Intensive care monitoring

Samuel Negash, MD
Pediatric Surgery Resident
Addis Ababa University

Intensive care monitoring

- Introduction
  - History of critical care
  - Indications for monitoring
  - Types of monitoring
- Part 1- Ventilator alarms: monitoring of lung mechanics
  - Use of ventilator alarms
  - Types of alarms
  - High pressure alarm
  - High volume alarm
  - Disconnect alarms
  - Apnea alarm
- Part 2 – Other commonly used methods of monitoring
  - ECG
  - Pulse oxymetry
  - Non invasive BP monitoring
  - Arterial lines
  - Central lines
- Summary & additional points

Critical care: where have we been and where are we going?

- The past
  - 1920's = John's Hopkins post op neurosurgical patients
  - World war II = shock ward
  - Polio outbreak = respiratory wards
  - 1950's = first ICUs
- The current
  - Better understanding of complex ICU syndromes (sepsis and ARDS)
  - Less invasive/interventional
  - More humane (unrestricted visiting, better communication, enable decision making)
  - Standardizing practice (guidelines, protocols, checklists)
- The future
  - Spread of intensive care beyond the ICU

Evolution of the ICU

Who needs Monitoring?

- Appropriate indications
  - detect physiologic abnormalities In patients at high risk
  - Aid in titration of therapy to physiologic endpoints

Types of Monitoring

Temperature - Thermistor, thermocouple

Neurologic - ICP (ventriculostomy catheter)

- **Cerebral perfusion (cerebral oximetry)**
- **Brain activity (EEG)**

Cardiovascular

- ECG
- Blood pressure (non invasive)
- Cardiac output monitoring
- Arterial catheterization
  - Invasive arterial pressure
- Central venous catheter
  - Central venous pressure (CVP)
- **Pulmonary artery catheter**
  - Pulmonary capillary wedge pressure (PCWP) & CO

Urine output - Bladder catheterization

Respiratory mechanics - Ventilator

Gas exchange

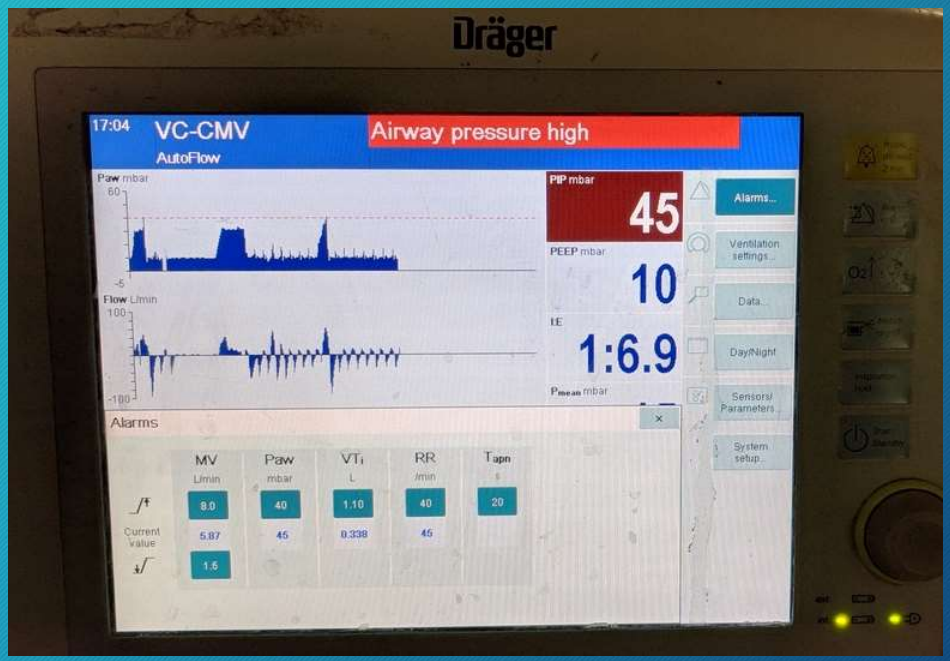
- Pulse oximetry
  - Peripheral capillary O2 saturation (SpO2) & HR
- Transcutaneous blood gas
  - Transcutaneous carbon-dioxide (PtCO2)
- Capnography
  - End tidal CO2 (PetCO2)
- Arterial catheterization
  - Arterial blood sampling (ABG) - PaO2, PaCO2, PH
- Central venous catheter
  - Central venous O2 saturation (ScvO2)
- **Pulmonary artery catheter**
  - Mixed venous O2 saturation (SvO2)

Ventilator Alarms: Monitoring lung mechanics

P -1

What's the use of Vent Alarms?

