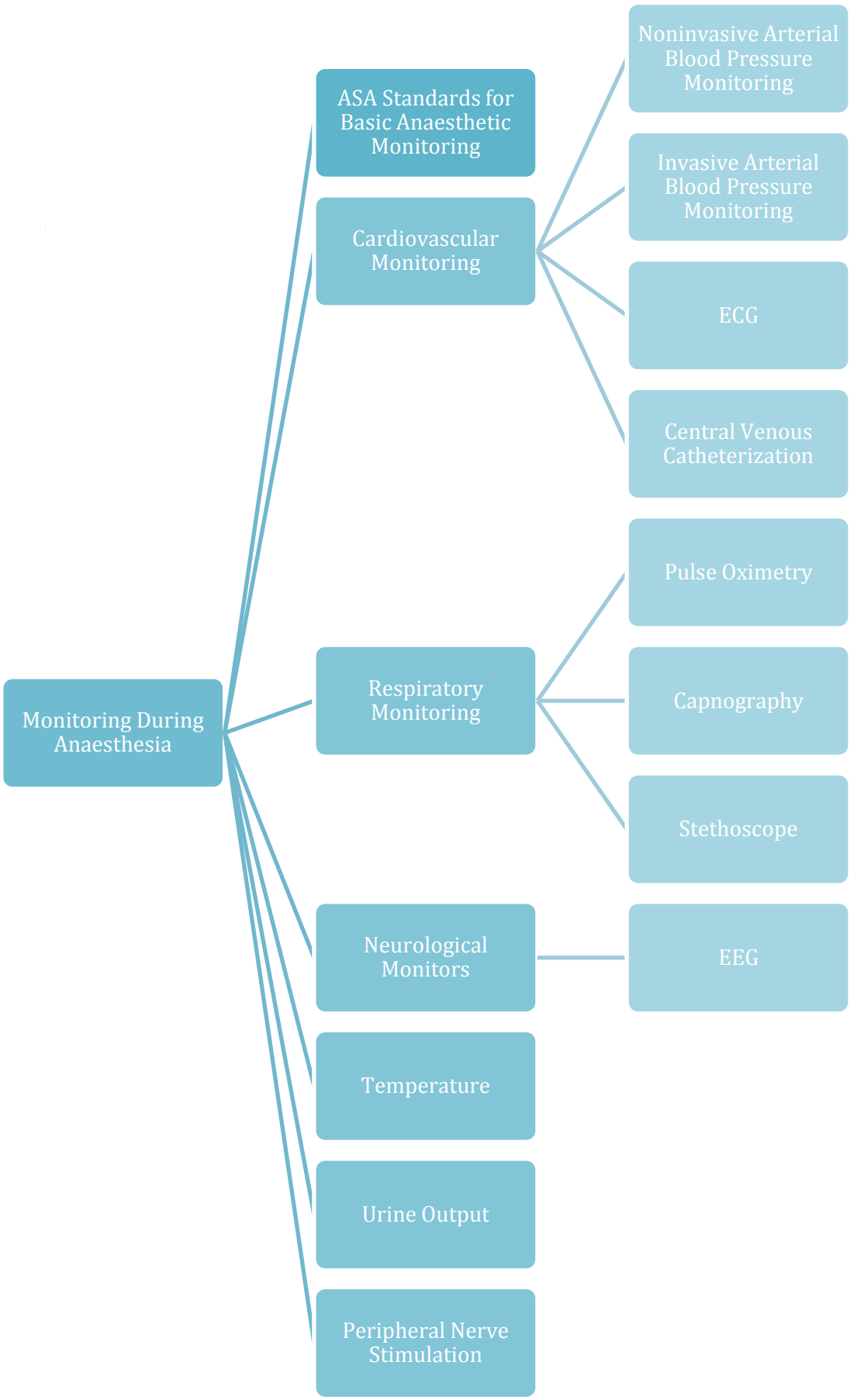
(9) Monitoring During Anesthesia

Leader: Moody A. Almarshad

Done by: Ghadah Alharbi

Revised by: Shatha Al-Shanqeeti

Doctor's note Team's note Not important Important 431 teamwork


Monitoring During Anaesthesia
ASA Standards for Basic Anaesthetic Monitoring
Cardiovascular Monitoring
Noninvasive Arterial Blood Pressure Monitoring
Invasive Arterial Blood Pressure Monitoring
ECG
Central Venous Catheterization
Respiratory Monitoring
Pulse Oximetry
Capnography
Stethoscope
Neurological Monitors
EEG
Temperature
Urine Output
Peripheral Nerve Stimulation

Inadequate monitoring Constitutes 10% of anesthesia related deaths.

