CPAP & Capnography

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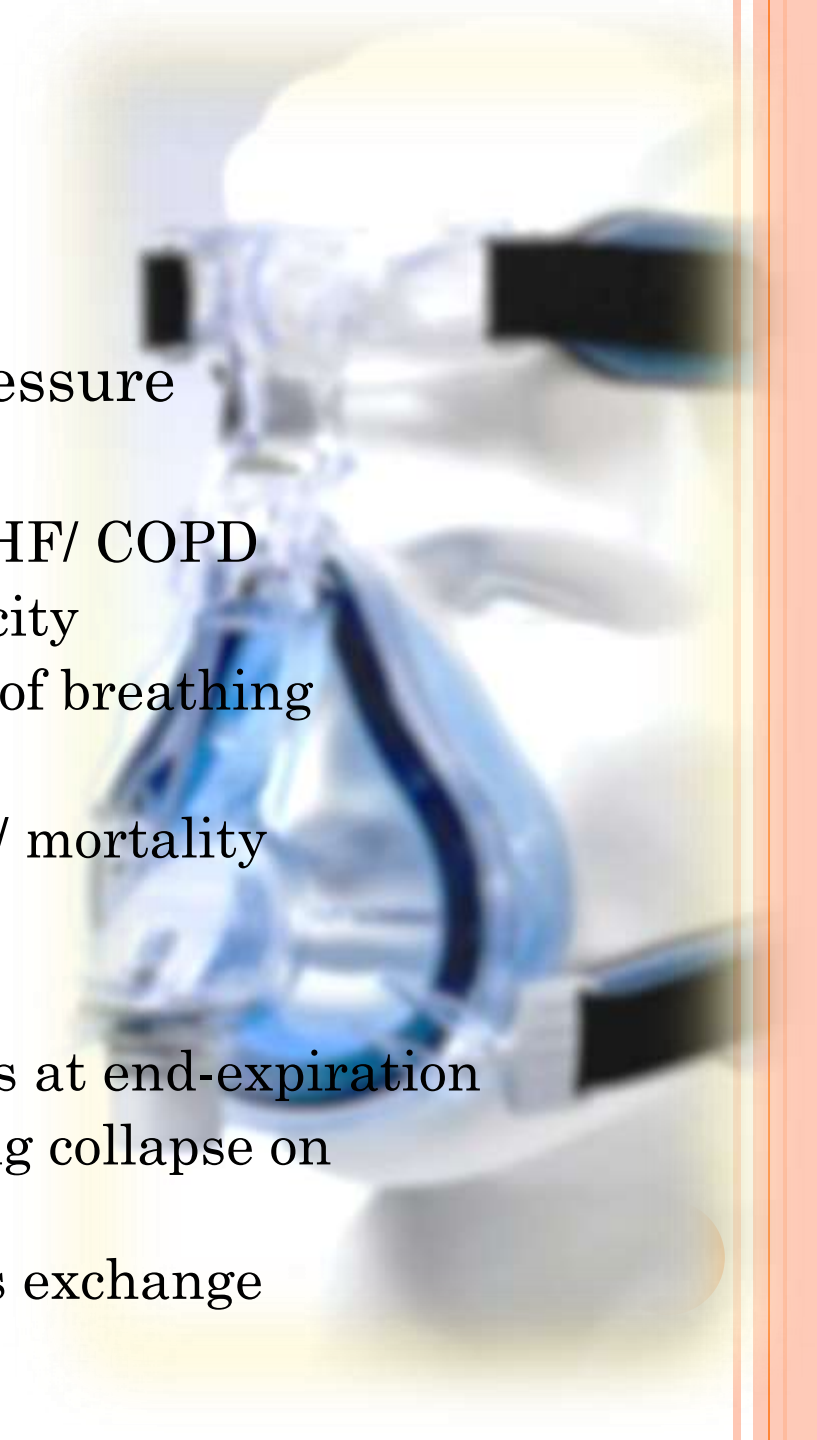
CPAP

