COUNTY OF VENTURA HEALTH CARE AGENCY		EMERGENCY MEDICAL SERVICES POLICIES AND PROCEDURES
Policy Title: Prehospital Capnography		Policy Number 711
APPROVED: Administration:	Steve L. Carroll, Paramedic	Date: June 1, 2021
APPROVED: Medical Director:	Daniel Shepherd, M.D.	Date: June 1, 2021
Origination Date: Date Revised: Date Last Reviewed: Review Date:	April 8, 2021 April 30, 2022	Effective Date: June 1, 2021

I. PURPOSE: To outline the use capnography in the assessment and treatment of EMS patients.

II. AUTHORITY: California Health and Safety Code, §1798, §1798.2; §1798.160 and §1798.170 and California Code of Regulations, Title 22, §100145 and §100146.

III. PRINCIPLES:

1. Ventilation is an active process, which is assessed with end-tidal CO_2 measurement. End-tidal CO_2 measurement is an indication of air movement in and out of the lungs. The "normal" value of exhaled CO_2 is 35-45 mmHg.

2. Oxygenation is a passive process, which occurs by diffusion of oxygen across the alveolar membrane into the blood. The amount of oxygen available in the bloodstream is assessed with pulse oximetry.

3. Capnography provides both a specific value for the end-tidal CO_2 measurement and a continuous waveform representing the amount of CO_2 in the exhaled air. A normal capnography waveform is square, with a slight upslope to the plateau phase during exhalation. (See figures below) The height of the waveform at its peak corresponds to the $ETCO_2$.

4. Capnography is necessary to monitor ventilation. For patients requiring positive pressure ventilation, capnography is most accurate with proper mask seal (two-hand mask hold for adults during bag-mask ventilation) or with an advanced airway.

5. Capnography can also be applied via a nasal cannula device to measure end-tidal CO_2 in the spontaneously breathing patient. It is useful to monitor for hypoventilation, in patients who are sedated either due to ingestion of substances or treatment with medication with sedative properties such as midazolam, opioids, or alcohol.

6. Capnography is standard of care for confirmation of advanced airway placement. Unlike simple colorimetric devices, capnography is also useful to monitor the airway position over time, for ventilation management, and for early detection of return of spontaneous circulation (ROSC) in patients in cardiac arrest.

7. Capnography is the most reliable way to immediately confirm advanced airway placement. Capnography provides an instantaneous measurement of the amount of CO_2 in the exhaled air. The absence of a waveform, and/or values < 10 mmHg, suggest advanced airway misplacement. However, patients in cardiac arrest or profound shock may also have end-tidal CO_2 values <10 despite proper airway placement.

8. Capnography provides the most reliable way to continuously monitor advanced airway position. The waveform provides a continuous assessment of ventilation over time. A normal waveform which becomes suddenly absent suggests dislodgement of the airway and requires clinical confirmation.

9. The value of exhaled CO_2 is affected by ventilation (effectiveness of CO_2 elimination), perfusion (transportation of CO_2 in the body) and metabolism (production of CO_2 via cellular metabolism). In addition to the end-tidal CO_2 value, the ventilation rate as well as the size and shape of the capnograph must be used to interpret the results.

10. Decreased perfusion will reduce the blood flow to the tissues, decreasing offload of CO_2 from the lungs. Therefore, patients in shock and patients in cardiac arrest will generally have reduced end-tidal CO_2 values.

11. A sudden increase in perfusion will cause a sudden rise in end-tidal CO_2 values and is a reliable indicator of ROSC. It is common to have an elevated $ETCO_2$ reading after ROSC. Hyperventilation should not be done to in attempt to normalize the $ETCO_2$.

12. Ventilation can have varied effect on CO_2 measurement. Generally, hyperventilation will reduce end-tidal CO_2 by increasing offload from the lungs. Hypoventilation and disorders of ventilation that reduce CO_2 elimination (e.g., COPD), will cause CO_2 to build up in the body.

13. End-tidal CO_2 can be detected using a colorimetric device ($ETCO_2$ detector). These devices provide limited information about $ETCO_2$ as compared to capnography. Colorimetric devices do not provide continuous measurement of the value of CO_2 in the exhaled air and cannot be used in ongoing monitoring. Colorimetric devices should only be used for confirmation of endotracheal tube placement if capnography is unavailable due to equipment failure.

