

Capnography

Clinical Indications:

1. Capnography shall be used as soon as possible in conjunction with any airway management adjunct, including endotracheal, Blind Insertion Airway Devices (BIAD) or Bag Valve Mask (BVM).
2. Capnography should also be used on all patients treated with CPAP or epinephrine for respiratory distress.
3. Acute respiratory distress.
4. Assisted ventilations.
5. Sustained altered mental status.

Procedure:

1. Attach capnography sensor to the BIAD, endotracheal tube, or oxygen delivery device.
2. Note CO₂ level and waveform changes. These will be documented on each respiratory failure, cardiac arrest, or respiratory distress patient.
3. The capnometer shall remain in place with the airway and be monitored throughout the prehospital care and transport.
4. Any loss of CO₂ detection or waveform indicates an airway problem and should be documented.
5. The capnogram should be monitored as procedures are performed to verify or correct the airway problem.
6. Document the procedure and results on/with the Patient Care Report (PCR) and the Airway Evaluation Form.
7. In all patients with a pulse, an ETCO₂ >20 is anticipated. In the post-resuscitation patient, no effort should be made to lower ETCO₂ by modification of the ventilatory rate. Further, in post-resuscitation patients without evidence of ongoing, severe bronchospasm, ventilatory rate should never be < 6 breaths per minute.
8. In the pulseless patient, and ETCO₂ waveform with an ETCO₂ value >10 may be utilized to confirm the adequacy of an airway to include BVM and advanced devices when SpO₂ will not register.

Critical Comment:

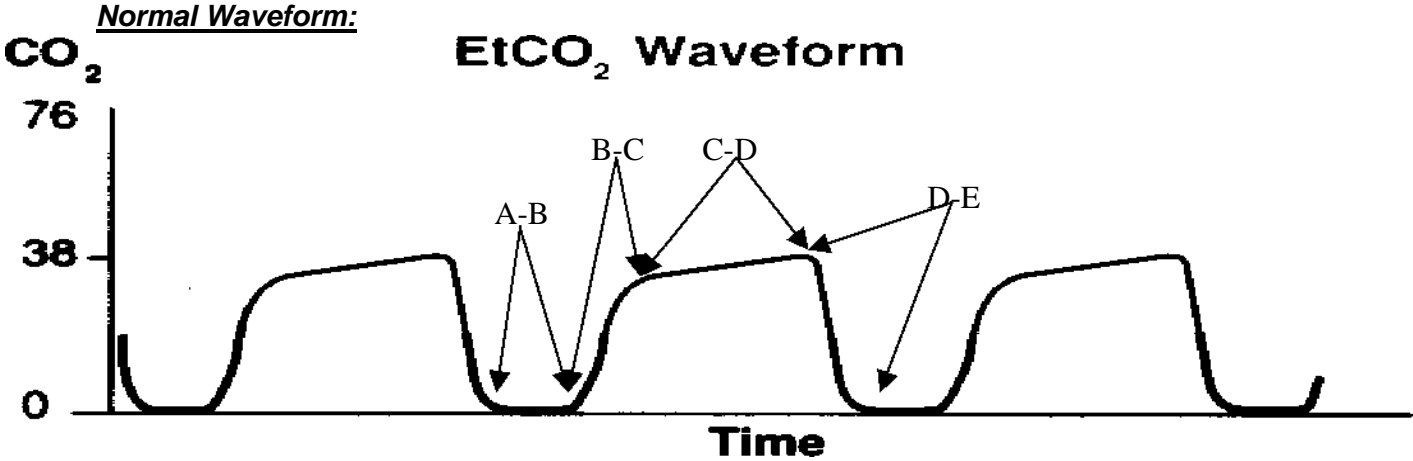
• *When CO₂ is **NOT** detected, three factors must be quickly assessed:*

1. Loss of airway - apnea? Esophageal endotracheal tube placement/migration? Obstruction?
2. Circulatory collapse - cardiac arrest? Massive pulmonary embolism? Exsanguination?
3. Equipment failure - disconnected or malfunctioning bag-valve or ventilator?

