Monitoring In Anesthesia

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In general we do monitoring for many things:

1. **Oxygenation**: we monitor it **Clinically** through patient color and pulse oximetry and **Quantitively** by using oxygen analyzer, equipped with an audible low oxygen concentration alarm.

2. **Temperature**: Continuous temperature measurements monitoring is **mandatory** if changes in temperature are **suspected**.

3. **Circulation**: we monitor it **Clinically** through pulse palpation, heart auscultation and monitoring intra-arterial pressure or oximetry and **Quantitively** by using ECG signals and arterial blood pressure measurements every 5 min.

4. **Ventilation**: **Clinically**, we monitor it through a correctly positioned endotracheal tube, also observing chest expansion, and breath sounds over both lungs, **Quantitively** by ETCO2 analysis, and by Arterial blood gas analysis for assessing both oxygen and ventilation.
• **Pulse Oximetry:**

A non-invasive method for monitoring person’s oxygen saturation (So2), though its reading of So2 isn’t always identical to reading through **ABG analysis**, which is the invasive method, but it consider a **safe, convenient, noninvasive and not expensive method for monitoring So2**.

**Timing of SpO2 monitoring**: Before intubation >> Throughout the surgery >> After extubation and Recovery.
Con’t...

• Allows beat to beat analysis of oxygenation.

• Red and Infra-red light frequencies transmitted through a translucent portion. (finger-tip or earlobe)

• Depends on differences in light absorption between oxyHb and deoxyHb.

• Microprocessors then analyze amount of light absorbed by the 2 wavelengths, comparing measured values, then determining concentrations of oxygenated and deoxygenated forms through only arterial blood
Con’t …

- It is uncertain when there is **severe vasoconstriction**, due to the reduced pulsatile component of the signal, also in **shock or cold extremities**.

- It is uncertain with certain hemoglobin:
  1. when **carboxyhemoglobin** is present, it overestimates SaO2
  2. when **methemoglobin** is present, at an SaO2 > 85%, it underestimates the saturation.

- It progressively under-reads the saturation as **the hemoglobin falls** (but it is not affected by polycythemia).

- It is affected by extraneous light.

- It is uncertain when there is excessive movement of the patient.
Pulse oximetry gives us many information:

- **SpO2**: arterial O2 saturation (oxygenation of the pt).
- **HR**.
- **Peripheral perfusion status**

**Example**: loss of waveform in hypoperfusion states: hypotension and cold extremities.

- Give an idea about the rhythm from plethysmography wave (arterial waveform), cannot identify the type of arrhythmia but can recognize it if irregularity is present.
- **Cardiac arrest**

**Note**: The pulse oximeter is not an indicator of the adequacy of alveolar ventilation.
ECG monitoring:

This is easily applied and gives information on heart rate and rhythm, and may warn of the presence of ischemia and acute disturbances of certain electrolytes (e.g. potassium and calcium).

**Timing of ECG monitoring:** Before intubation >> Throughout the surgery >> After extubation and Recovery.
• It can be monitored using three leads applied to the Right shoulder (Red), the Left shoulder (yellow) and the left lower chest (green), to give a tracing equivalent to standard lead II of the 12-lead ECG.

• Many ECG monitors now use five electrodes placed on the anterior chest to allow all the standard leads and V5 to be displayed.

• **Note**: The ECG alone gives no information on the adequacy of the cardiac output and it must be remembered that it is **possible to have a virtually normal ECG in the absence of any cardiac output**
Con’t...

- Identification of **P waves** in lead 2 and it’s association with the **QRS complex** is useful in distinguishing a sinus rhythm from other rhythms.

- Analysis of ST segment is used as an indicator of MI.
  
  **eg:** Depression: ischemia / Elevation: infarction

- Over 85% of ischemic events can be detected by monitoring ST segment of leads 2 and V5.

- QRS beep ON must be heard at all times, NO silent monitors.

- **Note:** Remember that your clinical judgement is much more superior to the monitor **So always** Check peripheral pulsations.
Blood pressure monitoring:

• **Non invasive blood pressure monitoring:** This is the most common method of obtaining the patient’s blood pressure during anesthesia and surgery.

• A pneumatic cuff with a width **40%** of the arm circumference must be used and the internal inflatable bladder should encircle at least half the arm. If the cuff is **too small**, the blood pressure will be overestimated, and if it is **too large**, it will be underestimated.
Con’t...

- **NIBP** can give rapid and accurate (± 9 mmHg) readings for: systolic BP, diastolic BP and MAP

  \[
  \text{Mean Arterial Pressure (MAP)} = \text{DBP} + \frac{1}{3}(\text{SBP} - \text{DBP})
  \]

- Goal of NIBP monitoring: Avoid and Manage of severe Hypotension or Hypertension.

- Risk of **Hypotension** episodes:
  - myocardial ischemia, ischemic stroke, hypoperfusion state, metabolic acidosis, delayed recovery, renal shutdown

- Risk of **Hypertension** episodes:
  - myocardial ischemia, pulmonary edema, hemorrhagic stroke, hypertensive encephalopathy.
Non-invasive BP measurement provides either intermittent or continuous readings, **For intermittent**: 

- By default every 5 minutes.
- Every 3 minutes: immediately after spinal anesthesia, in conditions of hemodynamic instability, during hypotensive anesthesia.
- Every 10 minutes: In awake patient under local anesthesia.

