I. **PURPOSE:**
To provide guidelines for capnography monitoring for the adult non-ventilated patient. Capnography monitoring enables Registered Nurses (RNs) and Respiratory Therapists (RTs) to assess the quality of ventilation and early detection of possible respiratory compromise (i.e. partial or acute airway obstruction, hypoventilation or apnea).

II. **POLICY:**
Capnography monitoring will be used for patients receiving procedural sedation, post sedation monitoring, continuous IV and epidural opioid infusions and at the discretion of the RN or RT for concerns of ventilation status. Patients in labor or receiving comfort care will be excluded from end-tidal carbon dioxide (ETCO2) monitoring during opioid infusions. A provider order is not needed for RNs or RTs to use ETCO2.

III. **DEFINITIONS:**
A. Capnography monitoring- Non invasive measurement of carbon dioxide ventilation through interpretation of a waveform produced for each respiration, which reveals respiratory rate, depth, efficiency of ventilation, and the presence of apnea.
B. ETCO2 – CO2 present in the airway at the end of expiration.
C. Capnogram – Displayed waveform of ETCO2.
D. Capnometers – Machines used to measure levels of CO2 in the airway
E. Continuous opioid infusions- Parenteral or epidural infusions delivering opioids, including Patient Controlled Anaesthesia (PCA) or Epidural
F. Return to Baseline Criteria - Refers to a measurement of patient specific criteria comparing pre sedation measurements to post sedation measurements. Criteria include level of consciousness, respiratory status, circulatory status, activity level, oxygen saturation, and ETCO2 numerical value.

IV. **STANDARD OF PRACTICE:**
Staff performing Capnography monitoring will have completed the capnography monitor validation checklist and sedation Computer Based Training (CBT). The RN/RT will:
A. Demonstrate proper application of the capnography cannula and use of device.
B. Appropriately intervene with capnogram waveform or respiratory status changes.

V. **OUTCOME STANDARDS:**
The patient can expect capnography monitoring during and after procedural sedation and continuous opioid infusion.

VI. **PROCEDURE:**
A. Obtain appropriate tubing for patient
   1. Intubated patients
      a. ETCO2 sampling tubing
      b. Place adaptor on advanced airway
2. Non-intubated patients
   a. Short term use for procedures usually indicated for applications less than 24 hours. Use combined ETCO2 sampling and O2 administration
   b. Long term use for opioid infusions and other applications longer than 24 hours. Use combined ETCO2 sampling and O2 administration tubing for non-intubated adult patients labeled for long term use if patient is on oxygen, and will switch tubing to the ETCO2 sampling tubing labeled for long term use once oxygen is weaned off.
   c. Place nasal cannula in nares
B. As moisture builds up in the tubing, the tubing will need to be changed if ETCO2 monitor indicates per corresponding alarm.
C. Connect appropriate filter tubing to device.
D. Turn on the monitor.
E. Verify that the monitor is working properly, by allowing the monitor to perform the self test.
F. Check battery pack for charging. Plug AC adapter to the monitor to charge.
G. Specific default parameters have been set. For patient specific diagnosis the parameters may be adjusted in the Alarm limit menu.
H. Alarm values for ETCO2 monitoring are:
   1. Default alarm limits for ETCO2 are set at 25 and 50.
   2. Respiratory rate default levels are set at 10 and 30.
I. Blood pressure (BP), SpO2, heart rate, and capnography will be monitored during the administration of sedation and during the delivery of continuous opioid infusions.
J. Baseline BP, SpO2, heart rate, and ETCO2 will be obtained prior to sedation or initiation of continuous opioid infusion. To obtain the baseline capnography information, observe the patient in a non-stimulated environment for 6-10 breaths. ETCO2 will be continuously monitored during procedural sedation and documented every 5 minutes and as needed throughout the procedure. Documentation will include ETCO2 level, changes in respiratory assessment and interventions provided.
K. The capnometer will remain in place during procedural sedation and for two hours after the last dose of sedation, or until the patient has returned to baseline, as defined by baseline level of consciousness, respiratory rate, circulatory status, Spo2 and ETCO2. It is important to note that sedation agents such as opioids, benzodiazepines, and Propofol may require a longer period of monitoring before the patient returns to baseline. Documentation of CO2 during the recovery phase of sedation will be with vital signs as ordered by the provider.
L. Following the administration of sedation, the patient should not be transferred to the receiving unit until the patient has returned to baseline ETCO2. If transfer of the patient is necessary before the patient meets criteria, or if the patient is transferring to a higher level of care, the RN must accompany the patient.
M. ETCO2 will be continuously monitored during continuous opioid infusions and documented with vital signs and SPo2 as ordered by provider. ETCO2 monitoring will continue for one hour after the opioid has been discontinued and patient meets baseline criteria.
N. The provider will be notified of changes in the patient’s respiratory status, which may include:
   1. Elevation in ETCO2 greater than 50 mmHg or increase of 10 mmHG above baseline, with corresponding change in respiratory rate/depth, waveform changes indicating apnea, obstruction, hypoventilation, hyperventilation.
2. Sudden drop in ETCO2 greater than 10 mmHG from baseline, with corresponding changes in respiratory rate/depth, waveform changes indicating hyperventilation, bronchospasm or laryngospasm.