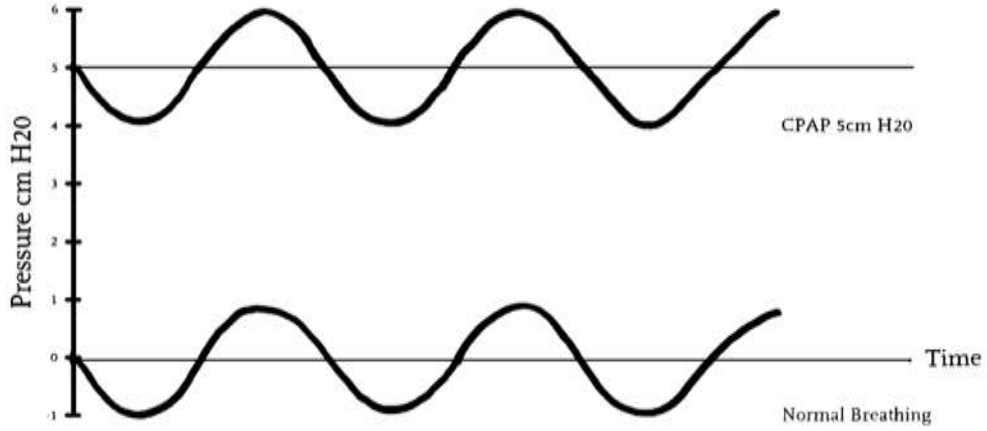
- Continuous Positive Airway Pressure
- Goals:
  - Have an effective way to treat CHF/ COPD
  - Increase functional reserve capacity
  - Eliminate dyspnea/ reduce work of breathing
  - Increase SpO2
  - Decrease the need for intubation/ mortality

- More on FRC
  - Volume of gas remaining in lungs at end-expiration
  - CPAP distends alveoli, preventing collapse on expiration
  - Greater surface are improves gas exchange



How CPAP works

- Partial pressure
  - "Pressure of a gas mixture is equal to the some of the partial pressures of its consituents"
  - 7.5cm H2O CPAP increases the partial pressure of alveolar air and forces more oxygen into the blood.
- Deoxygenated blood has a lower partial pressure of oxygen. Due to a pressure gradient between oxygen in the lungs and that in the blood, O2 from the alveoli moves into the blood.



How CPAP works

- Overcomes inspiratory work imposed by auto-peep (reduces work of breathing)
- Prevents airway collapse
- Redistribution of intra-alveolar fluid
- Increases transpulmonary and intrathoracic pressure
- Improves lung compliance

Current users of CPAP

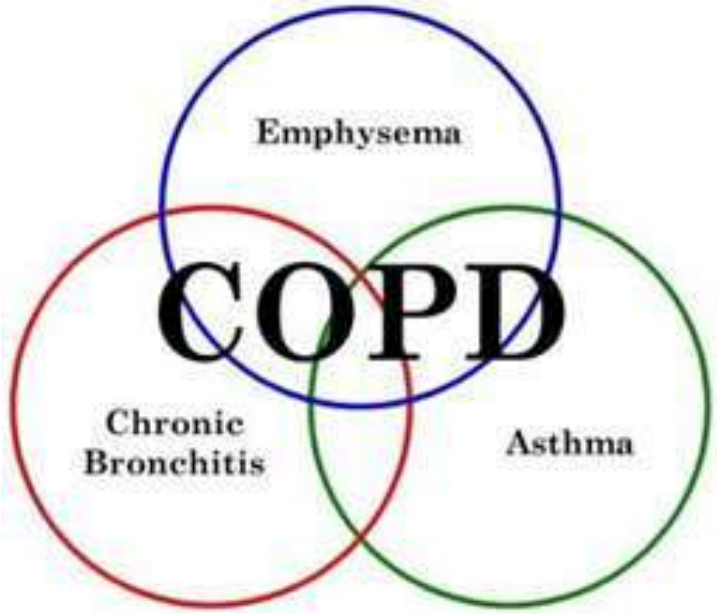
- EMS
- Emergency department
- Pre-operative (anesthesia)
- Intensive care
- Recovery room
- General ward
- Many patients also use CPAP at home