Vital signs should always be monitored in order to have proper standardized anesthesia.

Monitoring Recommendations of the Association of Anesthetists of Great Britain and Ireland:

Essential Monitoring:

Circulation: ECG, non-invasive measurements of systemic blood pressure, clinical observation.
Respiration: Capnography, pulse oximetry, clinical observation.
Body Temperature: Temperature probe.

Available Monitoring:

If muscle relaxants are used: Nerve stimulator.
If volatile anesthetics are used: Inspiratory and expiratory anesthetic concentration.

Assessing the Depth of Anesthesia:

Craniofacial electromyography
Respiratory sinus arrhythmia
Heart rate variability
Electroencephalogram derivatives:
- Spectral edge frequency
- Median power frequency
- Power band ratios

Evoked responses:
- P300
- Middle latency evoked responses
- Auditory steady state response
- Coherent frequency of the auditory steady state response

Guidelines for Pediatric Perioperative Anesthesia Environment:

- ECG
- Blood pressure
- Pulse oximetry
- Capnography
- FiO_2
- Anesthetic gas concentration
- Temperature

The emphasis is on the temperature and the respiratory system (They usually die of respiratory failure).

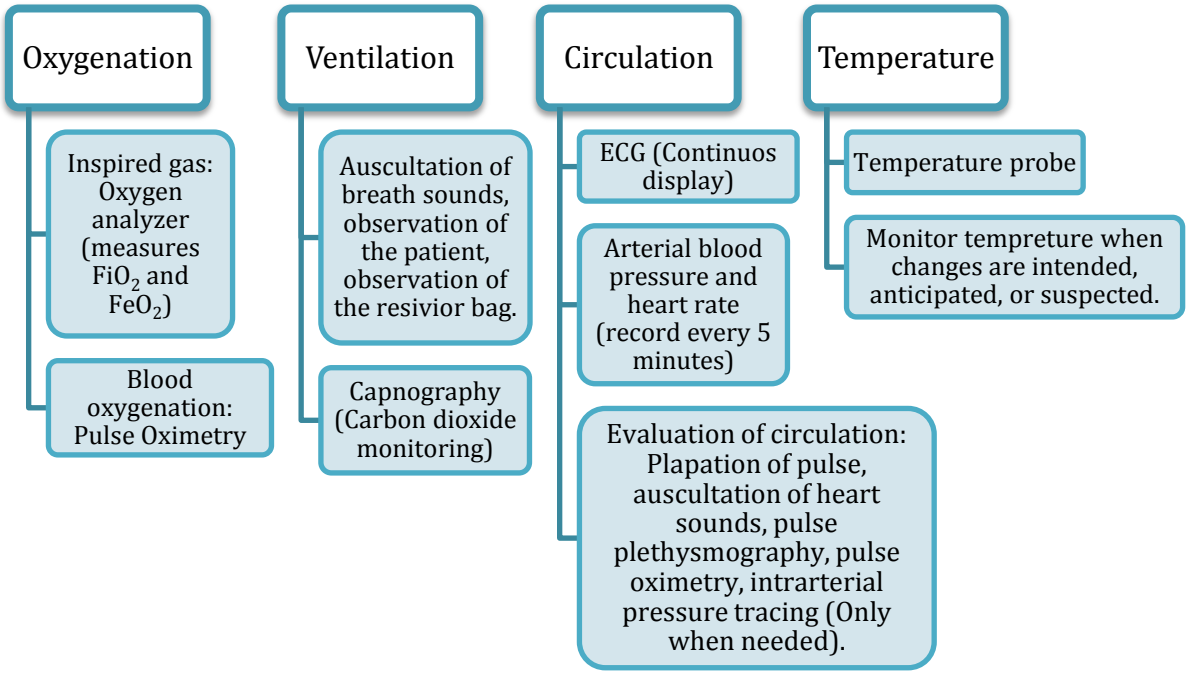
Practice Guidelines for Postanesthetic Care

Routine	Selected Patients
Respiratory	
Respiratory Rate Airway Patency Oxygen Saturation	Immediately available
Cardiovascular	
Pulse Rate Blood Pressure	Electrocardiogram
Neuromuscular	
Physical Examination	Neuromuscular Blockade Nerve Stimulator
Mental Status	
	Temperature
Pain	
Nausea and Vomiting	
	Urine Voiding Output
	Bleeding and Drainage

ASA Standards for Basic Anesthetic Monitoring

Standard I: Qualified anesthesia personnel shall be present in the room throughout the conduct of all general anesthetics, regional anesthetics and monitored anesthesia care.