IV. POLICY:

1. Capnography monitoring is indicated and shall be used for patients meeting any of the following indications:
   a. Patients receiving positive pressure ventilation via CPAP or BVM.
   b. Patients at risk of developing respiratory failure, hypoventilation, or apnea.
   c. Patients in cardiac arrest.
   d. Advanced airway confirmation per policy 0710
   e. Paramedic judgement

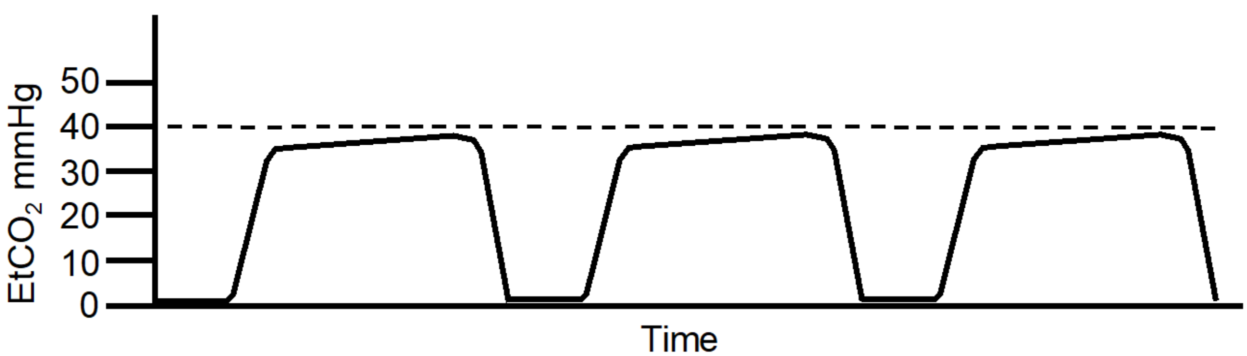
2. Capnography may also be utilized when the paramedic determines it may aid the clinical assessment.
3. Providers will initiate capnography monitoring as soon as feasible and ensure that the capnography waveform is visible on screen throughout patient care or until no longer indicated.

V. PROCEDURE:

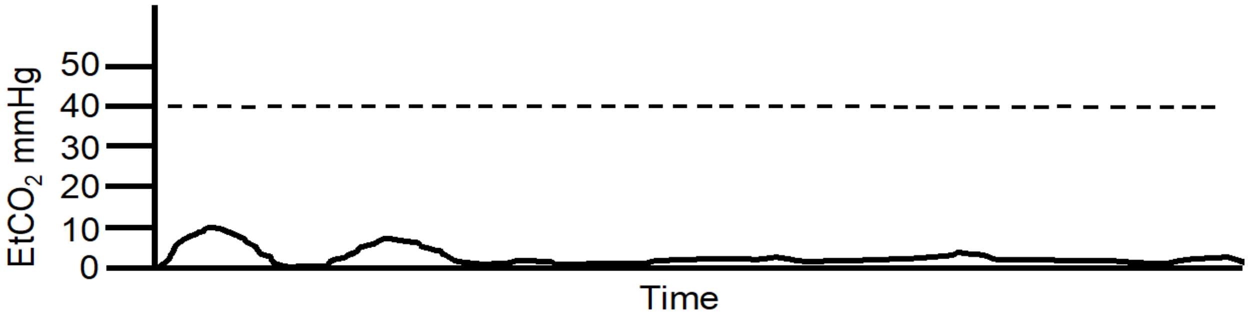
1. Chose the appropriate CO2 measuring device;
   a. Nasal cannula device for spontaneously breathing patients with or without CPAP
   b. Sidestream or mainstream inline measuring device for patients receiving BVM ventilations via BLS or ALS airway adjunct.
2. Attach measuring device to the monitor, wait for device to initialize, then attach to patient.
3. Assess that a capnography waveform is present with each breath prior to considering measurements to be accurate.
4. Assess EtCO2 value.
5. Assess for abnormalities in capnography waveform or EtCO2 value initially and for trends over time.
6. Endotracheal tube confirmation: per policy 710

VI. WAVEFORM INTERPRETATION

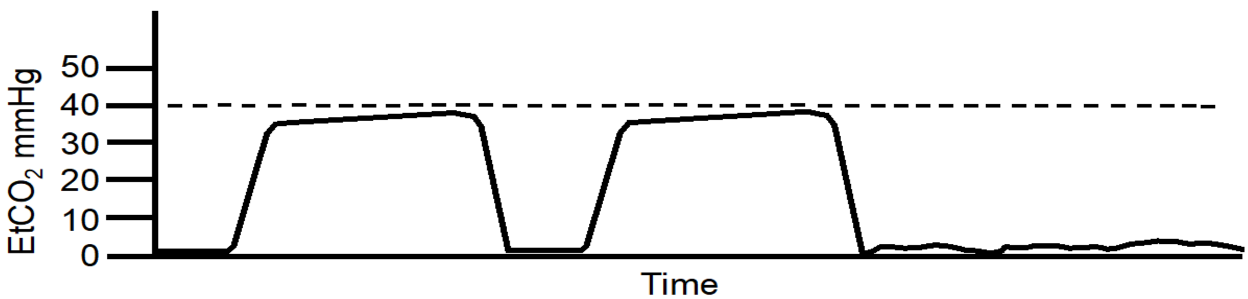
1. Normal shape of the capnograph is depicted below