Clinical indications for CPAP

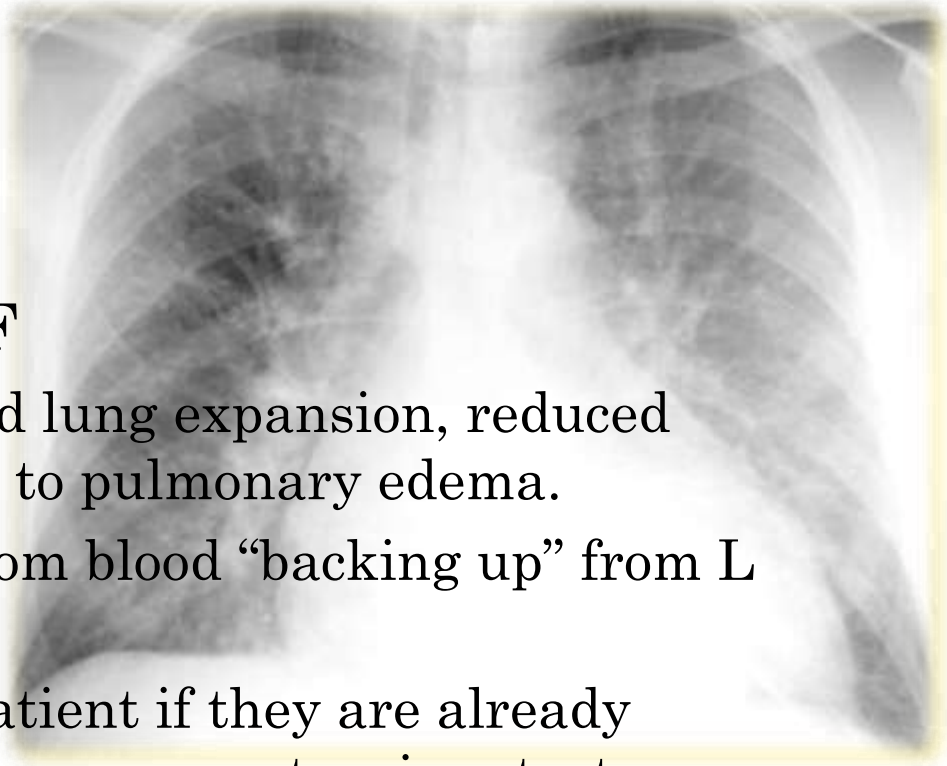
- Pulmonary edema
- CHF
- COPD
- Near drowning
- Atelectasis
- Sleep apnea
- ARDS
- Asthma

CPAP INDICATIONS

- COPD
  - Obstructive issue- air impeded from moving through airways. Increased airway resistance causing reduced expiratory airflow rates
    - CPAP Helps relieve obstructive issues- splinting airways
    - Gas exchange issues
    - Muscle tiring?
    - Temporizing treatment
    - Avoid intubation and mechanical ventilation



CPAP INDICATIONS



- Pulmonary edema/ CHF
  - Restrictive issue- limited lung expansion, reduced lung volumes secondary to pulmonary edema.
  - Fluid due to pressure from blood "backing up" from L side of heart.
  - Avoid in heart failure patient if they are already hypotensive- dopamine once normotensive start CPAP
    - CPAP Increases FRC
    - Improves lung compliance
    - Improves arterial blood oxygenation
    - Move fluid vs increase intrathoracic pressure?

CPAP INDICATIONS

- ARDS
  - Characteristics
    - Hypoxemia
    - Reduced compliance
    - Large intrapulmonary shunt
  - CPAP in early stages may
    - Correct hypoxemia
    - Improve compliance
    - Reduce shunt
- Acute respiratory failure
  - Overcomes inspiratory work
  - Prevents airway collapse durring exhalation
  - Improves ABG values