- must be set at all times to avoid patient injury due to hypoxia (and possibly death)
  - malfunctions of the ventilator (circuit leak)
  - malfunctions of the patient-ventilator interface (disconnect)
  - pathologic changes affecting the patient (high airway pressure)



Alarm settings should be set sensitive enough to detect critical events without producing false alarms (noise pollution, desensitization)

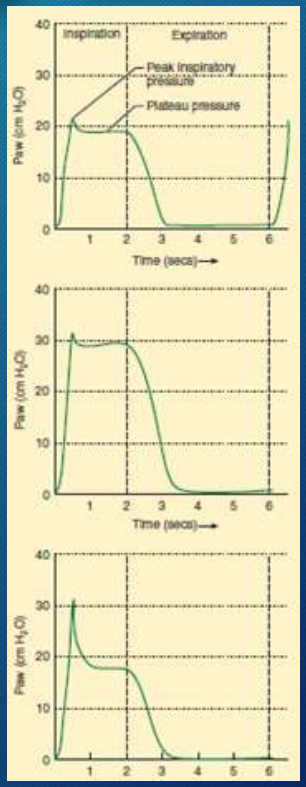
Different types of Alarms

- High Pressure alarm
  - !!! PIP high = 10 cm H20 above set (35-40)
- High volume alarm
  - !!! MV high = 10-15% above set
- Disconnect alarms
  - Low exhaled Vt (*trigged earlier than pressure)
    - !!! MV low = 10% below set
  - Low airway pressure
    - !!! PIP low = 5-10 cm H20 below set
    - !!! PEEP low = 2-5 cm H20 below set
  - *low exhaled CO2 (EtCO2)
- Apnea alarm
  - Apnea time = ? 20 sec

- Gas alarms
  - O2 supply failure
  - Low FiO2
- Power alarm
  - A/C disconnection
  - Battery low

!!! Paw high

- aim is to detect high pressure which can injury lung injury (also automatically cycles to expiration)
- For volume controlled modes (the pressure generated is dependent on set volume + resistance & compliance)
- Due to increased resistive pressure or elastic pressure
  - Airway resistance = tube obst (kinked, secretion)
    (-plateau pressure) = biting, coughing/straining,
    = asthma (bronchospasm)
    = migration of tube into bronchus
  - Lung compliance = pneumo/hemothorax, pul edema, ARDS
    (+plateau pressure) = extrapulmonary (abd. Compartment synd)



!!! MV high

- Due to
  - patient initiating own breath
  - Increase resp. rate (pain, anxiety, fever, hypoxia, PE),
  - High pressure support (improved compliance/resistance)

!!! Paw low

!!!MV low

- Aim is to detect air leak, which might be from
  - machine
  - breathing circuit
  - Accidental extubation (major leak)
  - patent's airway (cuff leak, chest wound/drain, esophageal intubation)

!!! Apnea ventilation

- Aim is to detect apnea (also automatically cycles into backup rate)
- For spontaneous modes (volume support or CPAP with pressure support) where patient has to trigger or initiate breath
- Due to sedatives, stroke, too weak

