CAPNOGRAPHY
by Nick Mark MD

PRINCIPLE: Measurement of exhaled carbon dioxide can be used to confirm ETT placement, for safer procedural sedation, to guide resuscitation, and to monitor cardiac & pulmonary physiology.

- PETCO2 – End-tidal CO2 (what’s measured by capnography)
- PACO2 – Alveolar CO2
- PaCO2 – Mixed venous CO2
- PaCO2 – Arterial CO2 (what’s measured on an ABG)

PETCO2 is usually less than PaCO2 because of dead space. If physiological dead space increases the difference between PETCO2 and PaCO2, will also rise. Examples include:
- Low cardiac output – reduced delivery of CO2 to lungs
- Blockage of Pulmonary arteries (pulmonary embolus)
- Poor gas exchange due to overdistension of alveoli – high TV, excessive PEEP, COPD

SPECIFIC CAPNOGRAPH PATTERNS:

DOWNSLOPING PHASE III
- Severe emphysema (alveoli destruction can cause rapid initial emptying of CO2)

CURARE CLEFT
- Patient dysynchrony during mechanical ventilation breath

DIMORPHIC PHASE II/III
- Right mainstem intubation
- Differential lung emptying (Single lung transplant, severe kyphoscoliosis, etc)

CARDIAC OSCILLATIONS
- Hypovolemia
- Hypoventilation
- Each heartbeat ejects a small amount of CO2

PROMINENT PHASE IV
- Obesity
- Pregnancy
- Poor compliance

SUDDEN DROP IN ETCO2
- Displaced ETT
- Decreased CO (arythmia, PE, etc)

ETT CONFIRMATION
Confirmation of exhaled CO2 can be used for ETT placement confirmation. Colorimetric capnograph is only appropriate in well perfusing patients; waveform capnograph is more accurate, particularly in low CO states.

ETCO2 IN PROCEDURAL SEDATION
Waveform capnography can be used to monitor for hypventilation in non-intubated patients during procedural sedation (using an ETCO2 sensor nasal cannula). Waveform capnography is more sensitive than just SpO2 monitoring, and can detect hypventilation up to 60 seconds before desaturation occurs.

COLORIMETRIC CAPNOGRAPH
Litmus paper changes color based on pH; exhaled CO2 lowers the pH and causes the the paper to transiently turn from PURPLE to YELLOW (“MELLOW YELLOW”); acidic vomitus can cause a false permanent color change.

PORTABLE ELECTRONIC CAPNOGRAPH
IR spectroscopy precisely measures exhaled CO2 content

WAVEFORM CAPNOGRAPH
IR spectroscopy measures exhaled CO2 content and displays results graphically; can also be used with special nasal cannula to monitor non-intubated pts.

The waveform is composed of 4 phases
- Phase I – anatomical dead space ventilation
- Phase II – dead space mixed with alveolar ventilation
- Phase III – alveolar ventilation (where ETCO2 measured)
- Phase IV – end of exhalation

ETCO2 IN CARDIAC ARREST
Adequacy of CPR
- Achieving an ETCO2 > 20mmHg is associated with adequate CPR. If not achieving this goal consider rotating the person performing compressions.

Detection of ROSC
- Sudden increase in PETCO2 during CPR is a marker for ROSC.

Determination of futility
- Persistent PETCO2 < 10 for > 20 min is associated with futility, and even 5 min with ETCO2 < 10 is associated with poor outcomes.

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