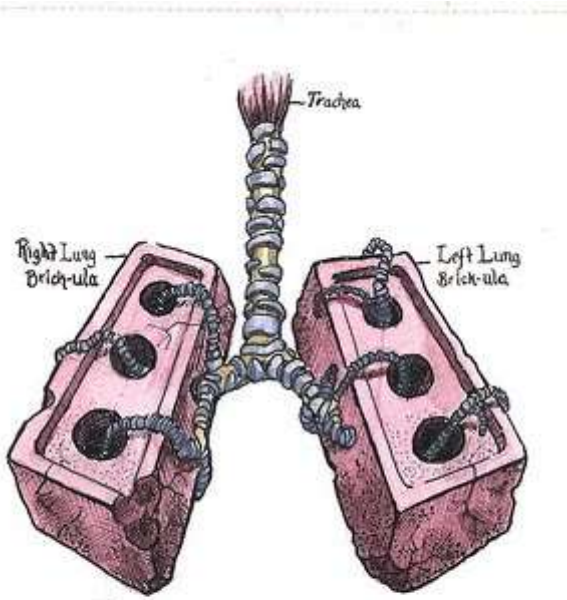


Fig. 347 Lung tissue has been dissected away to reveal the cause of respiratory failure - namely, abnormal "Brick"-ula enlargement.

Other indications

- Drowning
- CO poisoning
- Organophospate poisoning
- Pulmonary infections

Contraindiciations

- Age <8
- Respiratory or cardiac arrest
- Agonal respirations
- Severely depressed LOC
- Systolic BP <90
- S/S of pneumothorax
- Inability to maintain airway
- Trauma (CHI and chest trauma)
- Vomiting
- Airway edema

Common complications with CPAP

- Pressure sores
- Gastric distension
- Pulmonary barotrauma (pneumothorax)
- Reduced CO
- Hypoventilation
- Anxiety

Complications

- Address the emotional component
  - Claustrophobia is common complaint with CPAP masks
    - Don't give up too early but know when to give up
    - Allow patient to hold the mask
    - When benefits are felt, patients will be inclined to keep the mask on
    - Straps can then be attached as the patient becomes more comfortable
  - If the patient will not tolerate the mask don't force them.

Components of a CPAP system

- Flow Generator
- CPAP valve
- Mask/ tubing
  - Nebulizer?

Application

- Start flow to mask
- Attach mask to patient
- Adjust pressure as needed
  - Machine or pressure valve

- Mask should fit much like a BVM fits- over the bridge of the nose and above the chin

Common CPAP levels

CPAP Value	Uses
5 cm H2O	Mild pulmonary edema, relative contraindications
7.5 cm H2O	Moderate pulmonary edema, good initial setting
10 cm H2O	Moderate to severe pulmonary edema, significant benefit, most complications.

- Normal physiologic PEEP is 3-5cm H2O
- CPAP is not cumulative to this number.

BLS CPAP

- Wisconsin first state to address issue
- New Mexico and Pennsylvania followed
- CPAP is being used by BLS crews in some states

Capnography

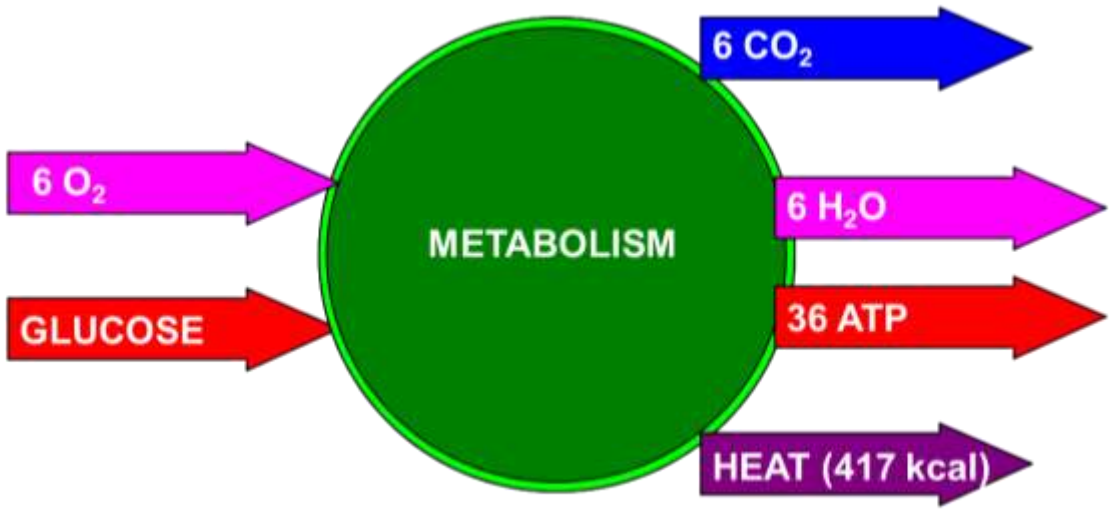
- First developed in the 1940's
- During the 1970's it became the standard for Pt ventilation monitoring in the OR
- In the 80's and 90's it moved to the ER and ICU as a means to monitor Pt's status
- Now used in all aspects of patient care, including EMS

