Mano Médical

Medical Equipment for Veterinarians

CAPNO-2

VETERINARY CAPNOGRAPH

USER'S MANUAL

Capno 2 is for veterinary use only.

I. Introduction

Capnography monitors the concentration of CO2 in the respiratory gases, which is a rapid and reliable method to detect life-threatening conditions, such as malposition of endotracheal tubes, unsuspected ventilatory or circulatory failure, and defective breathing circuits. Capnography is the most comprehensive way to monitor the patient's ventilation, making the difference between life and death.

The Capno-2 Veterinary Capnograph (hereinafter "the Unit") is an effective Anesthesia Disaster Early Warning System, which monitors not only your patient's ventilation but also the anesthesia system. Employing the VetSpecs® proprietary micro-flow™ side-stream capnography, the Unit works effectively in cats, dogs, and a wide variety of other animals, and provides:

- Real-time CO2 waveforms (capnogram)
- End-tidal CO2 reading (EtCO2)
- Respiratory rate (RR)
- Fractional Inspired CO2 (FiCO2)
- Audible and visual apnea alarms

II. Set up the monitor

Featuring internal rechargeable battery, the Unit comes with a battery charger and two disposable sensor lines, which is a thin clear tube with a moisture filter (light brown color) at one end and an airway adapter (clear) at the other end.

1. Turn on the Unit

Push and hold down the power button key on the front panel for about three seconds until the screen displays VetSpecs®. To turn off the Unit, push and hold down the power button.

2. Connect the sensor line

Connect the filter end of the sensor line to the port at the top of the Unit by pushing in and turning clockwise. The port is flashing blue when no sensor line is connected. After a sensor line is connected to the port, the port will flash purple and orange for several seconds, indicating the sensor line securely locked in place, and then stay lighted up in purple. After the patient is intubated, insert the airway adapter on the sensor line between the endotracheal tube and the breathing circuit.

3. Place the monitor

It is recommended to hang the Unit on the anesthesia machine with a string through the stand on the back, and tie the Unit securely to prevent it from being knocked around.

For monitoring in dentistry, place the Unit away from the patient mouth area to prevent it from getting wet.

Store the Unit at a secure and dry place when it is not in use. Avoid direct sunshine, heat, and corrosive materials.

4. Charge the battery

Connect the battery charger to the power port located at the right side of the Unit, and then plug it to a power outlet. The battery allows multiple hours of continuous operation after a full charge. For longer battery life, charge the battery frequently and do not drain it completely. Never use a battery charger which was not provided by VetSpecs for use exclusively with the Unit.

III. Clinical Instructions

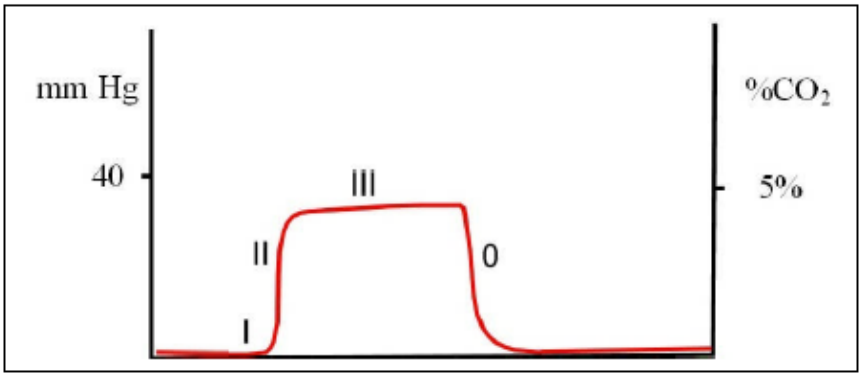
1. Capnography

Capnography is measurement and waveform display of CO2 concentration at the patient's airway. It monitors various components of patient and anesthesia equipment as well as the critical connection between the two. Capnography provides information about CO2 production, pulmonary perfusion, alveolar ventilation, respiratory patterns, and elimination of CO2 from the anesthesia circuit and ventilator, and therefore, is very effective for early detection of adverse respiratory events.