Interpreting Capnography:

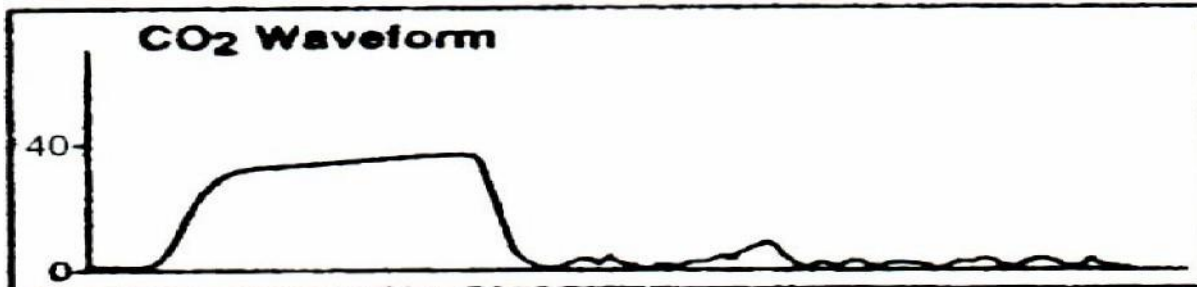
*The figure below shows a normal capnography waveform display. There are 4 phases of the waveform that require analysis. The flat **A – B** baseline segment (Respiratory Baseline) represents the beginning of exhalation of CO₂ – free gas that is contained in dead space from the conduction airways (trachea, bronchi). This value normally is zero. The **B – C** segment (Expiratory Upstroke), a sharp rise, represents exhalation of a mixture of dead space gases and alveolar gases. The **C – D** segment represents the alveolar plateau, characterized by exhalation of mostly alveolar gas. Point **D** is the end-tidal (EtCO₂) value that is recorded and displayed by the monitor, (peak concentration of CO₂ occurring at the end of expiration). The **D – E** segment (Inspiratory Downstroke), a sharp fall, reflects the inhalation of gases that are CO₂ – free (room air or supplemental oxygen). Alterations of the normal capno graph or EtCO₂ values are the result of changes in metabolism, circulation, ventilation, or equipment function.*

• A normal range for EtCO₂ is 35 – 45 mmHg, similar to the range of CO₂ in arterial blood.



Abnormal Waveforms:

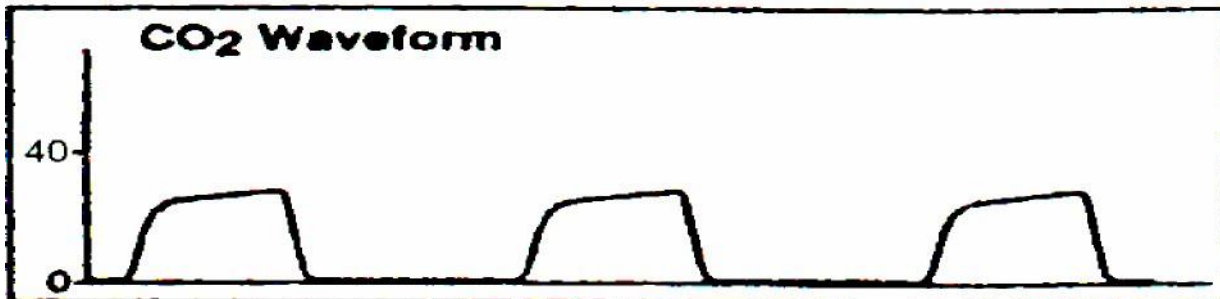
Sudden loss of ETCO₂ to zero or near zero:



Possible Causes:

1. *Endotracheal tube in esophagus*
2. *Incorrect King Tube tube being utilized for assisted ventilations*
3. *Apnea*
4. *Endotracheal tube or King Tube not connected to oxygen supply/capnography detector.*
5. *Total obstruction/mucus plugging*
6. *Capnography malfunction - if abnormal waveform persists with change in capnography adaptor, the endotracheal tube or King Tube MUST be withdrawn and intubation or King Tube placement reattempted*