Pulse Oximetry vs. Capnography

- Pulse Oximetry
  - Measures oxygenation or hemoglobin oxygen saturation
  - Can be affected by shock, movement, cold, nail polish, anemia, perfusion, cardiac arrest
  - Monitor lag, may take as long as 3-5 min to detect changes in O2
  - Pulse oximetry is considered to be a vital sign
- Capnography
  - Measures ventilation
  - You can tell how well your Pt is offloading CO2
  - Cardiac output
  - Fast detection of ventilation changes (apnea)

CO2 PRODUCTION

Aerobic metabolism



Anaerobic metabolism does not produce CO2.

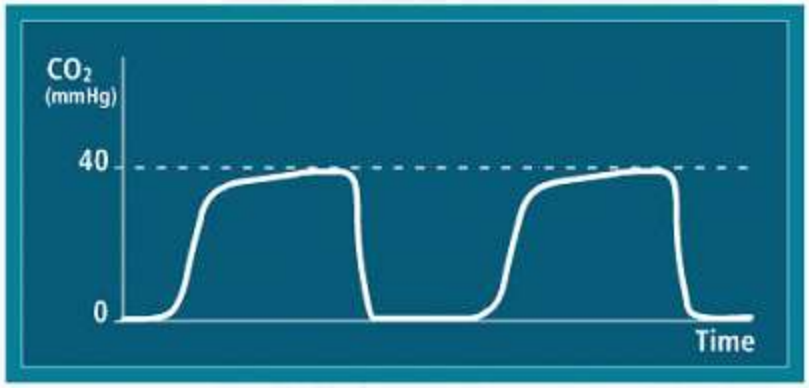
How do we measure EtCO2?

- Colorimetric
  - First CO2 detectors used in the field
  - Easy to use, disposable
  - Uses PH sensitive paper between the ET tube and the BVM
  - Only last about 15 minutes
  - Inaccurate when exposed to liquids
  - Will show presence of CO2, but not quantity
  - False negatives during cardiac arrest

Capnometry vs Capnography

- Capnometry
  - Numeric readout of the CO2 in each breath
  - For both non-intubated and intubated patients
  - Gives a constant readout of CO2