A capnogram is the graphical waveform depicting CO2 concentration throughout respiration. In a single breath, air sampled during inspiration should contain virtually no carbon dioxide. As exhalation begins, the air passing the sampling site initially represents dead space that has not been in contact with alveolar air, therefore containing virtually no carbon dioxide. As exhalation continues, alveolar air mixes with the dead space, with a resultant gradual increase in the amount of carbon dioxide measured (upstroke of the capnogram curve). Eventually, the air passing the sampling

site is alveolar air, and the partial pressure of CO2 reaches a plateau, which is reported as the end-tidal CO2.

The diagram below shows the shape of a normal capnogram.



Phase I: A near zero baseline — Exhalation of CO2-free gas contained in dead space.

Phase II: Rapid, sharp rise — Exhalation of mixed dead space and alveolar gas.

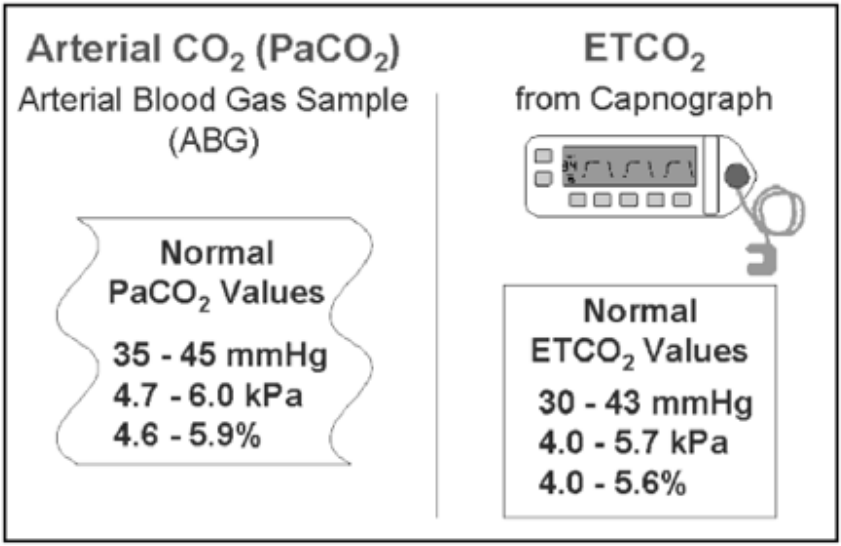
Phase III: Alveolar plateau — Exhalation of mostly alveolar gas. At the end of exhalation, CO2 concentration reaches the peak - end-tidal CO2 value.

Phase 0: Rapid, sharp down-stroke — Inhalation.

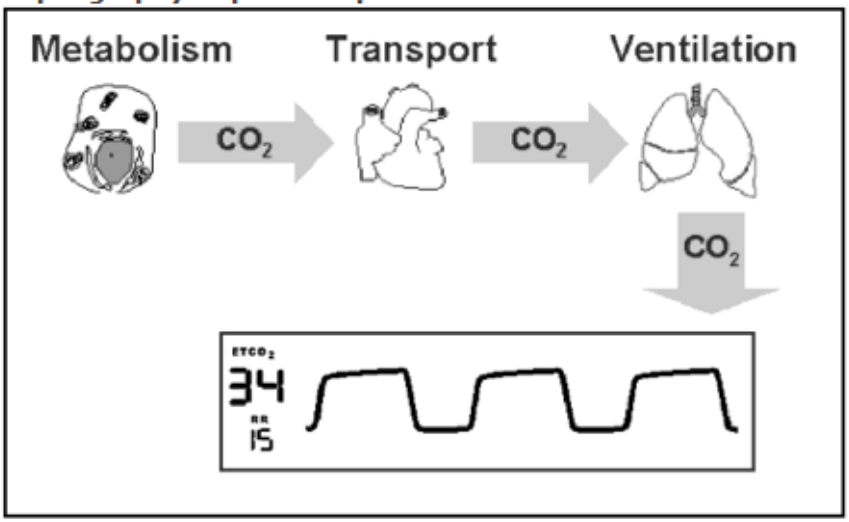
The end-tidal CO2 (EtCO2), which can be expressed as mmHg or percentage, refers to the measurement of CO2 concentration at the end of exhalation.

