TITLE: END TIDAL CARBON DIOXIDE (ETCO2) MONITORING (non-invasive) AND TUBE PLACEMENT (endotracheal and tracheostomy)

SCOPE: RN, RT

PURPOSE: Capnography is the measurement of exhaled carbon dioxide (end tidal CO2) via a numerical measurement (capnometry) and a graphical display (capnogram). EtCO2 is used to monitor a patient’s ventilatory status.

DELEGATION: Capnography is recommended for patients receiving the following:
- procedures utilizing conscious sedation
- patient controlled analgesia and continuous delivery of analgesia (PCA, basal IV, epidural, and IV Dilaudid (hydromorphone) administered post-procedure)
- confirmation of ET tube placement
- tracheostomy tube placement
- endotracheal tube placement and monitoring
- Post-op adult patients with STOP BANG score of 3 or higher (at risk for obstructive sleep apnea) and receiving IV push opioids
- Post-op cesarean section patients with a Dura Morph spinal injection
- intrathecal morphine administration (monitor for 24 hours post injection)

To monitor EtCO2 for tracheostomy patients, contact RT. RT will get the necessary supplies.

Consider Capnography in the following:
- history of significant pulmonary disease, i.e. COPD or asthma
- diagnosis and monitoring of sleep apnea
- hemodynamic instability
- acute brain injury
- other patients at risk for hypoventilation (ie) BiPAP therapy (intermittent or continuous EtCO2 monitoring; see NDM policy B-18, BiPAP Therapy, Care of the Patient)

EQUIPMENT: Welch Allyn Connex© VS monitor 6000 series or CASMED 750 multiparameter monitor
- Ear protectors
- GE CareScape® bedside monitor
- CapnoLine tubing (various styles available)
  - located in Omnicell, with intubation equipment, and stored in procedural areas

POINTS OF EMPHASIS:

1. If a patient refuses EtCO2 monitoring, the RN should explain risks and benefits and document the patient’s refusal.
2. Monitoring carbon dioxide (CO2) at the end of exhalation, known as End Tidal CO2 (EtCO2) provides a continuous, noninvasive measurement of the patients ventilation and respiratory rate.
3. The purpose of monitoring EtCO2 is to detect hypoventilation early and/or identify airway tube malposition in an effort to prevent hypoxia.
   a. Changes in EtCO2 typically occur before changes in SpO2.
   b. EtCO2 monitoring is one piece of patient data and should be considered relative to all assessment and monitoring data.
4. EtCO₂ monitoring should be assessed and documented along with routine or ordered RR and SPO₂ assessments and documentation.

5. **Patients receiving comfort care are exempt from above monitoring guidelines.** Patients with specific orders written by the Palliative Care Medical Service are exempt.

6. Active laboring patients may not require EtCO₂ monitoring.

7. Patients with PCA or basal IV or epidural analgesia do not require EtCO₂ monitoring while walking.

8. The CASMED and Connex VS monitors are not MRI compatible. The CapnoLine tubings are MRI compatible with one exception: the pediatric ETT CapnoLine has a spring in the adapter and is not MRI compatible.

9. EtCO₂ may be continuously monitored via ET tube and after tracheostomy tube placement.

10. PACU will initiate EtCO₂ monitoring for patients receiving the following:
   a. IV push opioids in adult patients with known history of obstructive sleep apnea (OSA) or at risk for OSA as determined by a STOP BANG score of 3 or greater.
   b. PCA, basal IV or epidural analgesia infusions

11. Monitoring and documenting EtCO₂ values are specified in the Epidural policy #E-5 and PCA policy #P-2.

**PROCEDURE/INSTRUCTIONS:**

1. Gather equipment, disposable supplies, and monitor.
   a. The CapnoLine tubing will sample EtCO₂ from the nose (prongs) or mouth (scoop) and allow oxygen delivery through pinholes under the nose.
      i. Consider using ear protectors.
      ii. If the patient is eating, remove the CapnoLine tubing. If oxygen is ordered, use NC to deliver oxygen during this time.
   b. Explain the purpose and use of the monitoring equipment to the patient.
   c. Proper positioning on the patient is imperative.
   d. For patients requiring supplemental oxygen, a catheter connected to the oxygen flow meter can be attached to the CapnoLine tubing.
      i. CapnoLine tubing can be used underneath an oxygen mask or BiPAP full-face mask as ordered.
   e. CapnoLine tubing is not routinely replaced. Replace when tubing becomes occluded. The message "Blocked Line" will appear on the monitor.