VII. OTHER INFORMATION:
A. Capnography monitoring is done by evaluating trends of the RR and ETCO2 value, and should be assessed together. Therefore, if the RR and ETCO2 value are both changing, the patient should be assessed and interventions done as needed. If the RR is stable while the ETCO2 is alarming, then the situation can be observed for a possible equipment malfunction or transient reading, before an intervention is warranted.
B. Any loss of CO2 detection or waveform indicates an airway problem and should be documented and provider notified. If there are changes in waveform, consider the following interventions.
1. Hypoventilation
   a. Caused from over-sedation/medication, procedural draping
   c. Ensure patient has open airway.
   d. Stimulate patient and instruct patient to take deep breaths
   e. Consider reversing sedation medications
   f. Notify provider and call ART if necessary.
2. Hyperventilation
   a. Caused from pain, anxiety, fear, shortness of breath
   b. Assess patient.
   c. Ensure patient has open airway.
   d. Consider decreasing pain stimulus/Give more analgesic/sedation
   e. Notify provider and call ART if necessary.
3. Partial Obstruction
   a. Caused by positioning, procedural draping, overmedication/sedation
   b. Assess patient and consider discontinuing drug delivery.
   c. Ensure patient has open airway.
   d. Stimulate patient and instruct patient to take deep breaths
   e. Reposition airway and/or drape, consider reversing analgesic/sedation
   f. Notify provider and call ART if necessary
4. No Breath/Apnea
   a. Caused from no breath or very shallow respirations, over sedation/medication or displaced cannula.
   c. Ensure patient has open airway.
   d. Stimulate patient and take and instruct patient to take deep breaths
   e. Consider reversing medications, stimulating patient, notify provider and call Code Blue team.
C. The capnogram consists of four phases.
   1. Phase 1 represents the beginning of exhalation where dead space is cleared from the upper airway.
   2. Phase 2 represents the rapid rise of in CO2 concentration in the breath stream as alveolar CO2 reaches the upper airway.
   3. Phase 3 represents the CO2 concentration reaching a uniform level in the entire breath stream from alveolus to mouth/nose. The end of Phase 3 represents the maximum CO2 concentration at the end of the tidal breath (ETCO2.)
   4. Phase 4 represents the inspiratory cycle.
A - B: Dead space ventilation  
B - C: Ascending expiratory phase  
C - D: Alveolar Plateau  
D - E: End-tidal CO₂  
D - E: Descending inspiratory phase