EtCO2 is a product of three major determinants: the rate of CO2 production by the tissues, the rate of exchange of CO2 from the blood to the alveoli, and the rate of CO2 removal by alveolar ventilation. Because CO2 is a highly soluble gas, diffusing from air to liquid and back again occurs very quickly. Because of this solubility, the relationship between CO2 and minute ventilation is a straight line, the higher the ventilation, the lower the CO2. Conversely, hypoventilation leads to high CO2 levels as the gas is retained. Therefore, EtCO2 provides a close clinical estimate of the alveolar and thus the arteriolar CO2. The normal range of ETCO2 for most mammals is 30 – 43 mmHg or 4.0 – 5.6%.

Normal Values



Capnography Depicts Respiration



2. Clinical implications

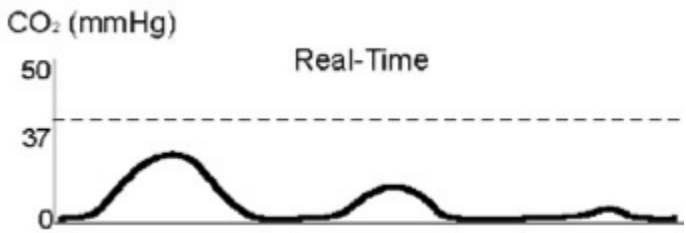
Normal EtCO2 readings, together with a normal capnogram, indicate normal function of the patient’s metabolism, circulation, and ventilation, and of the anesthesia machine.

Increases in EtCO2 may be due to anesthetic induced respiratory depression, increased metabolism, or the addition of CO2 to the circulatory system as a result of re-breathing CO2. Re-breathing CO2 can be due to soda lime exhaustion or incompetent expiratory valve on the anesthesia machine allowing exhaled CO2 to be re-inhaled. Decreased or abolished EtCO2 may be due to hyperventilation, low cardiac output, respiratory arrest, or cardiac arrest.

Capnogram also provides vital information regarding the patient's airway potency. A depressed or absent capnogram may be due to a dislodged, misplaced, or obstructed endotracheal tube or airway, a leak around endotracheal tube cuff, or disconnection of the endotracheal tube from the anesthetic machine.

The following are some examples of abnormal capnograms.

(1) No EtCO2 recorded

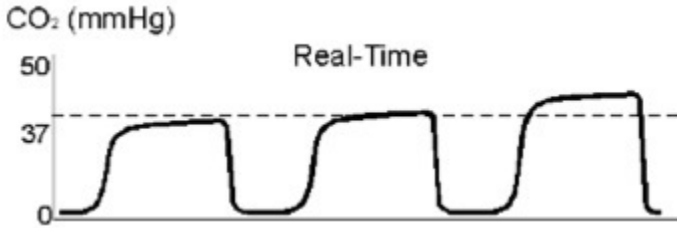


Possible causes:

- Apnea
- Accidental endotracheal tube disconnect
- Esophageal intubation
- Airway obstruction
- Cardiac arrest
- Respiratory arrest

A sudden drop of the EtCO2 to near zero followed by the absence of capnogram is potentially life-threatening, which could indicate malposition of the endotracheal tube, disruption of airway integrity, disruption of sampling lines, or a sudden cardiac arrest.

(2) Increasing EtCO2 (hypoventilation)

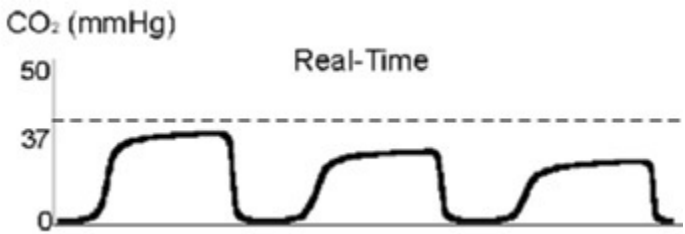


Possible causes:

- Decreased respiratory rate
- Decreased tidal volume
- Deep anesthesia
- Interference with chest expansion
- Increased metabolic rate

In anesthetized patients, EtCO2 higher than 50mmHg indicates hypoventilation.