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**Front Panel of CASMED Monitor**

![Front Panel of CASMED Monitor](image1)

**Side of CASMED Monitor**

1. ECG/Respiration Input Connector
2. SpO₂ Probe Connector
3. NIBP Hose Connection
4. CO₂ Scavenger Exhaust
5. Temperature Probe Input
6. MicroStream™ CO₂ Input Conn (under door)
2. Begin monitoring EtCO2.

3. Generally, normal EtCO2 values are 30-45 mmHg.
   a. values greater than or equal to 45 indicate hypoventilation
   b. values 20-30 indicate hyperventilation
   c. values 0-10 indicate severe hypoventilation and/or apnea

4. **PROCEDURE for Capnography:**
   High and low levels of EtCO2 may indicate ventilation abnormalities. See Addendum 2 for EtCO2 troubleshooting.
   a. Normal EtCO2 waveform
      i. Each waveform represents a single respiratory cycle. The waveform has several components and should be “squared-off” in appearance. See below.
      ii. EtCO2 is normally 30-45 mmHg. Consider pts baseline PaCO2 level.
      iii. RR is normally 8-16 breaths per minute.

   ![CO2 Waveform Diagram](image)
   A-B = inhalation
   C-D = exhalation
   D = end exhalation
   E = onset of inhalation

   b. Patients with respiratory depression (classic hypoventilation):
      i. Waveform will retain squared off appearance.
      ii. EtCO2 value (retention of CO2) will be increased (i.e) greater than 50 mmHg or change in EtCO2 of 10 above baseline
      iii. RR may be decreased

   ![CO2 Waveform Diagram](image)

   c. Patients with shallow breathing (may be due to head/neck position or relaxation of throat muscles and tongue creating partial airway obstruction):
      i. Waveform will not have sharp squared off appearance. Edges may be jagged or sloped.
      ii. Decreased EtCO2 values
      iii. RR may be increased or decreased.

![CO2 Waveform Diagram](image)
d. Patients who are hyperventilating
   i. Waveform will have squared appearance
   ii. EtCO2 values will be decreased (ie) 15-30 mm Hg.
   iii. RR will be increased

e. Apneic or sudden loss of waveform (no measured exhaled CO2)
   i. Flat waveform
   ii. Very low levels of EtCO2, close to 0 mm Hg
   iii. Respiratory rate of 0

   iv. Possible causes of flat waveform include: pt is apneic, pts breathing is extremely shallow,
       airway obstruction, tube dislodgment, CapnoLine is mal-positioned, kinked, or off of patient,
       and filter on CapnoLine is occluded

          Support ventilation with BVM (bag-valve-mask) as appropriate.
       2. If CapnoLine filter is occluded by secretions, do not attempt to clear. Discard
          Capnoline tubing and replace with a new set.

5. See Addendum 5 for procedure using Welch Allyn Cannex VS Monitor.

6. Procedure using CASMED Monitor:

   1. For Initial Monitoring:
      a. Press the POWER key to turn the monitor on. See Addendum 1 for basic monitoring operations.
         i. Note: While the CO2 module is initializing (typically 30-40 seconds) the monitor will display
            the message, "EtCO2 Warm-Up" and dashes "—" will remain in the numeric section. (No
            calibration of equipment is required.)
b. Verify that the monitor is detecting SpO2, HR, EtCO2, and RR.
   i. A "heart" will display under the SpO2 value with each cardiac cycle.
   ii. A "lung" will display under the EtCO2 value with each breath.
      a. If the lung visual indicator is not corresponding to the patient’s respiration, reposition the sensor until the indicator’s flash in synch with the patient’s breathing. This will help to minimize false alarms.
   c. The CASMED default alarms include:
      SpO2 low = 90%  HR high = 220
      EtCO2 low = 10 mm Hg  FiCO2 = 7 mm Hg
      EtCO2 high= 60 mm Hg  SBP high= 240
      RR low = 5 bpm  DBP high = 130
      Apnea = 30 seconds  MAP high = 180
   d. Check the alarm limits and adjust appropriately for the patient if needed by accessing the “Limits” soft key on the front panel.