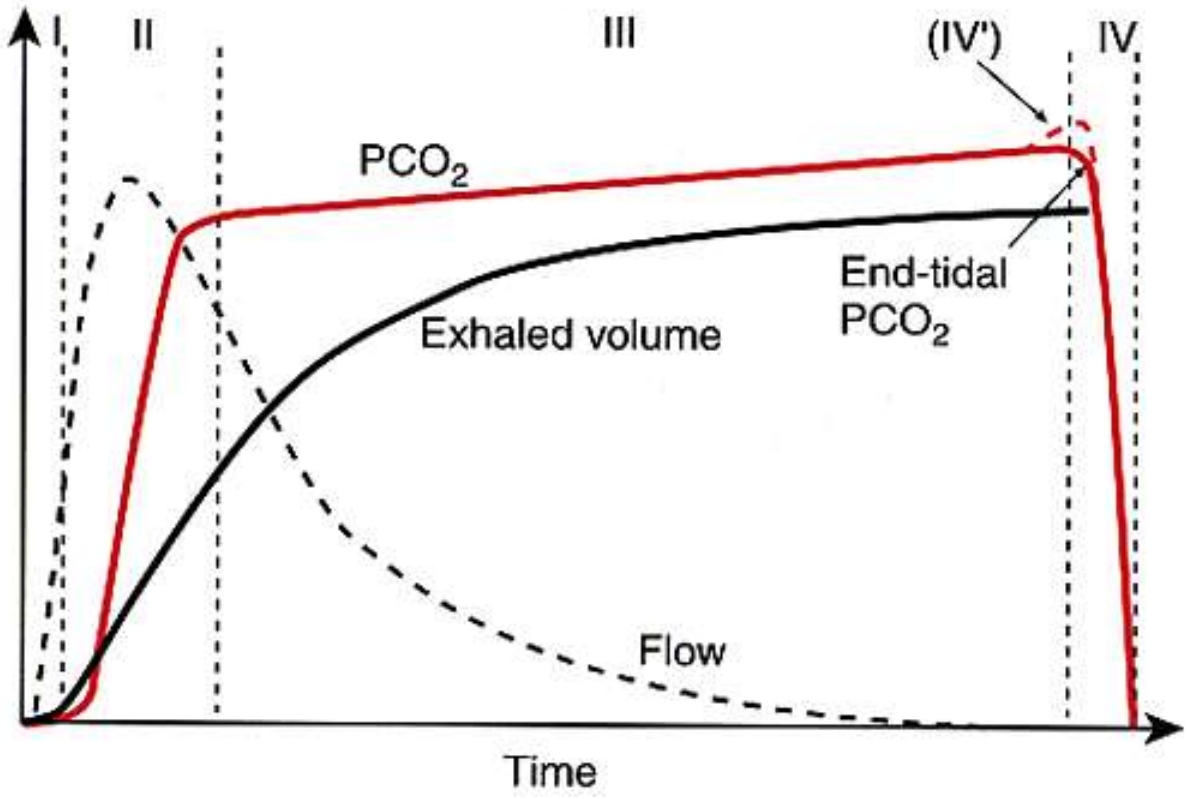
- Capnography
  - A numerical value of the $EtCO_2$
  - A waveform of the concentration of CO_2 present in the airway
  - For both non-intubated and intubated patients
  - Continuous breath-to-breath monitoring



Methods of monitoring Capnography

- Side Stream
  - Sensor located in a remote unit and CO2 is aspirated via a sampling tube connected to a T-piece adapter.
- Main Stream
  - CO2 sensor located between ETT and BVM/ Ventilator.
  - Most commonly used on intubated patients
  - Faster response

Capnographic Waveform



- Expired PCO2 versus time (real time vs. trends)

Capnographic Waveform

- Phase I: exhaled gas from the large airways has PCO2 = 0.
  - Mechanical deadspace
- Phase II: the transition between airway and alveolar gas.
- Phase III: Alveolar gas exchanged. This portion of the waveform is normally flat, but in the presence of V/Q mismatching has a positive slope.
  - The PCO2 value at the end of exhalation is referred to as the end-tidal CO2 (Normal 35-45)
- Phase IV: Onset of inspiration, downward

Abnormal waveforms

- Ventilation
  - Hyperventilation, RR increases CO_2 decreases
  - Hypoventilation, RR decreases CO_2 increases
  - Bronchospasm, sloped phase II (shark fin)
  - Apnea, no wave at all

