Capnography for Pediatric Procedural Sedation
Learning Module
Last revised: February 18, 2014
Capnography

*Non-invasive device that continually monitors EtCO₂*

- While pulse oximetry measures oxygen saturation, capnography monitors the status of the child’s *ventilation*
  - Pulse oximetry has a significant “lag time” between apnea and reading
  - Earlier intervention often prevents hypoxia and resulting complications
- Earliest indicator of airway or respiratory compromise (e.g. apnea, hypoxia, upper airway obstruction, laryngospasm, bronchospasm, and respiratory failure)\(^9\)
- Is now required at Virtua for moderate & deep sedation performed outside of the OR
- Moderate sedation requires a quantitative measurement
  - Numerical accuracy of measurement may be limited when measuring via nasal canula as opposed to measuring via endotracheal tube due to incomplete gas sampling
  - Monitoring of the waveform itself is of more clinical utility than the numerical value in moderate sedation

Ex. Normal Waveform = patent airway, patient breathing

Ex. Curved Waveform denotes bronchospasm

Adapted from Illinois Emergency Medical Services for Children “Pediatric Moderate Sedation” February 2008
Respiratory Cycle:
Oxygenation & Ventilation are Separate Functions

Oxygen → Lungs → Alveoli → Blood

Breathe

Lungs

Ventilation

Blood

Oxygenation

Muscles + Organs

Cells

Energy

Metabolism

CO2

Glucose

Oxygen

2002 Children’s Medical Center Corporation

Adapted from Capnography in the Sedation Setting by Elicia Parave MSN, CPNP, CEN and Lorie Reilly MSN, CRNP, CPNP-AC
Comparison of Capnography and Pulse Oximetry

<table>
<thead>
<tr>
<th>Capnography</th>
<th>Pulse Oximetry</th>
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<tbody>
<tr>
<td>Carbon dioxide concentration</td>
<td>Oxygen saturation</td>
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<tr>
<td>Reflects ventilation</td>
<td>Reflects oxygenation</td>
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<tr>
<td>Immediately detects hypoventilation/apnea</td>
<td>Late indicator of hypoventilation/apnea</td>
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<tr>
<td>Accurately monitors respiratory rate</td>
<td>Accurately monitors heart rate</td>
</tr>
<tr>
<td>Should be used with pulse oximetry</td>
<td>Should be used with capnography</td>
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</tbody>
</table>

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Capnogram

Waveform:
- Represents the shape of a single carbon dioxide expiration curve
- There is only one normal waveform shape

Phase I (A-B): Dead Space Ventilation:
  - No CO₂ - Baseline is normally zero
  - Late inspiration/early exhalation

Phase II (B-C): Ascending Phase:
  - Appearance of CO₂ in exhaled gases
  - Mixing of dead space and alveolar air

Phase III (C-D): Alveolar Plateau:
  - Consistent CO₂ concentration
  - Exhalation of mostly alveolar gas

Point D: EtCO₂ level (capnometer)
  - Measured at end of normal exhaled breath or maximal point of phase III
  - Normally 35-45 mmHg

Phase IV (D-E): Descending Phase:
  - Rapid descent in waveform during inspiration

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Capnogram

Exhalation

Inspiration

Exhalation

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Increase in ETCO2

Possible causes:
- Sedation
- Hypoventilation
- Fever
- Pain
- Shivering
- Increased metabolism
- Post-ictal state
- Sepsis
- Stroke
- Severe difficulty breathing

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Decrease in ETCO2

Possible causes:
- Hyperventilation
- Bronchospasm
- Partial airway obstruction
- Anxiety
- Hypothermia
- Hypotension
- Decreased metabolism
- Pulmonary embolus
- Leak in sampling system

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Shallow Breathing

Hypoventilation with shallow breathing followed by deep breath

Hypoventilation with shallow breathing followed by deep breath
Rebreathing

Waveform does not return to baseline

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Obstruction

Possible causes:
- Bronchospasm
- Partial occluded airway
- Presence of foreign body in the airway
- Partially kinked or occluded artificial airway
Sudden Loss of Waveform

Possible causes:

- Apnea
- Complete Airway obstruction
- Cardiac arrest

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