2. FICO2 (fraction of inspired CO2) represents the amount of CO2 the patient is rebreathing.
   a. This value is displayed under the EtCO2 value and should be less than 8 mm Hg.
   b. Patients with their face draped for procedures are at risk for rebreathing their EtCO2. If this value arises above 8 mm Hg, uncover patient face as appropriate. If unable, consider increasing FiO2 as appropriate until procedure completed and draping can be removed.
   c. Other causes for increasing FICO2 may include prone positioning and neck mal-alignment.

3. Attach CapnoLine to the monitor by lifting small door and snugly twisting into place. Plug cables into the side of the monitor.

4. Battery Life: The monitor has a battery life of 3-5 hours depending upon functions being used.
   a. When the monitor is connected to external power and turned off, the Main screen displays the Battery Indicator icon with a moving bar from left to right within the indicator signifying the battery is being charged. Once charged, the moving bar will stop and the battery icon will be completely filled in.
   b. The battery is low when the "Low Battery" or "Dead Battery" message is displayed or the power indicator changes from orange to red. When not in use, the CASMED monitor should be plugged in. A dead battery can be recharged in 5 hours.

5. Stored values or history. Depress HISTORY soft key on front panel of monitor.
   a. The monitor collects History data over a 24-hour period.
   b. Continuously measured parameters such as SpO2, HR, EtCO2, and RR are stored as one-minute averages. NIBP readings and alarm events are stored as they occur.
   c. History data is presented in two screens: the History (trend) and Alarm History screen. Once the History screen has been displayed, press and hold the HISTORY key for 2 seconds to toggle between the History (trend) and the Alarm History screens. Press the RETURN key to exit from the History screen.
   d. Turning the power off does not clear the stored data. Stored data will remain in the history for 24 hours. The manufacturer recommends stored data be manually deleted.
   e. Manual deletion of history.
      i. Press the HISTORY key to access the History (trend) screen.
      ii. Press the HISTORY key again to highlight "Erase All History No". Depress the down arrow to change NO to YES. Depress HISTORY soft key to complete the deletion of the history.

6. See ADDENDUM 3 for front panel configuration and monitoring parameters.
   a. Monitoring parameters can be accessed by depressing the PARAMETERS soft key.
7. NIBP
   a. Depress NIBP START CANCEL soft key on front of monitor to measure BP.
   b. NIBP monitoring using STAT mode.
      i. Press and hold the NIBP START/ CANCEL soft key for 2 seconds to access the NIBP menu.
      ii. Press ARROW down until STAT is highlighted.
      iii. Press the PARAMETERS soft key to highlight OFF. Press ARROW down to change OFF to ON.
      iv. Depress the NIBP START CANCEL soft key to complete initiation of the NIBPSTAT mode
          1. The message STAT will be displayed on the screen next to NIBP message.
          2. In the STAT mode, blood pressures will be measured continuously with a 10 second pause between determinations for 5 minutes.
          3. To end the STAT mode, depress the NIBP START/ CANCEL soft key for 2 seconds and reverse the above process, changing “YES” in the STAT mode to “NO”.
   c. See Addendum 4 for NIBP trouble shooting information.
   d. Freezing Traces
   e. While the Main screen is being displayed traces can be frozen by pressing the RETURN key. The message “Traces Frozen” appears at the top of the Main screen. While the traces are frozen, the numerics continue to update.
   f. Traces will automatically un-freeze if no key is pressed for 60 seconds or in case any other screen or menu is entered.
   g. Press the RETURN key again to manually un-freeze traces.