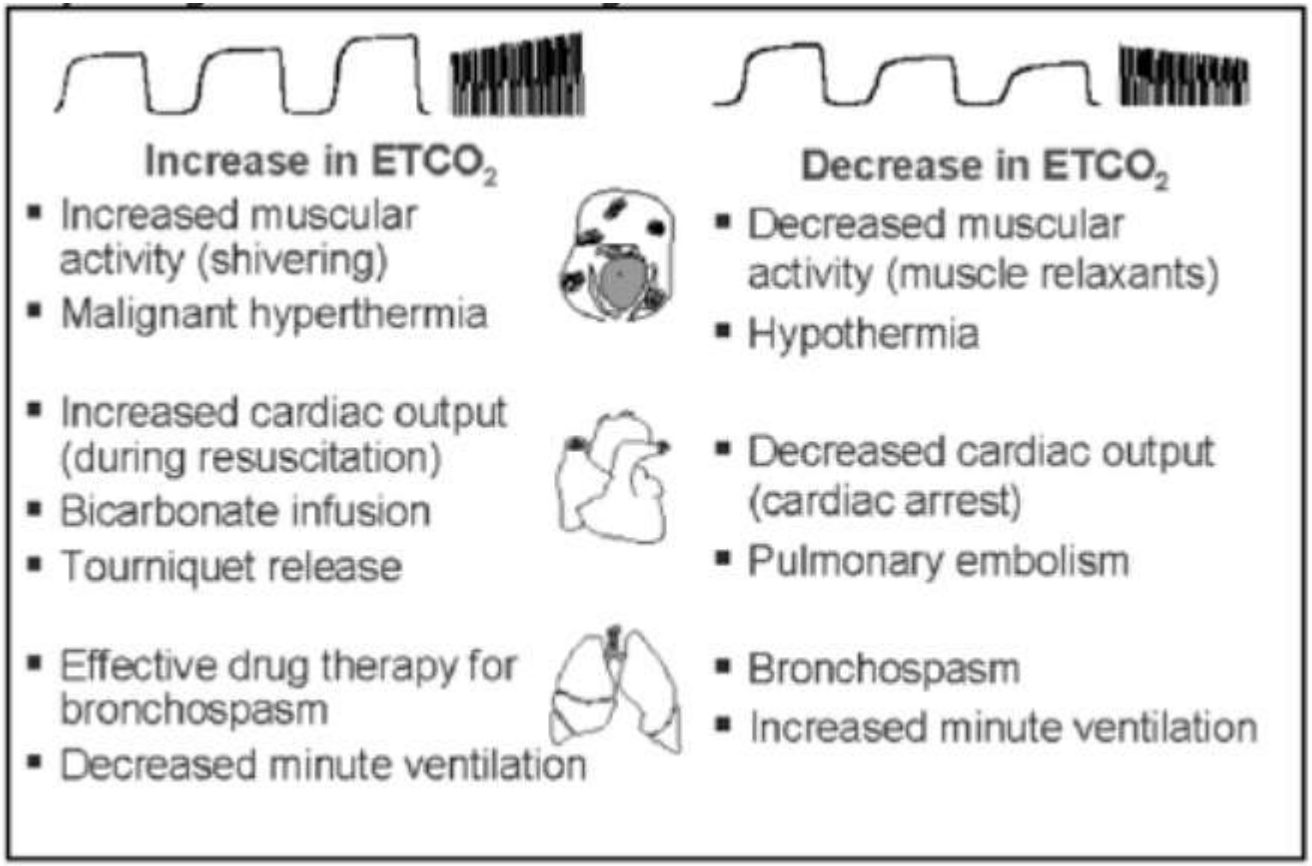
- Perfusion
  - Cardiac output
  - Decreased perfusion leads to a decrease in CO_2
  - Pulmonary embolism
  - Hypovolemia
  - CPR and ROSC

Abnormal waveforms

- Deadspace ventilation
  - Alveoli are perfused, but not ventilated
- Shunt
  - Alveoli are ventilated, but not perfused

- Metabolic
  - Fever
  - Malignant hyperthermia
  - Tourniquet release
  - Hypothermia
  - Street drugs

Abnormal waveforms



ET_{CO_2} vs P_{aCO_2}

- End-tidal CO_2- partial pressure of CO_2 at end of expiration.
  - Represents alveolar gas
  - Lower than ideal PCO_2 because dead space gas dilutes the sample, lowering the reading
- $PaCO_2$- Arterial blood sample

- Healthy patient $EtCO_2$ and $PaCO_2$ are very close with $EtCO_2$ being 2-5mmHg lower.
- A greater discrepancy may appear with a V/Q mismatch.

Capnography in EMS

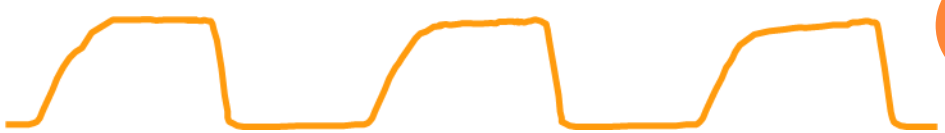
- Gold standard for ETT placement confirmation is waveform capnography.
  - Objective
- Confirm correct placement of ET tube
- Detect changes in ET tube position immediately
- Resuscitation
  - Assess adequacy of chest compressions
  - Detect ROSC
  - Objective data for decision to cease resuscitation
- Optimize ventilation of patients
- ICP patients?