(3) Decreasing EtCO2



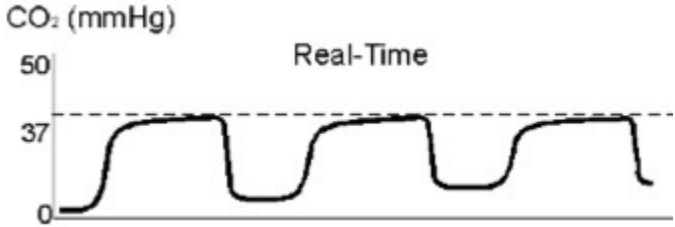
Possible causes:

- Increased respiratory rate
- Increased tidal volume

- Reduced cardiac output
- Leaks around the tube (dilution)
- Decreased metabolic rate – e.g. hypothermia

Gradual reductions in EtCO2 often reflect decreases in $PaCO_2$ that occur following increases in minute ventilation or a reduction of the metabolic rate.

(4) Baseline does not return to zero

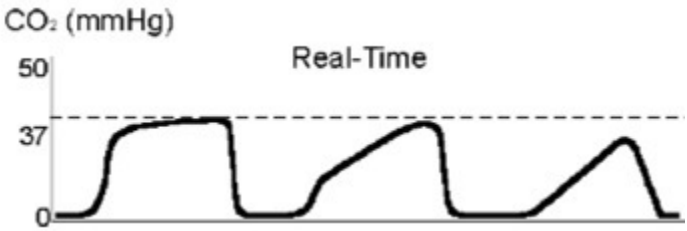


At the same time the EtCO2 value will also start to rise.

Possible causes:

- Incompetent or absent unidirectional dome valves
- Insufficient fresh gas in non-rebreathing circuit
- Exhausted soda-lime in rebreathing circuit
- Absorber canister bypassed
- Leak in Bain circuit inner hose
- Excessive dead space in anesthetic circuit

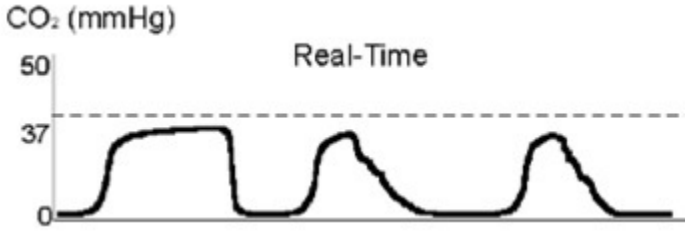
(5) Abnormal Upstroke (Shark Fins)



Possible causes:

- Kinked or occluded endotracheal tube.
- Upper airway obstruction
- Obstruction on expiratory side of anesthesia machine
- Bronchospasm

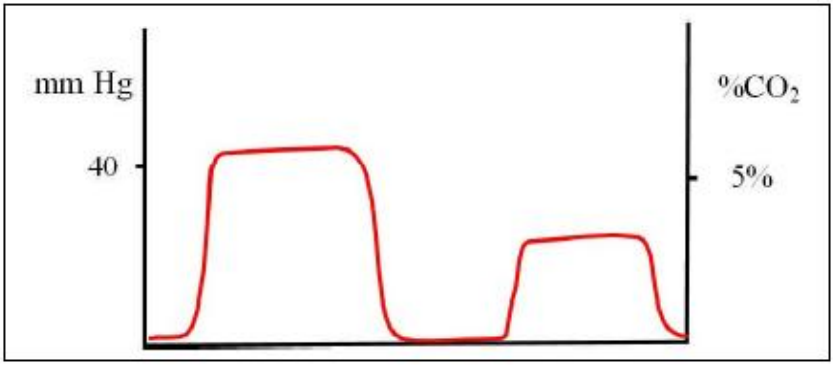
(6) Abnormal Down Stroke



Possible causes:

- Leak around endotracheal tube cuff
- Artificial airway is too small for the patient