8. MISCELLANEOUS
   a. Alarm silencing:
      i. Depressing the ALARM SILENCE/RESET soft key will silence alarms for 2 minutes. A “2 minute” message will appear on the screen. New alarms occurring during this 2 minute period are not audible.
      ii. When an alarm sounds due to a disconnect, the monitor will alarm and a yellow light will illuminate on the screen.
      iii. When an alarm sounds due to a high or low value, the monitor will alarm and a red light will illuminate on the screen.
   b. To turn the monitor off, press and hold POWER soft key for a few seconds.
   c. This monitor does not have printing capabilities.
   d. AUDIO/VISUAL soft key
      i. Audible alarms/beeps and screen contrast can be adjusted in this menu.
   e. If the patient receives extra oro/nasal humidification while a Capnoline is in place (ie) aerosol treatment or saline lavage, the Capnoline filter may become occluded prematurely. Suspend EtCO2 monitoring during suctioning or when receiving an aerosol treatment.

9. To set the Clock by adding Date and Time (excerpts from CASMED manual, pps. 75-78)
   a. Entering the setup menu, which shows all configuration options in a tabular form:
      i. Press and hold the LIMITS and VOLUME keys while the monitor is being turned ON.
      
      - Setup
      - Language English
      - Patient Adult
      - Audio Silence 2 Minute
      - Date 21-Mar-05
      - Time 11:26
      - DST OFF
      - O2 Alarm Delay 10 Sec
      - EtCO2 Units mmHg
      - Background Dark
ii. The cursor is initially positioned at the first item.
   • Use the UP and DOWN keys to select the item that needs to be changed.
   • Use the NEXT key to move the cursor to the right column.
   • Use the UP and DOWN key to scroll through the available options.
   • Press the RETURN key to exit the setup menu.
   • Note: If no key is pressed for 60 seconds, the monitor automatically exits the setup menu.

iii. All changes will be saved and the monitor returns to the main screen.

b. Setting the Date:
   i. Enter the setup menu as described above and follow the general instructions.
   ii. Press the DOWN key until the parameter “Date” is selected.
   iii. Press one of the NEXT keys to move the cursor to Day-Month-Year.
   iv. Use the UP or DOWN keys to increase or decrease the values for Day-Month-Year.
   v. Note: Altering the monitors’ date will affect the History data.

c. Setting the Time:
   i. Enter the Setup menu as described above and follow the general instructions.
   ii. Press the DOWN key until the parameter “Time” is selected.
   iii. Press one of the NEXT keys to move the cursor to Hours : Minutes.
   iv. Use the UP or DOWN keys to increase or decrease the values for hours or minutes.
   v. Note: Altering the monitors’ time will affect the History data.
**DEFINITIONS:**
- VS: Vital Signs, RN: Registered Nurse, RT: Respiratory Therapist, ET tube: Endotracheal intubation

**REFERENCES:**
- Capnography: A reference handbook, Marquette Medical Systems.
- NDM policy P-2, "Patient Controlled Analgesia Management"
- NDM policy E-5, "Epidural Analgesia Management"
- CCC policy Ee-6, "End-Tidal Carbon Dioxide Monitoring, Continuous ETCO2"

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<td>Revised Date:</td>
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<tr>
<td>2/13</td>
<td>11/14, 2/15</td>
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**SIGNATURE OF APPROVAL:**

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<tr>
<td>(see hard copy)</td>
<td></td>
<td>Karra Heggen, RN, MSN</td>
<td>VP Nursing</td>
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### ADDENDUM 1
CASMED 750 Monitor Basic Operations

<table>
<thead>
<tr>
<th>CAS 750 Monitor</th>
<th>Basic Operations</th>
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</thead>
<tbody>
<tr>
<td><strong>NIBP</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Start:</strong></td>
<td>Initiates a NIBP measurement.</td>
</tr>
<tr>
<td><strong>Cancel:</strong></td>
<td>Terminates any active NIBP measurement and immediately deflates the cuff.</td>
</tr>
<tr>
<td><strong>Menu:</strong></td>
<td>Activates the NIBP menu when pressed and held for 2 seconds.</td>
</tr>
</tbody>
</table>

| **RETURN**      |                  |
| **Main Screen:**| Returns to the Main screen when pressed while any other screen or menu is being displayed. |
| **Freeze:**     | Freezes all traces when pressed while the Main screen is active. Press again to un-freeze. Traces will un-freeze automatically after 60 seconds. |
| **Print:**      | Activates a print of the actual screen content (Traces, Trend or Alarm History) when key is pressed for 2 seconds. |

Refer to paragraph “Main Screen” on page 34 for more information.