Patient-ventilator system check should be performed at regular intervals

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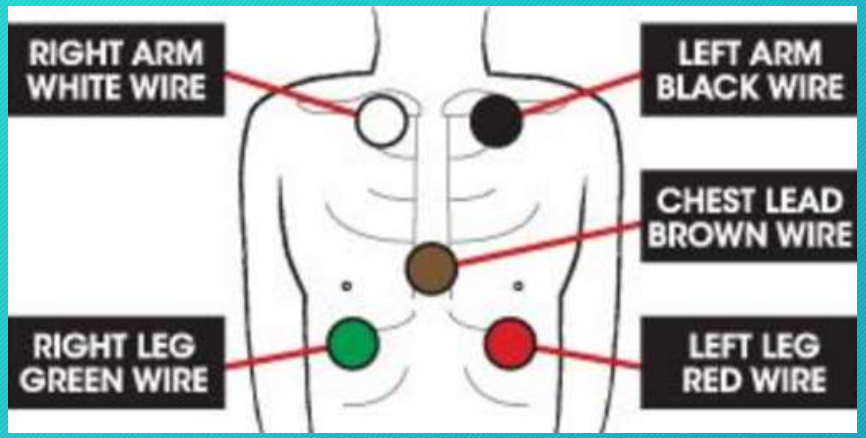
Other commonly used methods of monitoring

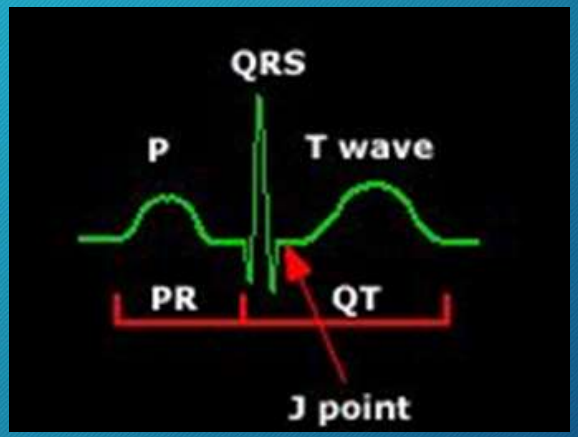
Part -2

Electrocardiography (ECG)

recording of the electrical potentials generated by myocardial cells

- Indications
  - Detect rate, arrythmia, MI, electrolyte disturbance
  - evaluate pace maker function
- Application
  - Apply conductive gel on clean & dry skin (remedies low signal)
  - electrode placement (limb leads over shoulders)
  - May use amplifiers (monitoring & diagnostic settings)
- Limitations
  - Motion artifact – patient or lead wire movement
  - Electrical noise – loose electrode, broken wire, poorly fitting
  - Common mode voltage – proximity to electrical lines