Capnography in EMS

- Differential diagnosis of respiratory patient.

Before

After



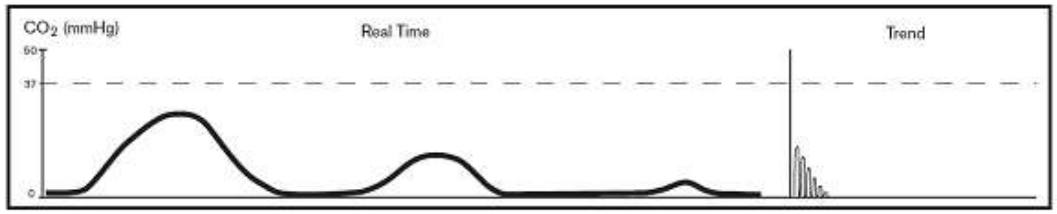
Capnography in EMS

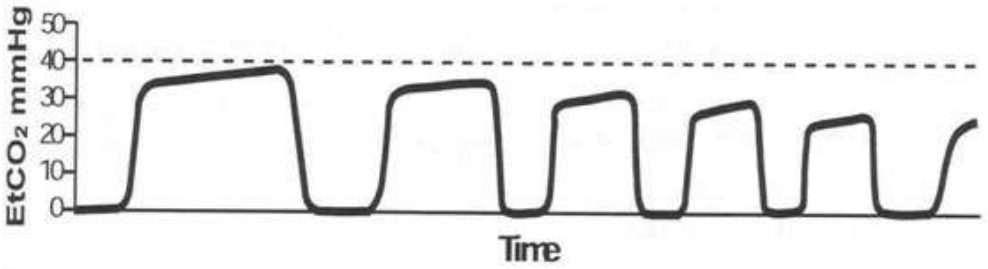
- Monitors the respiratory status
- Respiratory failure
  - Hypoxemic respiratory failure- generally involve fluid filling or collapse of alveolar units (pulmonary edema, pneumonia)
    - PaO2 lower than 60mmHg
  - Hypercapnic respiratory failure- patient is unable to "blow off" CO2 due most commonly to airway disorders (COPD, asthma)
    - PaCO2 higher than 50 mmHg.
    - pH changes?

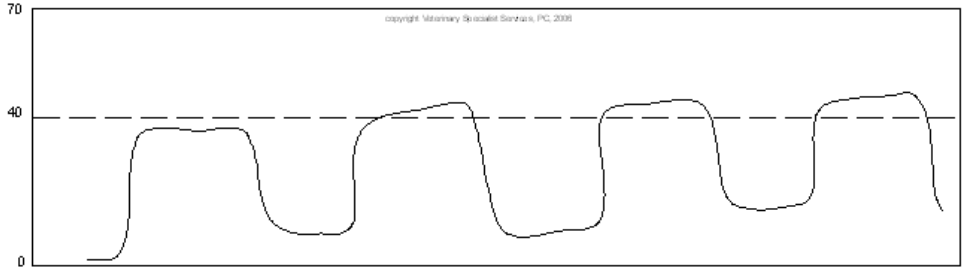
Capnography in EMS

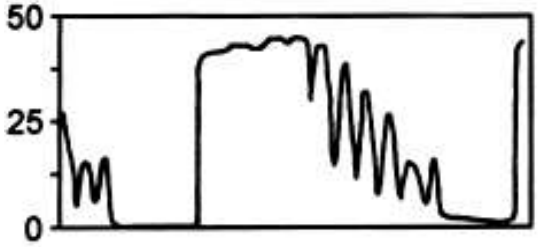
- Check effectiveness of cardiac compressions
- Monitor low perfusion states
- Also useful in DKA cases
  - Respiration rate goes up and EtCO2 goes down
- Pt in metabolic acidosis
  - Correct EtCO2?

"That doesn't look right?!"









Thanks!

Questions? Comments?