### PARAMETERS
Activates the Parameters menu, which provides an overview of parameters and screen layout settings and gives access to change these settings. Refer to paragraph “Parameters Menu” on page 40 for more information.

### LIMITS
Activates the Alarm Limits menu, which provides an overview of all actual limit settings and gives access to change, save and restore alarm limits. Refer to section “Alarms” starting on page 43 for more information.

### HISTORY
Activates the Trend History and the Alarm History screen. Gives access to erase History data. Refer to paragraph “History Screens” on page 36 for more information.
Basic Operations

<table>
<thead>
<tr>
<th>AUDIO/VISUAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activates the Audio/Visual menu which allows the user to configure the audio and visual signals the monitor can generate. Refer to paragraph &quot;Audio/Visual Menu&quot; on page 41 for more information.</td>
</tr>
</tbody>
</table>

| UP |
| Move cursor upward or scrolls through menu options, press and hold for quicker advance. |
| Sets patient mode to Adult when pressed and held while the monitor is being turned on. |

| DOWN |
| Move cursor downward or scrolls through menu options, press and hold for quicker advance. |
| Sets patient mode to Neonate when pressed and held while the monitor is being turned on. |

**NEXT Function**

In the menus: The HISTORY and AUDIO/VISUAL keys are programmed to advance horizontally to the next parameter selection.

**PREVIOUS Function**

In the menus: The PARAMETERS and LIMITS keys are programmed to move backwards horizontally to the previous parameter selection.

**Main Screen**

**Note:** When switching from the Main screen to any other screen or menu, the monitor will continue to update and display the numeric values of the parameters being monitored.

**Note:** The actual displayed information depends on the parameter configuration of the monitor and the user defined screen layout.
ADDENDUM 2

CO₂ Troubleshooting: If the accuracy of any measurement does not seem reasonable, check the patient’s vital signs by an alternate method.

CO₂ related messages

- Pressing the ALARMS key will silence the audio alarm tone for the following CO₂ related messages.

Blocked Line
The CO₂ module has attempted to purge the line with no success.
- Disconnect the FilterLine.
- Check the FilterLine for kinks and/or blockages.

Cal EtCO₂
The CO₂ module’s calibration timer has reached zero hours.
- Perform a CO₂ calibration check.

Clearing Line
The CO₂ module has detected an occlusion and is attempting to purge the line.
- Check the FilterLine tube for kinks and/or blockages.

Chk EtCO₂ Flow
The CO₂ module has detected a blockage in the exhaust port.
- Check the exhaust port and associated tubing for kinks and blockages.

EtCO₂ Error
A failure occurred on the CO₂ Board.
- To reset the CO₂ board turn the monitor off and disconnect it from external power (AC Line or 12VDC). Remove the battery, and then reconnect the battery and external power. Turn the monitor on.
- If the message remains, the monitor needs to be serviced.

EtCO₂ Module
A failure occurred on the CO₂ Board. The monitor needs to be serviced.

EtCO₂ OFF
The CO₂ module is no longer receiving a signal from the patient or the FilterLine is no longer connected to the monitor.
- Check the external tubing for disconnections.

Service EtCO₂
The CO₂ module’s service timer has reached zero hours. The monitor will continue to function.
- Arrange for service as soon as possible.
ADDENDUM 3
FRONT PANEL CONFIGURATION

FRONT PANEL

The Parameters menu shows the settings of all parameters and allows changing them.

- Press the PARAMETERS key to enter this menu.

Note: The information being displayed depends on the monitor configuration and patient specific settings.