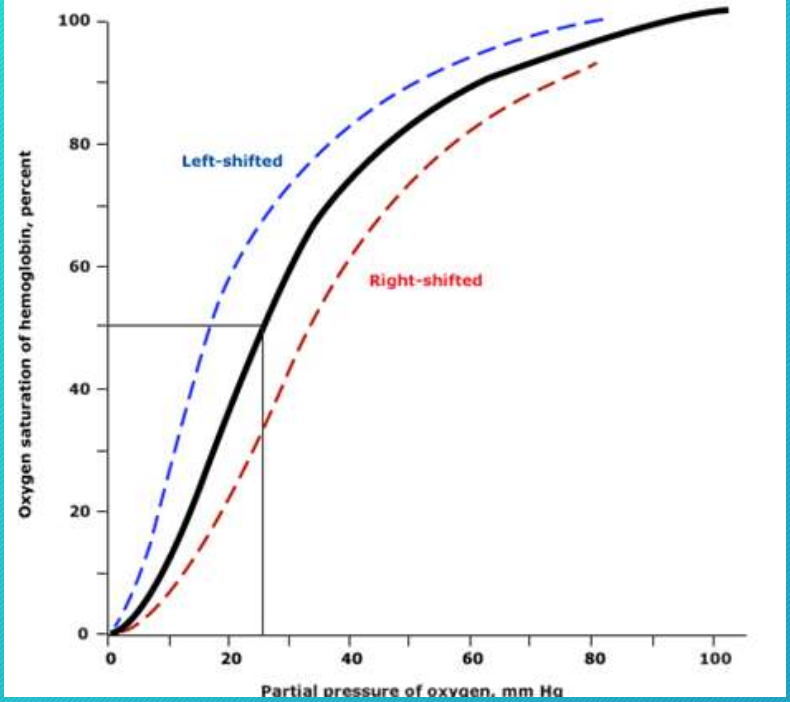
5 Lead ECG placement

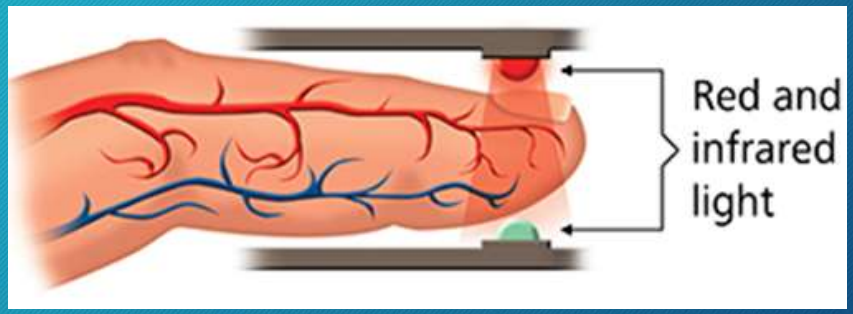
Normal tracing

Pulse oxymetry (SPO2, HR)

change in light absorption across vascular bed during arterial pulse

- Indications
  - monitoring during endoscopy, hemodialysis, cardioversion
  - Adjusting Mechanical ventilator/ inspired oxygen
- Application
  - Finger or ear
- Limitations
  - Artifact errors – movement of oximeter probe, extraneous light, nail polish
  - Dec accuracy in hypoxemia (<75%), abn. Pulsation hypotension (MAP)
  - Hypoperfusion (MAP<30), anemia (hb <3-5 g/dl), venous congestion, hypothermia
  - Abnormal hemoglobin (carboxyhemoglobin, methemoglobin)





Oxyhemoglobin dissociation curve

Pulseoxymetry

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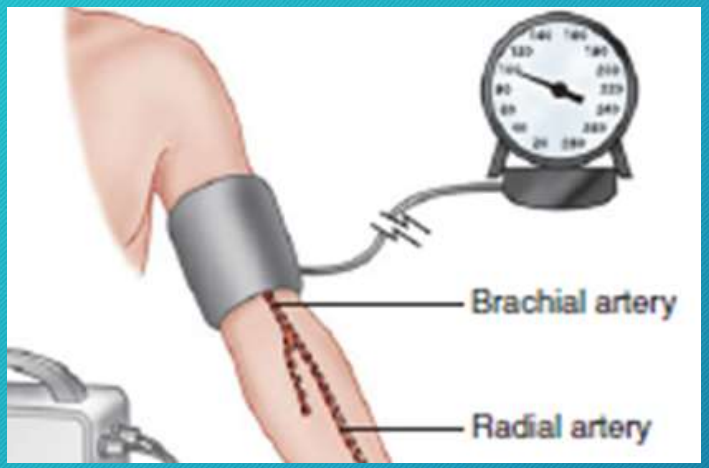
Non invasive BP monitoring

Inflating cuff to occlude artery and deflating to pressure at which flow resumes

- Indications
  - Standard but the frequency should be chosen
- Application
  - Cuff
    - Palpation
    - Auscultation
    - Doppler
    - Oscillometry (preferred)
  - *arterial tonometry
- Limitations
  - avoid extremity with vascular abn., IV lines, burns