Sustained low ETCO₂ with good alveolar plateau:

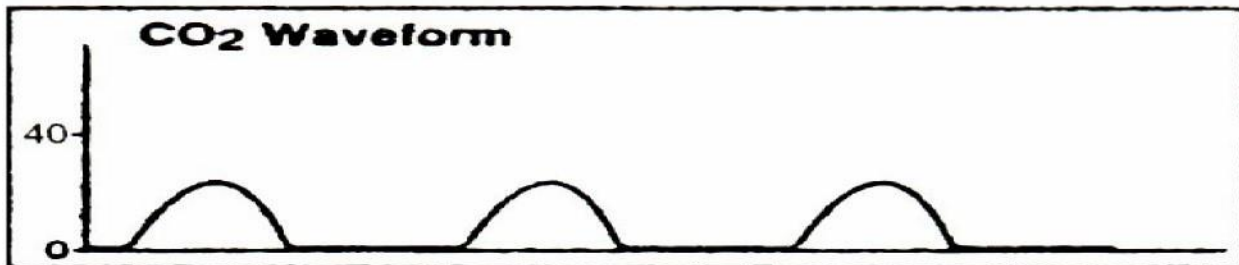


Possible Causes:

1. *Hyperventilation (due to underlying illness/injury or excessive assisted ventilations)*
2. *Hypothermia (Decrease in Metabolism)*

Abnormal Waveforms:

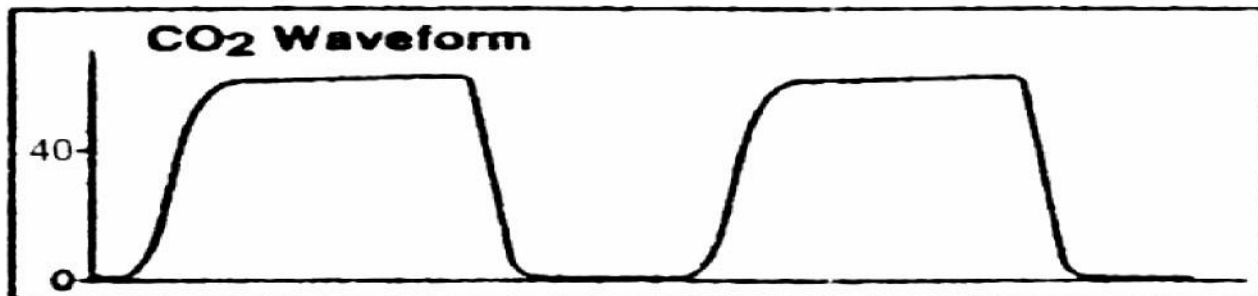
Sustained low ETCO₂ without alveolar plateau:



Possible causes:

1. *Bronchospasm of asthma or COPD exacerbation*
2. *Incomplete obstruction/mucus plugging*

Elevated ETCO₂ with good alveolar plateau:

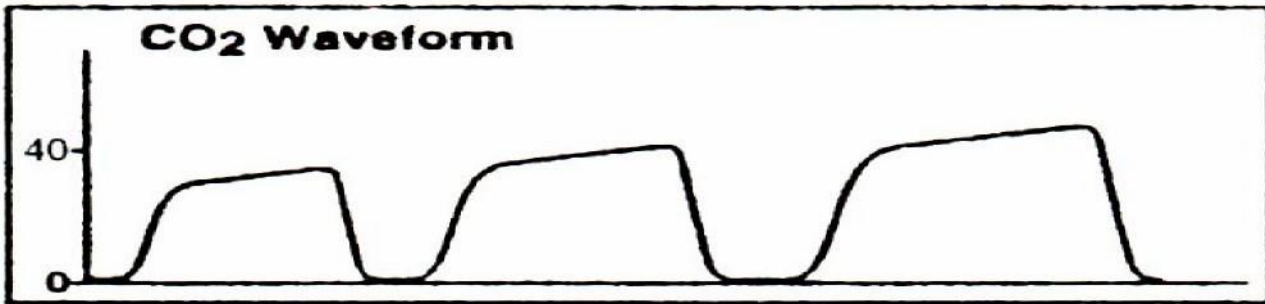


Possible causes:

1. *Hypoventilation (due to underlying illness/injury or inadequate assisted ventilations)*
2. *Hyperthermia, pain, shivering (Increase in Metabolism)*

Abnormal Waveforms:

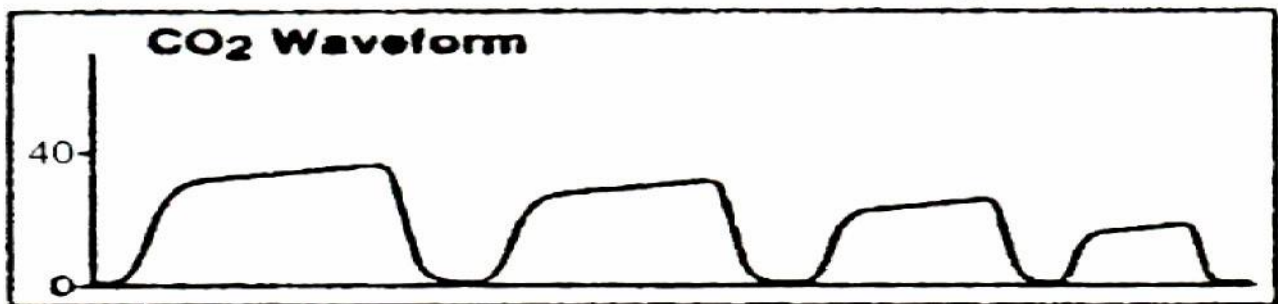
Gradually increasing ETCO₂:



Possible causes:

1. Hypoventilation (due to underlying illness/injury or inadequate assisted ventilations)
2. Rising body temperature, increasing pain (Increasing Metabolism)

Exponential decrease in ETCO₂:

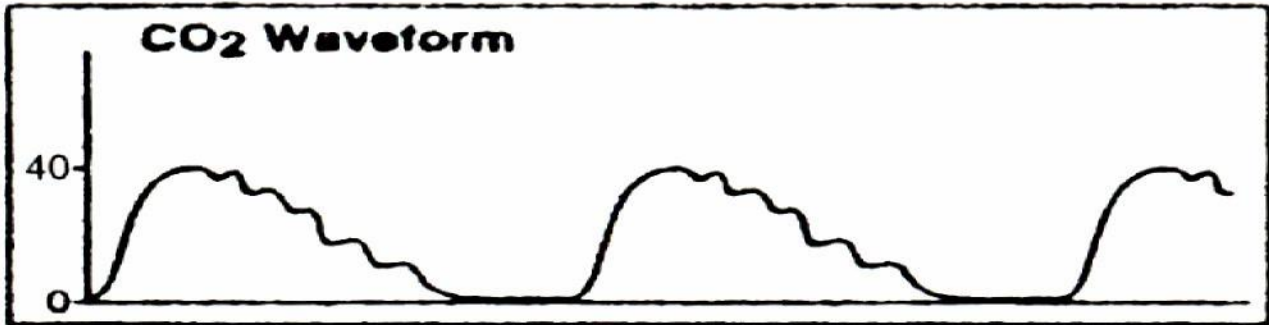


Possible causes:

1. Cardiopulmonary arrest
2. Pulmonary embolism
3. Sudden hypotension, massive blood loss
4. Cardiopulmonary bypass

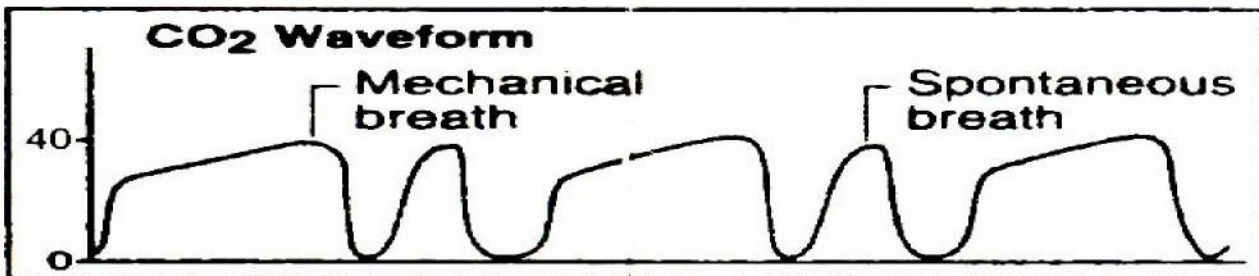
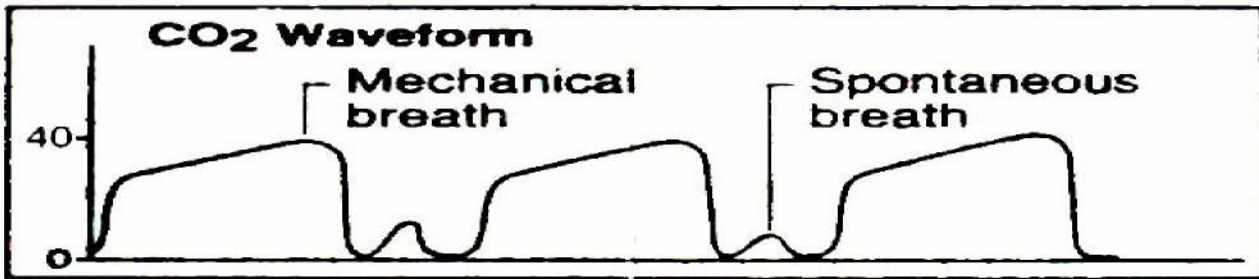
Abnormal Waveforms:

Cardiogenic oscillations:



Cardiogenic oscillations are caused by changes in thoracic volume secondary to expansion and contraction of the myocardium with each heartbeat. They are usually seen in patients with small tidal volumes and slow respiratory rates, and are of little physiologic consequence.

Spontaneous breathing during mechanical ventilation:



Spontaneous breathing efforts may be evident on the CO₂ waveform display. The patient on the top demonstrates poorer quality spontaneous breathing effort than the patient on the bottom.

Troubleshooting Tips for EtCO2 monitoring:

Observation	Possible Cause	Corrective Action
ALARM APNEA message appears	No breath has been detected for 30 seconds since last valid breath	<ul style="list-style-type: none"> • Check the patient, then ventilation equipment for leaks or
CO2 FILTERLINE OFF message appears	FilterLine, or any other CO2 accessories disconnected or not securely connected to the	<ul style="list-style-type: none"> • Connect FilterLine, or any other CO2 accessories, to input connector or tighten connection
CO2 FILTERLINE BLOCKAGE message appears	FilterLine is twisted or clogged. The message appears after 30 seconds of unsuccessful purging	<ul style="list-style-type: none"> • Check the FilterLine and if necessary replace it • Check the Airway
CO2 FILTERLINE PURGING message appears	Airway Adapter cloggedFilterLine tube twisted or clogged with water	<ul style="list-style-type: none"> • Check the FilterLine and if necessary,
EtCO2 values erratic	A leak in the tubing Assisted ventilated patient breaths spontaneously	<ul style="list-style-type: none"> • Check for connection leaks and line leaks to patient and correct if necessary
EtCO2 values are consistently higher or lower than	Physiological cause Ventilator/Assisted	<ul style="list-style-type: none"> • Check patient • Check ventilator &/or assisted ventilation
XXX appears in place of EtCO2 value	CO2 module not calibrated successfully CO2 module failed	<ul style="list-style-type: none"> • ^{rate} Notify appropriate supervisor/materials of critical

Certification Requirements:

Maintain knowledge of the indications, contraindications, technique, and possible complications of the procedure. Assessment of this knowledge may be accomplished via quality assurance mechanisms, classroom demonstrations, skills stations, or other mechanisms as deemed appropriate by the PAEMS EMS System. Assessment should include direct observation at least once per certification cycle, or other mechanisms as deemed appropriate by the PAEMS EMS System.