Note: The monitor will automatically return to the Main screen if no key is pressed for 30 seconds.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>mm/Sec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trace 1</td>
<td>ECG II</td>
</tr>
<tr>
<td>Trace 2</td>
<td>Resp</td>
</tr>
<tr>
<td>Trace 3</td>
<td>SpO₂</td>
</tr>
<tr>
<td>Print Traces</td>
<td>All</td>
</tr>
<tr>
<td>Print On Alarm</td>
<td>OFF</td>
</tr>
<tr>
<td>ECG Gain</td>
<td>Automatic</td>
</tr>
<tr>
<td>Impedance Resp</td>
<td>ON</td>
</tr>
<tr>
<td>EtCO₂ Scale</td>
<td>0-50 mmHg</td>
</tr>
<tr>
<td>EtCO₂ Print</td>
<td>OFF</td>
</tr>
<tr>
<td>EtCO₂ Trace</td>
<td>Line</td>
</tr>
</tbody>
</table>

Figure 10: Parameters Menu

The cursor position is automatically at the first item in the left column.

- Use the UP and DOWN keys to select the item that needs to be changed.
- Use the NEXT key to move the cursor to the next column to the right.
- Use the UP and DOWN key to scroll through the available options.

Note: Several changes may be done in one session. Use the PREVIOUS key to return the cursor back to the left column and repeat the steps as before.

- Press the RETURN key when finished. All changes will be saved and become immediately effective.

Note: A continuously updating Trend History or a menu of NIBP event readings can be chosen, in the Parameters Setup menu as Trace 3.
ADDENDUM 4

CAS 750 Monitor

NIBP Troubleshooting

Note: If the accuracy of any measurement does not seem reasonable, first check the patient’s vital signs by an alternate method.

NIBP related Messages

- Pressing the ALARMS key will cause the following NIBP related messages to be removed from the display and silence the audio alarm tone.

Air Leak

Air leak in the cuff, the NIBP hose or in the internal pneumatic system of the monitor.
- Check that the cuff/hose/monitor connection is secure.
- Check cuff for leaks. Do not use a known leaky cuff.

Appl Error

Neonate cuff is detected in Adult Mode.
- Check cuff. Replace cuff or change operating mode.

Flow Error

Stable cuff pressure cannot be maintained by the NIBP pneumatic system.
- Check the external tube for kinks.
- Perform a Pneumatic Pressure Check as described on page 108.
- Replace cuff.

Loose Cuff

Cuff applied too loosely.
- Check cuff for proper fit on patient.

Motion

There was too much extremity motion for the monitor to accurately complete the NIBP measurement in 120 seconds. Measurements can be obtained when there is limited extremity movement, but the measurement time may be extended.
- Restrain patient extremity motion.

NIBP Cal

Pressure calibration data corrupted within NIBP module. Pressure module needs recalibration. The monitor needs to be serviced.
NIBP Error
A failure occurred on the NIBP board. The monitor needs to be serviced.

NIBP Module
A failure occurred on the NIBP board. The monitor needs to be serviced.

Over Press
Cuff pressure exceeded 280 mmHg in the Adult mode or 145 mmHg in the Neonate mode. Very rapid squeezing of the cuff can cause this error.
- Repeat the measurement.
- If this message repeatedly occurs during normal use, the monitor must be serviced.

Range Error
The systolic reading exceeds the measurement range of 255 mmHg in the Adult mode or 135 mmHg in the Neonate mode.
- Repeat measurement.
- If the message is displayed again, use another method to measure the patient's blood pressure.

Signal Sat
Signal Saturation or motion pulses too strong.
- Repeat measurement. Limit patient activity; the arm must be still and/or relaxed.

Time Out
The monitor was unable to complete a measurement within 120 seconds in the Adult mode or 90 seconds in the Neonate mode. An extremely long measurement can be due to a loose cuff, high blood pressure, or monitor re-pumps.
- Repeat measurement.
- Try higher initial cuff pressure.
- If message consistently reappears try using another means to obtain patient's blood pressure.

Weak Signal
The monitor did not detect any pulses during a NIBP measurement.
- Check the fit of the cuff.
- Repeat measurement.