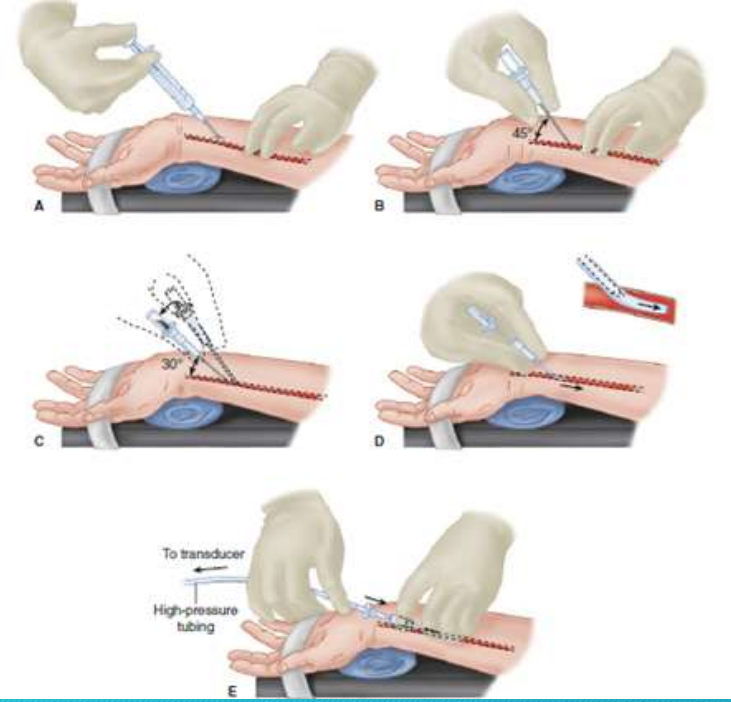


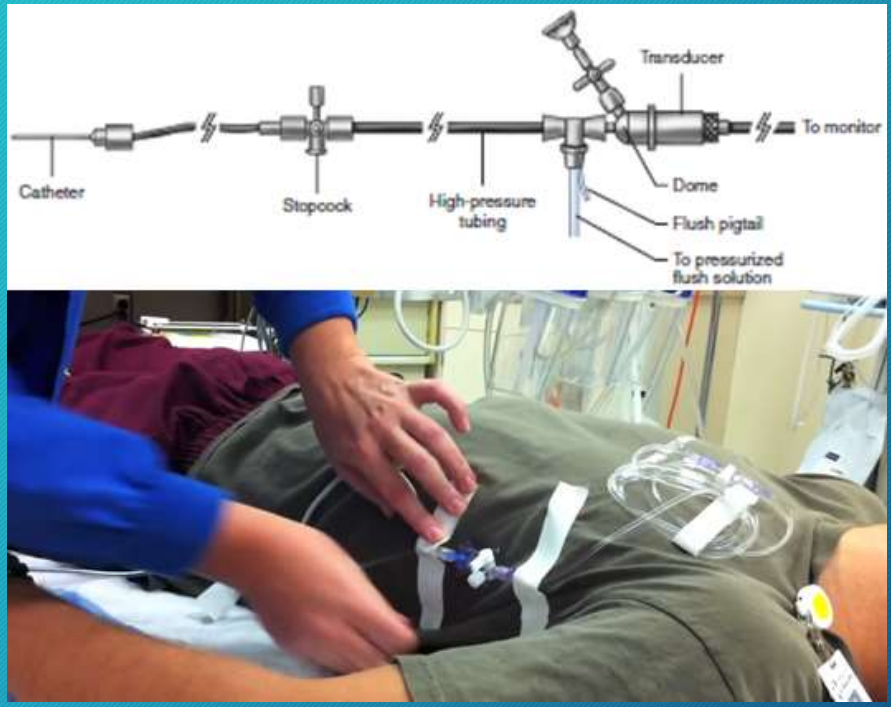
Non invasive BP monitoring

Arterial line monitoring (BP & ABG)

catheter connected to transducer to detect pressure & convert to electric current

- Indications
  - disease necessitating precise beat-to-beat blood pressure regulation
  - the need for multiple arterial blood gas
- Application
  - Instrumentation of artery
    - Radial> ulnar> dorsalis pedis> posterior tibial> femoral> axillary
  - Transducer at phlebostatic axis (61% of the way from back to front; midline; ¼ the distance above the inferior tip of the xiphoid process)
- Complications
  - bleeding, spasm
  - air emboli, thrombosis, infection
  - pseudoanurysm, skin necrosis, nerve damage