Standard II: During all anesthetics, the patient's oxygenation, ventilation, circulation and temperature shall be continually evaluated. (This is called the Minimum Mandatory Monitoring (MMM))


Oxygenation
Inspired gas: Oxygen analyzer (measures FiO_2 and FeO_2)
Blood oxygenation: Pulse Oximetry
Ventilation
Auscultation of breath sounds, observation of the patient, observation of the resivior bag.
Capnography (Carbon dioxide monitoring)
Circulation
ECG (Continuos display)
Arterial blood pressure and heart rate (record every 5 minutes)
Evaluation of circulation: Plapation of pulse, auscultation of heart sounds, pulse plethysmography, pulse oximetry, intrarterial pressure tracing (Only when needed).
Temperature
Temperature probe
Monitor tempreture when changes are intended, anticipated, or suspected.

1. Cardiovascular Monitoring (1)

A. Noninvasive Arterial Blood Pressure Monitoring

The use of any anesthetic is an indication for arterial blood pressure monitoring. The techniques and frequency of pressure determination depend on the patient's condition and the type of surgical procedure. The results should be viewed as an indicator of organ transfusion. **Blood pressure cuff are best avoided in extremities with vascular abnormalities or intravenous line, or in cases of burns.**

Arterial blood pressure can be measured by: palpation, doppler probe, oscillometry, and arterial tonometry.

B. Invasive Arterial Blood Pressure Monitoring

It allows continuous beat-to-beat blood pressure measurements. **The radial artery is commonly cannulated.** Allen's test is a simple, non reliable method of assessing the safety of radial artery.

Types:

Swan Ganz Catheter, PiCCO System (Pulse Contour Cardiac Output), Advanced PAC: SVO_2, CCO, REF, EDV, TEE.

Indications for Invasive Blood Pressure Monitoring:

A. Patient-dependent factors

Hemodynamic instability (shock)
Cardiac disease
Respiratory insufficiency (ABG monitoring in COPD patients)
Increased intracranial pressure
Polytrauma

B. Type of Surgery

Cardiac surgery
Craniotomy
Major thoracic surgery
Major abdominal surgery

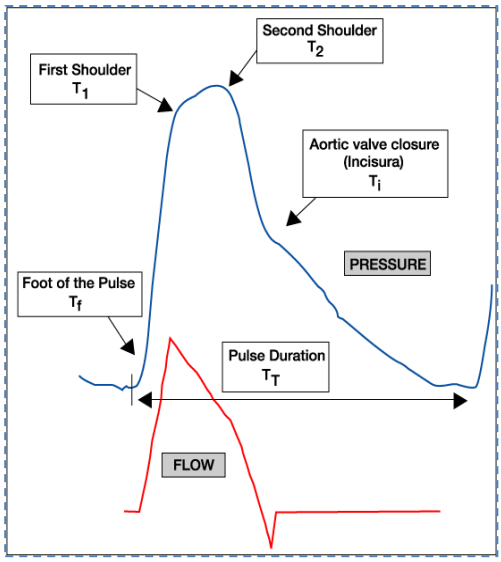
Risk factors of complications are: Prolonged cannulation, hyperlipidemia, repeated insertion attempts, female gender, and the use of large catheters in small vessels and the use of vasopressors.

Complications of intra-arterial monitoring include: Arterial laceration, hematoma, bleeding, loss of distal perfusion to the hand, vasospasm, arterial thrombosis, air embolism, pseudoaneurysm, nerve damage, infection, and necrosis of skin overlying the catheter, errors in monitoring, failed attempt.

