Applying Capnography in the Clinical Setting

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EVERY BREATH YOU TAKE I’LL BE WATCHING YOU

Sting
Oxygenation and Ventilation

• **Oxygenation**
  – Oxygen for metabolism
  – SpO$_2$ measures % of O$_2$ in RBC
  – Reflects change in oxygenation within 5 minutes

• **Ventilation**
  – Carbon dioxide from metabolism
  – EtCO$_2$ measures exhaled CO$_2$ at point of exit
  – Reflects change in ventilation within 10 seconds
I want all my patients to have a pulse ox on....
SHOULD YOU BELIEVE YOUR GREAT SATS???

• Reflects changes in Oxygenation within 5 MINUTES!!!
• NOT ACCURATE when sat is > than 70
• Grossly inaccurate when a finger probe is placed on the ear or forehead

• Inaccurate readings can occur if patient is:
  – Hypotensive
  – Hypovolemic
  – Hypothermic
  – Has Sickling red cells
  – Wears Nail polish, esp blue, beige, purple and white
  – Treated w vasoactive drugs
  – Has Cardiac Failure/arrythmias
  – Has PVD
  – Under bright lights
Wouldn’t You Rather Have an ETCO2 Monitor?

- First hypoventilation then apnea, then comes hypoxia
- Capnography can recognize hypoventilation, airway obstruction or apnea,
- Enables caregiver to take corrective measures prior to critical events
Results of National Audit Project to Identify and Study Serious Airway Complications

- 310 NHS hospitals: anesthesia, ICU&ED
- 80% intubations performed by anesthesia or critical care MDS
- Events: Pts who died, had brain damage or needed a surgical airway emergently or had prolonged ICU stay

- 20% of reported critical events came from ICU but counted for 50% of deaths in the study
- O.R.: 130 cases 14% led to death or brain damage
  Occurred after hours, mostly to junior residents
National Audit Project to Identify and Study Serious Airway Complications

- More males than females, young, multi organ failure, more than 60% FiO2 needs at time of event
- 50% were obese
- Obese pts in ICU worse outcome
- Failure to use ETCO2 caused 74% of death and brain damage
Results of National Audit Project to Identify and Study Serious Airway Complications

- Problems with intubations:
  - Failed or delayed or misplaced intubations
- Loss of airway in pt dependent on it, most were tracheostomies
- Almost 50% were misplaced trach tubes
- 36 intensive care events...only 1/4 of true events were captured...
Results of National Audit Project to Identify and Study Serious Airway Complications

• AT RISK:
  • Fresh trachs
  • In for 3-4 days
  • Adjustable phalange changed to speaking trach. Trach displaced with turns, sedation hold
  • Delay in diagnosis of displacement, few had ETCO2
Physiological Factors Affecting ETCO$_2$ Levels

Increase in ETCO$_2$
- Increased muscular activity (shivering)
- Malignant hyperthermia
- Increased cardiac output (during resuscitation)
- Bicarbonate infusion
- Tourniquet release
- Effective drug therapy for bronchospasm
- Decreased minute ventilation

Decrease in ETCO$_2$
- Decreased muscular activity (muscle relaxants)
- Hypothermia
- Decreased cardiac output (cardiac arrest)
- Pulmonary embolism
- Bronchospasm
- Increased minute ventilation
CAPNOGRAPHY

• MUST USE IN TRANSPORT / ER/ICU/ CPR
• PCO2 is usually 2-5 mmHg higher than ETCO2
• Significant difference in PCO2 to ETCO2 if:
  – multiple trauma
  – severe chest trauma
  – hypotension, and heavy blood loss.
  – due to increased dead space secondary to decreased alveolar perfusion or disruptions in pulmonary blood flow
USE OF ETCO2 in INTUBATED PATIENTS

- Verify and document ETT or tracheostomy placement
- Detect changes in ETT during traveling or patient position changes immediately
- Detect changes in tracheostomy placement immediately
- Adjust rate and/or tidal volume in head injury patients
- Identify obstruction in ETT or Trach
- Provides optimal ventilation prehospital
- Predictive of outcome in trauma resuscitation
- Assess effectiveness of chest compressions
- Earliest indication of ROSC
- Helps predict whether CPR will have been successful in resuscitation
Only capnography provides Numerical as well as Continuous graphic waveform for immediate visual recognition of ETT placement. ACLS Standard
ACLS POST INTUBATION GUIDELINES

• Colormetric ETCO2 devices should only be used when waveform capnography is not available.