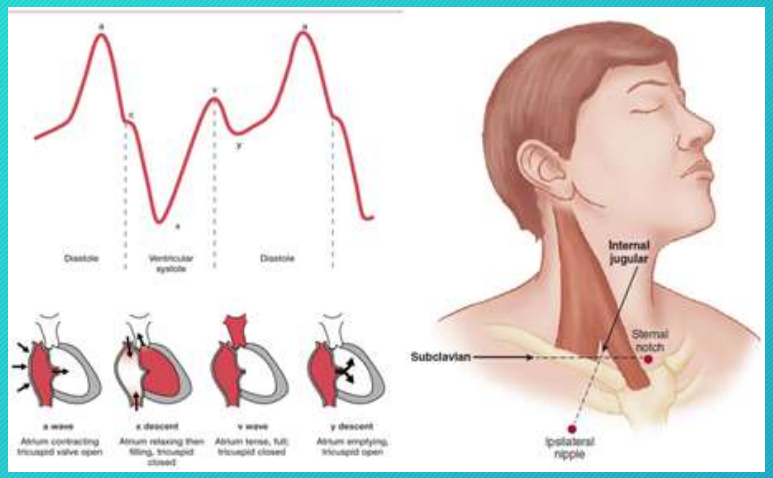
Arterial line placement

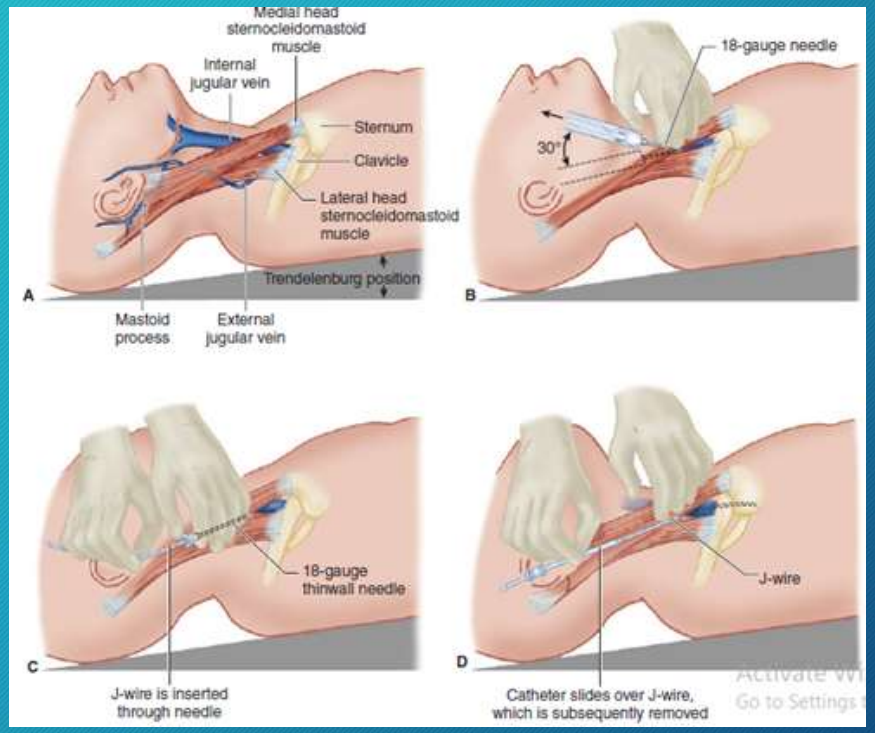
Positioning of transducer
IV fluid in pressure bag (to flush the line)

Central line monitoring (CVP & ScvO2)

Venous catheter (with transducer) inserted so that tip is around SVC-RA junction

- Indication
  - Critically ill patients, MOF, open heart surgery
- Application
  - Instrumentation of vein
    - internal jugular, subclavian
    - *Femoral (for infusion), external jugular (difficult) , veins in arm (basilic)
  - catheter over a needle, through needle or over a guidewire (Seldinger's technique)
- Complications
  - Air emboli (more during removal), infection in 5%, thrombosis (axillary, subclavian),
  - arterial insertion in 2% (hematoma, stroke, airway compromise, death)
  - Perforation/laceration (SVC, RV), brachial plexus, phrenic nerve
  - Pneumothorax (subclavian), effusion/chylothorax (lt IJV)
  - Arrythmia (catheter tip migration RA/RV)





central line placement

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The Information from monitors is only as good as its interpreter

References

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Thank you!