1. Cardiovascular Monitoring (1)

- Arterial Waveform Evaluation:

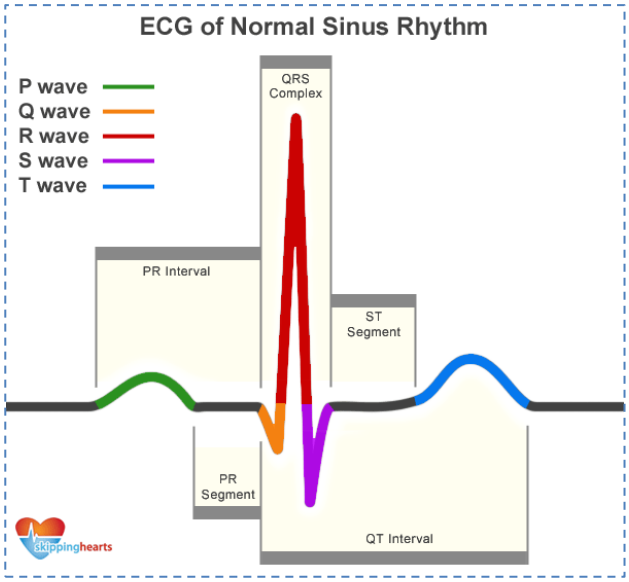
Tf- Foot: onset of ejection, systole.
T1- First shoulder: peak flow.
T2- Second Shoulder: peak pressure.
Ti- Dichotic Notch: end of ejection, closure of aortic valve, precedes the onset of diastole.
Tt- Pulse Duration.



Non-invasive Methods vs. Arterial Cannulation:

	NIBP	**Arterial Cannulation**
Pros	Healthy Patients	Continuous BP
		Sick patients
	Short case	Difficult cases
		ABG monitoring
Cons	Bladder cuff size	Thrombosis / Ischemia
	Flow dependant	
	Motion	Hematoma formation
	Interruption of IV infusion	Infection
	Injury	
	Cuff deflation rate	Nerve dysfunction
	Hydrostatic errors	

C. Electrocardiogram "ECG":



All patients should have intraoperative ECG monitoring.

What to expect from the ECG: rate, rhythm, propagation of the excitation wave, heart position, muscle hypertrophy, and regional ischemia.

It gives NO information about pump function.

P wave represents *atrial contraction "Atrial depolarization".* **The QRS complex** represents *ventricular contraction "depolarization"* following the 120-200 msec atrioventricular nodal delay, it can be prolonged in patients with **cardiomyopathies and heart failure.** **T wave** represents *ventricular repolarization*, prolongation of the QT interval is secondary to **electrolytes imbalance or drugs which could lead to life-threatening arrhythmias.**

Lead Selection:

The electrical axis of lead II is parallel to the electrical axis of the atria, this orientation **enhances the diagnosis of arrhythmias by detecting inferior wall ischemia** **"Lead II is the most common lead used for monitoring"** but it is not the optimal monitoring lead.

Lead V_5 can detect **ST-T changes** (anterior and lateral wall ischemia**).**

D. Central Venous Catheterization:

CVC is indicated for **monitoring of the central venous pressure, administration of fluids to treat hypovolemia and shock, infusion of caustic drugs and total parenteral nutrition, aspiration of air emboli and gaining venous access in patients with poor peripheral veins.** Usually we choose the **right internal jugular vein** "subclavian vein cannulation is associated with increased risk of pneumothorax during insertion but a reduced risk for other complications during prolonged cannulations (e.g. in critically ill patients)".

Contraindications: Patient refusal, tumors, clots or tricuspid valve vegetations, severe coagulopathy, infection at site, previous failed attempts at specific site, hematoma and unusual anatomy, bundle branch block (relative contraindication).

The risks are: infections, air or thrombus embolism, arrhythmias, hematoma, pneumothorax, hemothorax, cardiac perforations and tamponade, trauma to the nerves and arteries, and thrombosis.

Central Line Techniques:

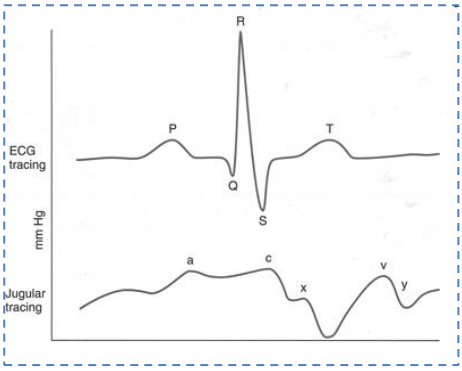
- Sterile techniques should be used for all central line cannulation
- Surgical scrub with Sterile gown and gloves
- Sterile prep of skin and surgical drapes.
- Local anesthetic should be used for central catheters in awake patients
- Success may be improved by using ultrasound guidance
- Techniques of gaining access include:
  - Catheter over needle
  - Catheter through needle
  - Seldinger technique
  - Surgical cut-down is surgical technique as last resort.