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Waveform</th>
<th>Features</th>
<th>Intervention</th>
</tr>
</thead>
</table>
| Normal                            | ![Normal Waveform](image1) | **SpO₂** Normal  
**EtCO₂** Normal  
**Waveform** Normal  
**RR** Normal | No intervention required  
Continue sedation |
| Hyperventilation                  | ![Hyperventilation Waveform](image2) | **SpO₂** Normal  
**EtCO₂** ↓  
**Waveform** Decreased amplitude and width  
**RR** ↑ | Reassess patient  
Continue sedation |
| Bradypneaic Hypoventilation (Type 1) | ![Bradypneaic Hypoventilation Waveform](image3) | **SpO₂** ↓  
**EtCO₂** ↑  
**Waveform** Increased amplitude and width  
**RR** ↓↓↓ | Reassess patient  
Assess for airway obstruction  
Supplemental oxygen  
Cease drug administration or reduce dosing |
| Hypopneaic Hypoventilation (Type 2) | ![Hypopneaic Hypoventilation Waveform](image4) | **SpO₂** ↓  
**EtCO₂** ↓  
**Waveform** Decreased amplitude  
**RR** ↓ | Reassess patient  
Continue sedation |
| Hypopneaic Hypoventilation with periodic breathing | ![Hypopneaic Hypoventilation with periodic breathing Waveform](image5) | **SpO₂** Normal or ↓  
**EtCO₂** ↓  
**Waveform** Decreased amplitude  
**RR** ↓ | Reassess patient  
Assess for airway obstruction  
Supplemental oxygen  
Cease drug administration or reduce dosing  
Other Apneic pauses |
<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Waveform</th>
<th>Features</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physiological variability</td>
<td></td>
<td>SpO₂ Normal</td>
<td>No intervention required</td>
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<tr>
<td></td>
<td></td>
<td>EtCO₂ Normal</td>
<td>Continue sedation</td>
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<tr>
<td></td>
<td></td>
<td>Waveform Varying*</td>
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<tr>
<td></td>
<td></td>
<td>RR Normal</td>
<td></td>
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<tr>
<td>Bronchospasm</td>
<td><img src="image" alt="Waveform" /></td>
<td>SpO₂ Normal or ↓</td>
<td>Reassess patient</td>
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<tr>
<td></td>
<td></td>
<td>EtCO₂ Normal, ↑, or ↓*</td>
<td>Bronchodilator therapy</td>
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<td></td>
<td>Waveform Curved</td>
<td>Cease drug administration</td>
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<td>RR Normal, ↑, or ↓*</td>
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<tr>
<td></td>
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<td>Other Wheezing</td>
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<tr>
<td>Partial airway obstruction</td>
<td><img src="image" alt="Waveform" /></td>
<td>SpO₂ Normal or ↓</td>
<td>Full airway patency restored</td>
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<td></td>
<td></td>
<td>EtCO₂ Normal</td>
<td>with airway alignment</td>
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<tr>
<td></td>
<td></td>
<td>Waveform Variable</td>
<td>Noisy breathing and stridor resolve</td>
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<tr>
<td></td>
<td></td>
<td>RR Variable</td>
<td>Reassess patient</td>
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<tr>
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<td>Other Noisy breathing and/or inspiratory stridor</td>
<td>Establish IV access Supplemental O2 (as needed)</td>
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<tr>
<td>Partial laryngospasm</td>
<td><img src="image" alt="Waveform" /></td>
<td>Arrow indicates loss of ventilation</td>
<td>Airway not fully patent with airway alignment</td>
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<tr>
<td></td>
<td></td>
<td>SpO₂ Normal or ↓Δ</td>
<td>Noisy breathing and stridor persist</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EtCO₂ Zero</td>
<td>Airway not fully patent with airway alignment</td>
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<tr>
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<td></td>
<td>Waveform Absent</td>
<td>Noisy breathing and stridor persist</td>
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<tr>
<td></td>
<td></td>
<td>RR Zero</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other No chest wall movement or breath sounds</td>
<td>Reassess patient Stimulation</td>
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<tr>
<td>Apnea</td>
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<td>Airway patency restored with airway alignment</td>
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<td>EtCO₂ Zero</td>
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<td>Airway not patent with airway alignment</td>
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<td>RR Zero</td>
<td>No waveform</td>
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<tr>
<td></td>
<td></td>
<td>Other No chest wall movement or breath sounds</td>
<td>Positive pressure ventilation</td>
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</tbody>
</table>
II. REFERENCES:

National Guidelines/National Standards/Regulatory


Literature


Manufacturer’s Guidelines

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