Department of Anesthesia Techniques

Title of the lecture: - capnography

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Capnography and CO_2 measurement

Capnometry: is the measurement of CO_2 in a gas mixture

Capnometer: is the device that performs the measurement and displays the reading in numerical form

Capnograph: is the machine that generates the wave form

Capnography: is the recording of CO_2 concentration versus time

Capnogram: is the actual wave form

General principles:

1. Technology methods to measure CO_2 levels includes infrared and chemical colorimetric analysis
2. The CO_2 level may be reported as either partial pressure or volume percent and may be displayed continuously or as the peak (normally end tidal) value
3. Other parameters such as respirotary rate and I:E ratio may be displayed
4. Portable battery-operated CO_2 monitoring devices are available, these are useful in emergency medicine and patient transport, and MRI- compatible infrared CO_2 monitor are available
5. Normally end-tidal CO_2 is (35—45 mmHg) and 5% volume percent

Some clinical conditions of Co2 alteration

1. increased end-tidal CO2

a. absorption of CO2 from peritoneal cavity
b. injection of sodium bicarbonate, blood administration
c. pain, anxiety, shivering
d. increased muscle tone (as from muscle relaxant reversal)
e. convulsion
f. hyperthermia
g. excessive catecholamine production or administration
h. increased transport of CO2 to the lungs (restoration of peripheral circulation after it has been impaired

2. decreased end-tidal CO2

a. hypothermia
b. increased depth of anaesthesia
c. use of muscle relaxant

- **Capnometry alteration as a result of circulatory changes**

1. Decreased end tidal CO2

a. Decreased transport of CO2 through the lungs (pulmonary embolism, either air or thrombus, surgical manipulation)
b. Decreased transport of CO2 to the lungs(impaired peripheral circulation) e.g. decrease cardiac out put
c. Increased patient dead space
d. During resuscitation exhaled CO2 is better guide to the effectiveness of resuscitation

- **Capnometry with respiratory problem**

1. Absent in disconnection, apnea, stop ventilation, esophageal intubation
2. Decreased end- tidal CO_2 in hyperventilation
3. Increased in $ETCO_2$ in hypoventilation, upper air way obstruction, rebreathing (e.g. under drapes)

- **Clinical advantages associated with respiratory system**

1. Give information about the rate, frequency, and depth of respiration
2. It can be used to evaluate the patient ability to breath spontaneously
3. To assess the effect of bronchodilator or nitric oxide or other ventilation parameter
4. It allows control of ventilation with fewer blood gas determination
5. It is noninvasive available on a breath by breath basis

- **Capnometry alteration with equipment**

1. Increased $ETCO_2$

a. Increase apparatus dead space

b. Rebreathing with circle system (faulty or exhausted absorbant)

c. Rebreathing with mapelson system (inadequate FGF, misassembly, problem with inner tube of Bain system
d. Rebreathing due to malfunctioning non rebreathing valve
e. Obstruction to the expiration in the breathing system

2. Decrease ETCO2

a. Leakage in the sampling line
b. Low sampling rate with diverting device
c. Too high sampling rate with diverting device
d. Inadequate seal around tracheal tube
e. Blockage of sampling line cause absent of ETCO2

capnography

General criteria

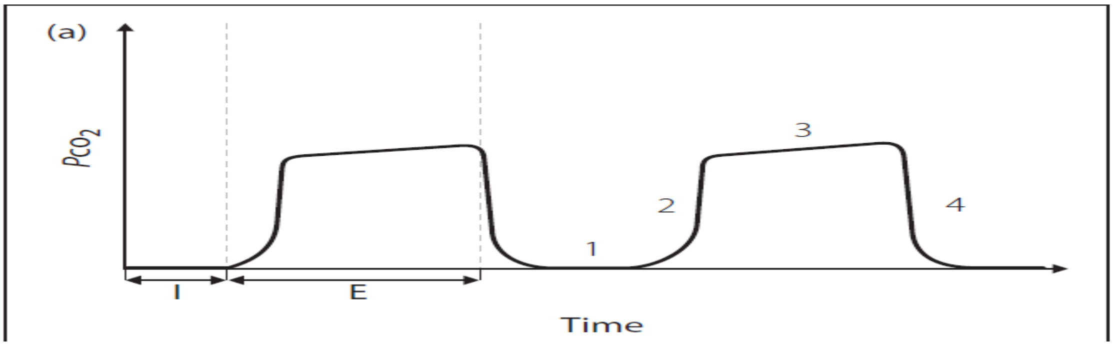
1. Wave form can be displayed on an oscilloscope or printed on paper
2. The waveform should be examined systematically for height, frequency, rhythm, base line and shape (height depend on the ETCO2, frequency depends on the respiratory rate
3. The base line is normally zero, an elevated base line can result from deliberate administration of CO2, rebreathing,

exhaust absorbent, incompetent expiratory unidirectional valve

4. Only the shape (top hat or sine wave) is considered normal, phase I (inspiratory base line) begin at E and is normally zero reflecting inspired gas which is normally devoid of CO_2

Phase II (expiratory upstroke) begins at B and continues to C. this rapid S-shaped upswing represents the transition from gas from the dead space that does not participate in gas exchange and alveolar gas that contains CO_2

Phase III begins at C and continue to just before D, as gas coming almost entirely from alveoli is exhaled, a plateau is normally seen. The very last portion of phase III identified by D is referred to as end tidal CO_2 point, the CO_2 level her is normally at its maximum



(In normal individuals this is 5%-5.5% or 35-40 mmHg)
In phase IV the patient inhales, normally CO2 fall abruptly to zero and remain at zero until the next exhalation.

The angle between phase II and III is called the α angle (take off, elevation) its decrease with obstructive lung disease, as the dead space volume takes longer to be exhaled

The angle between the end of phase III and the descending limb of the capnogram is called the B-angle, these will increased with rebreathing, and prolong response time compared with the respiratory cycle time

Thank you