• Complications come during ongoing care of patient not just one brief picture....DO YOU TAKE OFF PULSE OX AFTER ONE LOOK AT SATS ???
Traveling with the Intubated Patient

- ALL intubated patients should be transported on ventilators with pulse oximetry and ETCO2
- Mechanical Ventilation and ETCO2
  - Provides strict control of PCO2
  - Prevents episodes of CBF fluctuations in TBI
  - Maintains ventilator settings that ABG’s were obtained on
  - Ability to maintain set PaO2
Detect ET Tube Displacement During Transport, Position Changes, Taping, X-Ray ETC.....

- Immediately detects ET tube or trach tube displacement

ETT or trach tube Dislodgement
ETCO2 Waveform of Obstruction

Is there a foreign body in the airway?
Is there a partial or complete obstruction in the airway?
Did the expiratory side of the vent circuit get kinked?
Is the patient starting to get bronchospastic?
ETCO2 is a fundamental component of care of the TBI patient

Hyperventilation causes hypocapnia

• Hypocapnia causes vasoconstriction and decreases CBF
• Hypocapnia reduces cerebral blood volume and lowers ICP
• Hyperventilation associated with cerebral ischemia
• Muizelaar vasoconstriction effects last >24 hours
Optimize Ventilation with ETCO2

• Use capnography to titrate EtCO₂ levels in patients sensitive to fluctuations

• Patients with suspected increased intracranial pressure (ICP)
  – Head trauma
    • Critically important in preventing low cerebral blood flow. First 24 hours post injury TBI have 50% less blood flow than normal patients.
    • Low ETCO2 shown to increase mortality and disability (ETCO2 <20mmHg, pre hospital)
  – Stroke
  – Brain tumors
Sudden Loss of Waveform

- Fully obstructed Airway
- Esophageal Intubation
- Airway dislodged
- Paralytics given to spontaneously breathing patient
- Ventilator circuit disconnect
- Ventilator failure
- Apnea
- Cardiac Arrest
Capnography in Cardiopulmonary Resuscitation

- Assess chest compressions
- Early detection of ROSC
- Objective data for decision to cease resuscitation
CPR: Assess Chest Compressions

- Use waveforms from EtCO$_2$ to depth/rate/force of chest compressions during CPR
CPR: Detect ROSC

• Briefly stop CPR and check for organized rhythm on ECG monitor
• ETCO2 can detect presence of pulmonary blood flow even in absence of major pulses
ETCO$_2$ & Cardiac Resuscitation

• **Non-survivors**
  – Average ETCO$_2$: 4-10 mmHg

• **Survivors (to discharge)**
  – Average ETCO$_2$: >30 mmHg
ETCO2 and Trauma Resuscitation

- 191 patients J Trauma study 2004
  ETCO2 < 10 mm Hg only 5% survived to discharge
Use of ETCO2 In Non Intubated Patients

- Identify and monitor bronchospasm
  - Asthma
- Can be used to Assess and monitor
  - Hypoventilation states
  - Hyperventilation
    - Weaning, CHF, exercise
  - Low-perfusion states
    - CHF
Capnography in Bronchospastic Diseases

- Uneven emptying of alveolar gas alters emptying on exhalation
- Produces changes in ascending phase (II) with loss of the sharp upslope
- Alters alveolar plateau (III) producing a “shark fin”
Hypoventilation
Hypoventilation

• Neuromuscular diseases monitoring
  – ALS, MD, MG
• Titrating optimal settings on non invasive ventilation
• SCI patients
• Obstructive sleep apnea
• Procedures
• PCA infusions
SUMMARY

• Capnography is standard of care for approx 15 years in O.R. equipment is in hospitals already

• Respiratory Therapists and Nurses should have it set up in the ER or ICU room ready to go
  — Non-Invasive, Quick set up

• Capnography use in hospitals, and in the field, is a patient safety issue
  — It has been shown to prevent critical events
SUMMARY

• Capnography should be used on all intubations
  – ACLS guidelines mandate
• Capnography should be used on intubated patients in pre hospital / ER / ICU / transport
• Capnography should be used on trach patients:
  – spontaneous breathing patient had marked de sats then arrest
• Capnography should be used to confirm trach changes
• Capnography should be used in code situations
• Capnography should be used in conscious sedation procedures and PCA infusions
Tips to improve accuracy

• Position monitor higher than patient.
  – Water and secretions then will not drain into monitor and block the filter

• Position sampling line upright
  – Water, patient secretions and neb rain out can contaminate the sampling tube and increase resistance in the tubing
References


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• Special thanks to Tommy Leonard RRT, Remote Monitoring Product Manager, Covidien