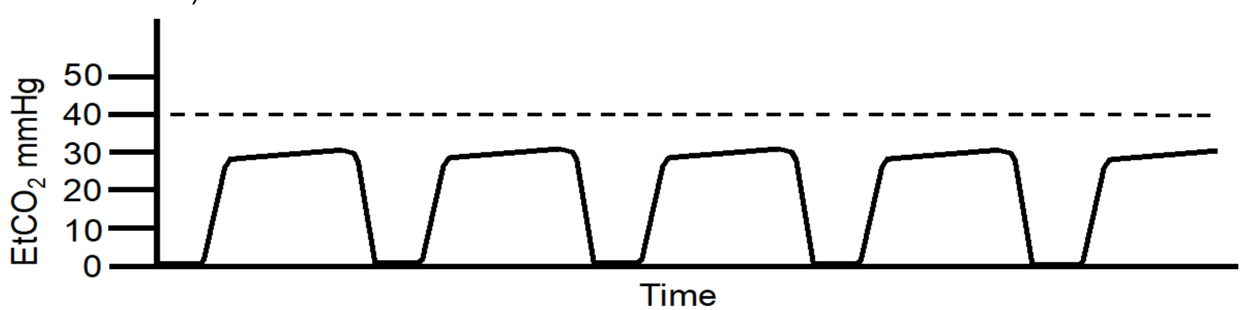
2. Esophageal Intubation (Low values and irregular waveform or flat line).



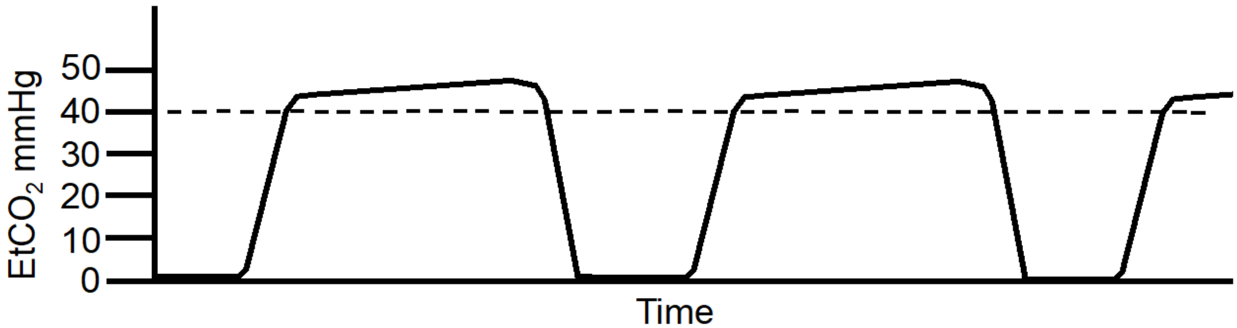
3. Obstructed or dislodged endotracheal tube (sudden loss of normal waveform followed by low irregular waveform or flat line).



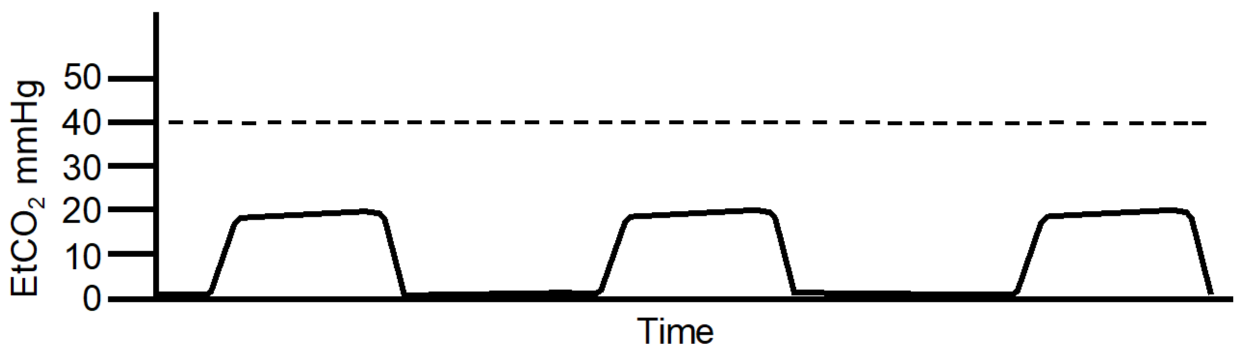
4. Hyperventilation (Normal waveform with reduced height, < 35 mmHg, and high ventilation rate)