(7) Abrupt fall in EtCO2 level

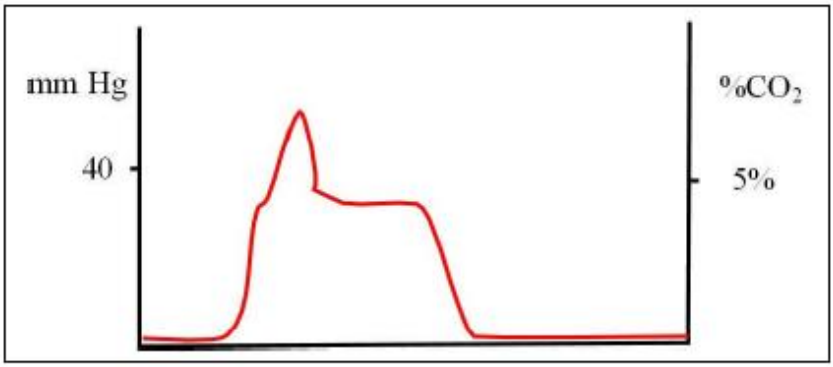


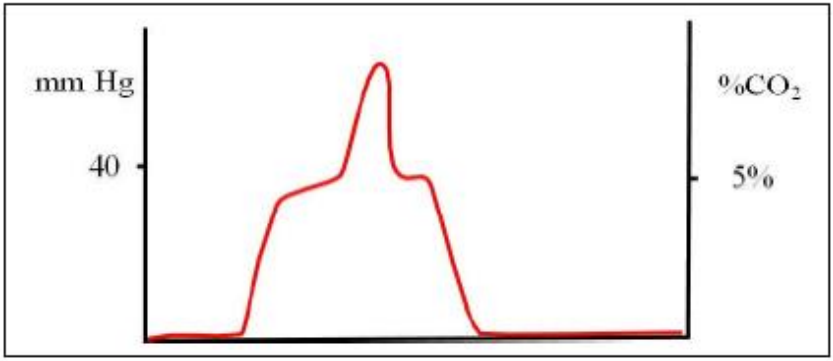
Possible causes:

- Pulmonary artery compression
- Pulmonary artery embolism
- Sudden hemorrhage
- Acute cardiac tamponade
- Cardiac compression

Abrupt decreases in the EtCO2 are often associated with an altered cardiopulmonary status (embolism or hypoperfusion).

(8) Differential emptying

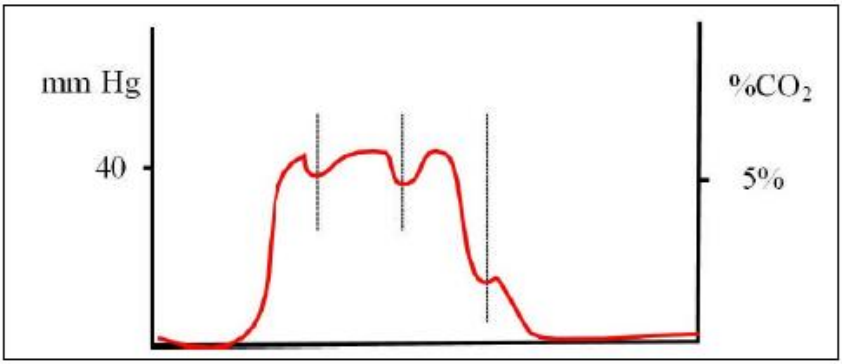




The above capnograms can result from the following:

- Positioning of the endotracheal tube at or beyond the carina, so that one side of the lung has impaired emptying. This makes the retained gas higher in CO2 and later to empty than from the normal lung. The “spike” can occur anywhere in the plateau phase.
- Any functional blockage of a major airway, below the carina – foreign body, mucous, compressed airway, etc.

(9) Cardiogenic oscillations



Cardiogenic oscillations are ripples superimposed on the expiratory plateau and the descending limb of the capnogram, which are caused by small gas movements inside the airway. Although cardiogenic oscillations can occur in any animal where the pulsations of the aorta and heart cause areas of lungs to be compressed and thereby emptied and filled, they are typically seen in large dogs with a slow RR. The guide to the fact that this is happening is that the oscillations are in synch with the heartbeats. The displayed respiratory rate can be much higher than the actual respiratory rate when cardiogenic oscillations occur.

IV. Operation Instructions

1. MENUS

Push MENU key to display MAIN MENU.

MAIN MENU

CO2 SET

TREND

TIME SET

SOUND SET

NEW PATIENT

EXIT

Push ▲ or ▼ keys to select and push ENTER key to enter a selected sub-menu.

CO2 SET

EtCO2	ALARM H 50.0
	ALARM L 19.0
RESP	ALARM H 30
	ALARM L 08
FLOW SET	100

APNEA TIME	30 S
CO2 UNIT	mmHg
CO2 PUMP	ON
AUTO OFF TIME	10 M
SWEEP SPEED	NORMAL
WAVE SCALE	54mmHg
EtCO2 AVER	1 BREATH
LOAD DEFAULTS	
EXIT	

Push ▲ or ▼ keys to select items, push ◄ or ► keys to change settings, and the push ENTER key to confirm.