1. Cardiovascular Monitoring (1)

Anatomy of Central Access:

- Internal jugular vein
  - Right sided access preferred because apical pleura does not rise as high on right and avoids thoracic duct
  - Patient positioned head down to engorge the vein
  - In the low approach triangle formed by two heads of sternomastoid and clavicle identified
  - Cannula aimed down and lateral towards ipsilateral nipple
- Subclavian vein
  - Usually approached from below clavicle
  - Patient positioned head down
  - Needle inserted below junction of medial 2/3 and lateral 1/3 of the clavicle
  - Needle aimed towards suprasternal notch
  - Passes immediately behind clavicle
  - Vein encountered after 4-5 cm

- **Normal CVP Waveform:**
- **- A wave:** due to the **increased atrial pressure** during right atrial contraction *"correlates with P wave on EKG"*.
- **- C wave:** caused by **slight elevation of the tricuspid valve into the right atrium during early ventricular contraction** *"correlated with the end of QRS complex"*.



- **- X descent:** caused by **downward movement of the ventricular during systolic contraction**, occurred before the T wave in EKG.
- **- V wave:** arises from the **pressure produced when the blood filling the right atrium comes up against a closed tricuspid valve** *"correlated with the end of T wave"*.
- **- Y descent:** produced by **the opening of tricuspid valve in diastole** with the blood flowing into the right ventricle, it occurs before the P wave in EKG.

2. Respiratory Monitoring (1)

A. Pulse Oximetry

Pulse oximeter is mandatory for all anesthetic, including cases of moderate sedation. It measures the **oxygen saturation in arterial blood.** In addition to SpO_2, pulse oximeters provide an indication of tissue perfusion (pulse amplitude) and measure heart rate, and **provide rapid diagnosis of hypoxia.** Clinically detectable cyanosis requires 5 g of desaturated hemoglobin and SpO_2 less than 80%.

B. Capnography

Determination of **end-tidal CO_2 ($ETCO_2$) concentration** to confirm adequate ventilation is mandatory during all anesthetic procedures, but particularly so for general anesthesia. A rapid fall in $ETCO_2$ **is a sensitive indicator of air embolism.**

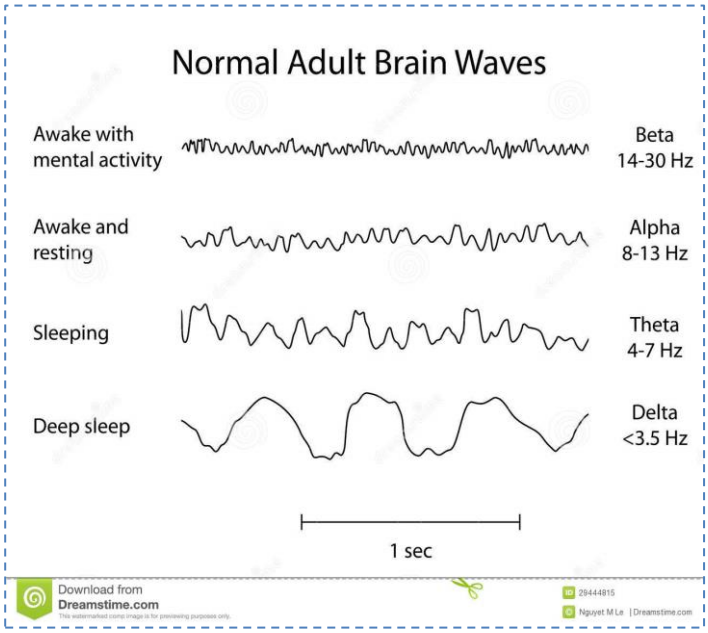
C. Stethoscope

Used with the placement of endotracheal tube **to hear the breath sounds** clearly with with the delivery of oxygen into the ET tube with correct placement, it can be used in placement of nasogastric (NG) tube.

3. Neurological Monitors [1]

A. Electroencephalogram "EEG"

The electroencephalogram is occasionally used during cerebrovascular surgery to **confirm the adequacy of cerebral oxygenation.** It is a recording of electrical potentials generated by cells in the cerebral cortex.