- Heart rate is also determined and displayed.
Con’t…

• Invasive blood pressure monitoring (Arterial BP):

Indications:

• Rapid moment to moment BP changes
• Frequent blood sampling
• Major surgeries (cardiac, thoracic, vascular)
• Circulatory therapies: vasoactive drugs, deliberate hypotension
• Failure of indirect BP: burns, morbid obesity
• Sever metabolic abnormalities
• Major trauma

The radial artery at the wrist is the most common site for an arterial catheter. Alternatives are femoral, brachial and dorsalis pedis.
Con’t...

- Complications of arterial cannulation
  - Hematoma.
  - Vasospasm.
  - Thrombosis.
  - Embolization of air or thrombus.
  - Skin necrosis infection.
  - Nerve damage.
  - Disconnection and fatal blood loss
Central Venous line and Pressure (CVP)

• This is measured by inserting a catheter via a central vein, usually the internal jugular or subclavian, so that its tip lies at the junction of the superior vena cava and right atrium.
• It is then connected via a fluid-filled tube to a transducer that converts the pressure signal to an electrical signal
• Then, This is amplified and displayed as both a waveform and pressure
Con’t…

• Loss of circulating volume will reduce venous return to the heart, diastolic filling and preload, and be reflected as a low or falling CVP.

• CVP is usually monitored in operations during which there is the potential for major fluid shifts (e.g. prolonged abdominal surgery) or blood loss (e.g. major orthopaedic and trauma surgery).

• CVP is driving force for filling RA + RV.

• Central Venous Pressure (CVP): 1-10 mmHg
Con’t…

Internal jugular vein

- Advantages of Internal jugular vein
  - Internal jugular vein lies in groove between sternal and clavicular heads of sternocleidomastoid muscle, it’s lateral and slightly anterior to carotid artery. So it is readily identifiable landmark.
  - Short straight course to SVC.
  - Easy intra OP access for anesthesiologist at patient’s head.
  - High success rate 90-99%.

- Complications of Internal jugular vein?
Con’t…

• **Subclavian vein:**
  - Easier to insert *Vs IJV*
  - Better patient comfort *Vs IJV*.
  - Higher Risk of pneumothorax 2%

• **External jugular:**
  - Easy to cannulate if visible.
  - no risk of pneumothorax,
  - high risk of bleeding.
  - 20% : cannot access central circulation
Ventilation monitoring:

• As we known before we must monitor a patient to ensure adequate ventilation of the patient.

**Clinically**, we monitor it through a correctly positioned endotracheal tube, also observing chest expansion, and breath sounds over both lungs. **Quantitively** by capnography and ETCO2 analysis, and by Arterial blood gas analysis for assessing both oxygen and ventilation.
• **What is Capnography?**

  Continuous CO2 measurement displayed as a waveform sampled from the patient’s airway during ventilation.

• **What is EtCO2?**

  A point on the capnogram.

  It is the **final measurement** at the endpoint of the patient’s **expiration** before inspiration begins.

  It is usually the highest CO2 measurement during ventilation.
Con’t...

- Phases of the capnogram:
  - Inspiratory baseline
  - Expiratory Upstroke
  - Expiratory Plateau
  - End-tidal (EtCO2)
  - Expiratory Downstroke
Con’t...

• **Applications:**
  • confirmation of intubation
  • monitoring for circuit disconnection
  • identification of airway obstruction
  • rebreathing/metabolic monitoring
Con’t…

• **Normal range:** 35-45 mmHg.
• **Value** (data gained from capnography & ETCO2):
• Endo tachial tube: esophageal intubation.
• Ventilation: hypo & hyperventilation, curare cleft (spontaneous breathing trials).
• Pulmonary perfusion: pulmonary embolism.
• Breathing circuit: disconnection, kink, leakage, obstruction, unidirectional valve dysfunction, rebreathing, exhausted soda lime.
• Cardiac arrest: adequacy of resuscitation during cardiac arrest, and prognostic value (outcome after cardiac arrest).
Monitoring Temperature

Objective
- aid in maintaining appropriate body temperature

Application
- readily available method to continuously monitor temperature if changes are intended, anticipated or suspected

Methods
- thermostat
- temperature sensitive chemical reactions
• Potential heat loss or risk of hyperthermia necessitates continuous temperature monitoring
• Normal heat loss during anesthesia averages 0.5 - 1 C per hour, but usually not more that 2 - 3 C
• Temperature below 34C may lead to significant morbidity
• Hypothermia develops when thermoregulation fails to control balance of metabolic heat production and environment heat loss
• Normal response to heat loss is impaired during anesthesia
• Those at high risk are elderly, burn patients neonates, spinal cord injuries
Con’t...

**Monitoring Sites**

- Tympanic
- Esophagus
- Rectum
- Nasopharynx
- Blood (PA catheter)
- Skin
RULES NEVER to FORGET:

- Never start induction with a missing monitor: ECG, BP, SpO2.
- Never remove any monitors before extubation & recovery.
- Never ignore an alarm

**ALWAYS**

Remember that your clinical sense and judgement is better than and superior to any monitor.

You are a doctor you are not a robot, the monitor is present to help you not to be ignored and not to cancel your brain.