FLOW SET – the sample flow rate (volume of the gas withdrawn in a minute) ranges from 50 to 250 ml/m. Generally speaking, for cats and dogs, the flow rate should be set between 50 and 100, and for very small patients, such as kittens and exotics, the flow rate should be set at 50.

APNEA TIME – the time set to trigger a visual and audible alarm after the patient has stopped breathing.

CO2 UNIT – EtCO2 can be expressed as mmHg, %, or KPA.

CO2 PUMP – after the Unit has been idle for a period of time, the pump will automatically be turn off in order to save battery energy. PUMP OFF will be displayed. To turn on the pump, simply push the ENTER key.

AUTO OFF TIME – after the Unit has been idle for the period of time, the Unit will be turned off automatically to save battery energy.

SWEEP SPEED – the speed of the displayed waveforms.

WAVE SCALE – the magnitude of the displayed waveforms.

EtCO2 AVER –the displayed EtCO2 is the averaged reading for the number of breaths.

LOAD DEFAULTS – to restore all default settings.

TREND

To display EtCO2 and RR trends, select TREND in the main menu and push ENTER key. Push ▲ or ▼ keys to switch between the EtCO2 trend and the RR trend. Push ◄ or ► keys to see trends for previous hours.

SOUND SET

To change alarm volume, select SOUND SET in the main menu, and then push ◄ or ► keys to increase or decrease.

NEW PATIENT

To clear the memory of the Unit, select NEW PATIENT in the main menu, and then select YES.

2. The sensor lines

The Unit comes with two sensor lines. It is suggested to rotate the two sensor lines between procedures so that the moistures inside can have enough time to dissipate.

The sensor line is a disposable item. In order to ensure proper performance, the sensor lines must be replaced due to accumulated residuals inside after it has been used for a period of time. It is recommended to replace the two sensor lines every month. If the Unit is used heavily everyday, it is expected to replace the sensor lines more frequently.

3. Calibration

The Unit will automatically calibrate itself whenever necessary. A calibration process usually takes only about a couple of seconds in which the measurement is suspended (waveforms go flat for 1 - 2 seconds).

4. The exhaust port

In order for the Unit to perform properly, do not block the exhaust port located at the bottom of the Unit. It is recommended to connect the exhaust port to the hospital scavenging system.

V Limited Warranty

MANO MEDICAL warrants the Capno-2 Veterinary Capnograph (hereinafter “the Unit”) to be free from defects in materials and workmanship, when stored under appropriate conditions and given normal, proper and intended usage, for ONE (1) YEAR from the date of delivery of the Unit to the original end user purchaser (“Buyer”). MANO MEDICAL agrees during the applicable warranty period to repair or replace defective unit without cost to Buyer. VetSpecs shall not have any obligation under this Limited Warranty to make replacements which result, in whole or in part, from catastrophe, fault or negligence of Buyer, or anyone claiming through or on behalf of Buyer, or from improper use of the Unit, or use of the Unit in a manner for which it was not designed, or by cause external to the Unit.

The battery charger is covered by a one (1) year limited warranty. The sensor lines are disposable items and have no warranty.

Buyer shall notify MANO MEDICAL of any product which it believes to be defective during the warranty period. Such product shall be returned by Buyer, transportation and insurance prepaid, to VetSpecs for examination and testing.
MANO MEDICAL shall repair or replace any such product found to be so defective and return such product to Buyer, transportation and insurance prepaid. The provisions of the foregoing Limited Warranty are exclusive and are expressly in lieu of any other warranty, whether express or implied, written or oral.
MANO MEDICAL' liability arising out of the manufacture, sale or supplying of the Unit shall not exceed the actual purchase price paid by Buyer for the Unit. In no event shall MANO MEDICAL be liable to Buyer or any other person or entity for special, incidental or consequential damages (including, but not limited to, loss of profits, damages to properties, and injuries to the patient and/or the user) arising out of the manufacture, sale, supplying or use of the Unit. The foregoing Limited Warranty extends to Buyer only and shall not be applicable to any other person or entity including, without limitation, customers of Buyer.

VI. Customer Support

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