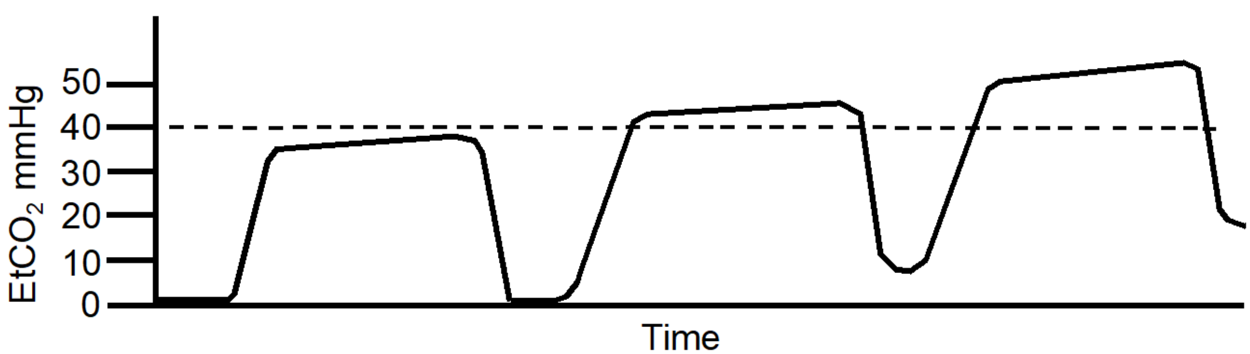
5. Hypoventilation/ Bradypnea (Normal waveform with increased height, > 45 mmHg)



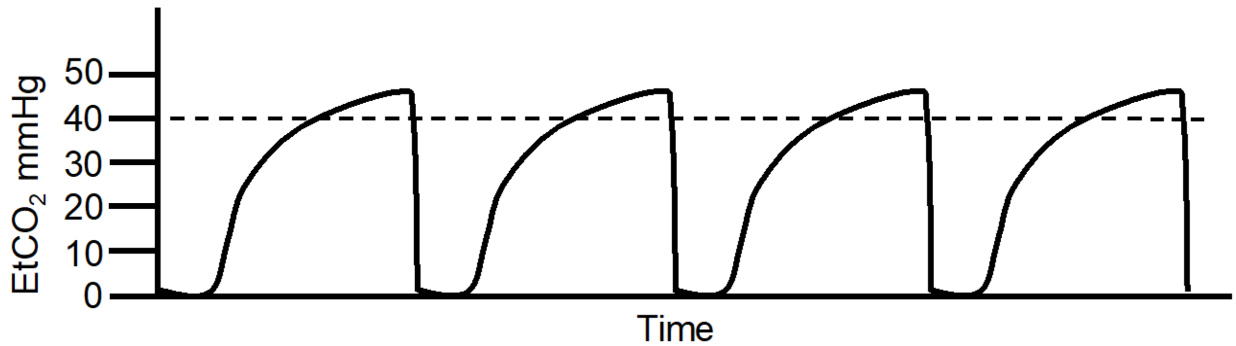
6. Hypoventilation/ Low tidal volumes (Normal waveform with reduced height, < 35 mmHg, and slow ventilation rate; A similar reduced height waveform can also be seen with shock - see progressive hypotension below).



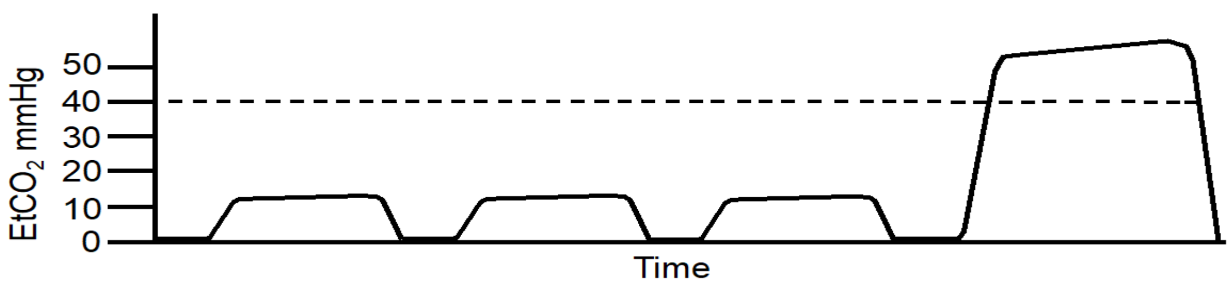
7. Air Trapping / Breath Stacking (Box wave forms that show increasing values with each successive breath)



8. Bronchospasm ("Shark Fin Pattern")



9. Return of Spontaneous Circulation (Sudden increase in values in a patient in cardiac arrest)



10. Progressive Hypotension or Re-arrest (Progressive decrease in values with each successive breath)