- Normal EEG waves [2,3]:

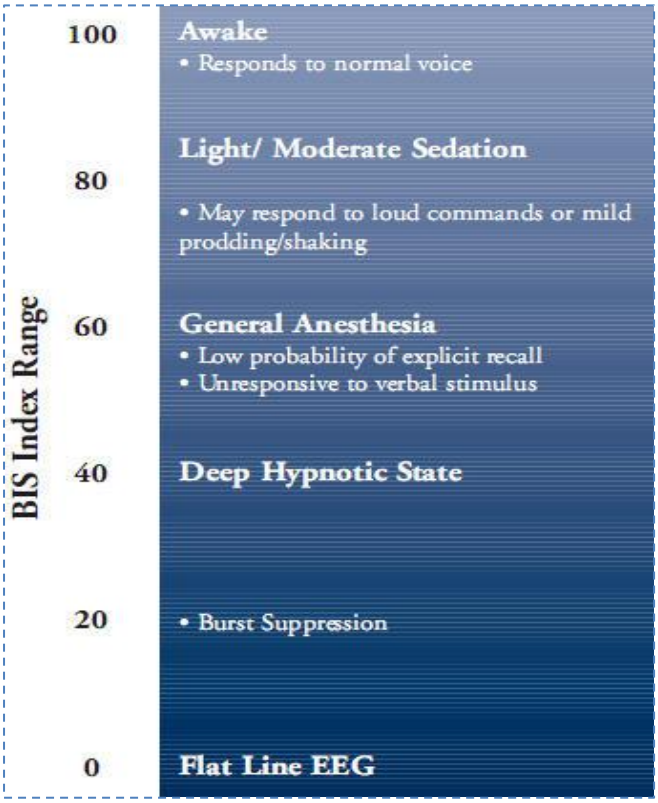
Beta waves: frequency greater than 13 Hz, seen in all age groups, normally found when you are alert or have taken high doses of certain medications like benzodiazepines and barbiturates.

Alpha waves: frequency 8-13 Hz, seen in all age group but commonly in adults, present only in the waking state when your eyes are closed but mentally alert. They disappear with attention (stress, opening eyes).

Theta waves: frequency 3.5-7.5 Hz, they are normally found when you are sleeping or in young children. Theta and delta waves are known collectively as slow waves.

Delta waves: frequency 3 Hz or less, seen normally in deep sleep in adults as well as in infants and children.

Wakefulness is indicated by **bispectral index (BIS),** used to prevent awareness during anesthesia.



4. Temperature (1)

Postoperative temperature is used as a quality anesthesia indicator. Hypothermia is associated with delayed drug metabolism, increased blood glucose, vasoconstriction, impaired coagulation, and impaired resistance to surgical infections.
Hyperthermia have deleterious effects perioperatively, leading to tachycardia, vasodilation, and neurological injury.
The temperature is measured using **thermistor or thermocouple.**

5. Urine Output (1)

Urinary bladder catheter is the only reliable method for monitoring urinary output.

Insertion of a urinary catheter is indicated in patients with congestive heart failure, renal failure, advanced hepatic disease, or shock.
It is a routine in some surgical procedures such as cardiac and aortic surgeries, renal vascular surgery, major abdominal surgery, or procedures in which large fluid shifts are expected.
It should not be done in patients with high risk of infections.

6. Peripheral Nerve Stimulation (1)

Neuromuscular function should be monitored in all patients receiving intermediate or long-acting neuromuscular blocking agents. Peripheral nerve stimulation is helpful in assessing paralysis during rapid sequence induction or during continuous infusion of short-acting agents, also in locating peripheral nerves for regional anesthesia.

Indications for Neuromuscular Monitoring:

1. Use of long-acting muscle relaxants
2. Abnormal pharmacokinetics of muscle relaxants (sever liver or kidney disease, severe illness, extreme of age) → Prolonged action of muscle relaxants
3. Patients with neuromuscular disease
4. Situations in which antagonizing muscle-relaxants should be avoided e.g. severe heart disease or bronchial asthma
5. Situations in which postoperative respiratory muscle power must be maximal e.g. sever pulmonary disease or marked obesity
6. Lengthy surgery
7. Continuous infusion of neuromuscular blocking drug

Summary

- Monitoring of oxygenation: pulse oximeter, and make sure that you have exposed the patient adequately to assess the color.
- Monitoring of ventilation: capnogram, chest excursion, breath sounds auscultation, and observation of the reservoir breathing bag.
- Monitoring of circulation: noninvasive arterial blood pressure, ECG, and heart rate.
- Monitoring of temperature: temperature probe.
- Monitoring of urine output: urinary bladder catheter.
- Monitoring of neurological function: EEG.
- Monitoring of neuromuscular function: peripheral nerve stimulation.

References

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For mistakes or feedback

Anesthesiateam432@hotmail.com