Introduction to Capnography

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Airway Management
One of the biggest mistakes
during the administration of moderate sedation

Utilizing too much benzodiazepines and
not administering enough narcotic.

BECAUSE...

Airway Management
THE BIGGEST FEAR
What do I do if the patient stops breathing?
Respiratory Physiology

The primary responsibility in anesthesia is to make sure... that the good air goes in and the bad air gets out

The surface area of the lungs is equivalent to a tennis court

HOW DOES THE BODY CONTROL VENTILATION?

PaO2 -Partial Pressure of Blood Oxygen

PaCO2 -Partial Pressure of Blood Carbon Dioxide

Ph and Acid-Base Levels
Peripheral chemoreceptors of the CAROTID and AORTIC bodies at the bifurcation of the common carotid arteries

- Stimulated by decreased PaO2
- PaO2 drops below 100 mm Hg, receptor activity increases
- PaO2 of 65-60 mm Hg (O2 Sat of 85%-90%), minute ventilation (tidal volume and respiratory rate) will increase significantly.

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**Oxyhemoglobin Disassociation Curve**

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**Supplemental Oxygen**

O2 covers a multitude of "sins"
Using a pulse oximeter

Using a pre-tracheal stethoscope

Pre-cordial or pre-trachael stethoscope

Standard of care or...
Pre-cordial or pre-trachael stethoscope

A dinosaur?

Capnography

- Minimal monitoring gives you the small picture

- NIBP
- Pulse oximetry
Capnography

1. The pulse oximeter is only a poor and incomplete measure of ventilation

2. As long as the pulse oximeter is in the high 90's and the patient is responsive continuously to verbal command, the level of CO2 is inconsequential.

3. If the patient gradually gets more deeply sedated without the dentist giving more drug, consider that increasing levels of CO2 will produce a general anesthetic. For the sedationist who has an unconscious patient, they need to call 911, provide positive pressure ventilation and reverse the patient's sedation while maintaining the airway. The CO2 will rapidly decrease.

4. Finally, so long as the oxygenation is adequate, the human body can endure extremely high levels of CO2 without permanent damage

author: Joel Weaver, DDS, PhD
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Capnography
Capnography- breath by breath response time (5-7 seconds)
Pulse Oximetry- 2-4 minute delay before desaturation
EKG- 3-6 minute to demonstrate an arrhythmia to hypercarbia or hypoxia

Early detection of a problem is easy to manage and may be treated a a nuisance. Later problems require more attention, time, personnel, and training, and equipment.

Capnography
Room air contains a partial pressure of 0.36mmHg of CO2
Expired air contains a partial pressure of 40mmHg of CO2
Normal EtCO2 is 40mmHg
Hypercarbia > 45mmHg
Narcotized patients may need 55-60mmHg to stimulate the respiratory center

Physiologic effects of hypercarbia
At the cellular level
H2O + CO2 ⇌ H2CO3 ⇌ H+ + HCO3-

Cardiac effects
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\text{sympathetic discharge by epinephrine and norepinephrine, myocardial contractility and output, risk of arrhythmias}
\]

Effects on the CNS
cerebral vasodilation, lowering of the seizure threshold
Physiologic effects of hypoxia

Capnography

Is the measurement of airway CO₂ concentration or partial pressure measurement as a function of time.

The waveform is called a capnogram.

This is a reliable estimate of the arterial partial pressure of CO₂.

Evaluation of his waveform is useful in the measurement of:

1) adequate alveolar ventilation (R/O esophageal intubation)
2) airway patency
3) cardiopulmonary perfusion
   (etCO₂ strongly correlates with changes in CO)
4) diagnosis of malignant hyperthermia
5) return of circulation following CPR
Respiratory Physiology

\[
\text{H}_2\text{O} + \text{CO}_2 \rightleftharpoons \text{H}_2\text{CO}_3 \rightleftharpoons \text{H}^+ + \text{HCO}_3^- \\
\]

CO2 readily diffuses across cell membranes, leading to the formation of carbonic acid and the generation of hydrogen ions.

Fortunately, intracellular buffering is rapid, reaching 90% within 3 hours after the onset of hypercarbia.

4. Finally, so long as the oxygenation is adequate, the human body can endure extremely high levels of CO2 without permanent damage

Respiratory Physiology

Permissive Hypercarbia

Controlled hypoventilation - a ventilation strategy

Allowing alveolar hypoventilation will lead to hypercarbia and respiratory acidosis.

This hypoventilation is safe, is well tolerated, and may improve outcome.
Respiratory Depression?
It is this respiratory acidosis that stimulates the respiratory center in the brain stem.

Narcotics suppress this stimulation, which then requires more CO2 to produce more acidosis to irritate this respiratory center.

Narcotics slow the respiratory rate NOT the inspiratory rate (obstruction will) This is not pathologic.

Traditional methods of assessing the obstructed airway

Sight  Sounds  Pulse oximeter

Visual and auditory evaluation of the obstructed airway

- snoring
- mouth breathing
- nasal flaring
- pursing lips
- thoaco-lumbar rocking
- cyanosis
- reservoir bag movement
Visual and auditory evaluation of the obstructed airway

- snoring

Visual and auditory evaluation of the obstructed airway

- mouth breathing

Visual and auditory evaluation of the obstructed airway

- nasal flaring
Visual and auditory evaluation of the obstructed airway
• pursing lips

Visual and auditory evaluation of the obstructed airway
• tracheal tugging

Visual and auditory evaluation of the obstructed airway
• thoraco-lumbar rocking
Visual and auditory evaluation of the obstructed airway

• cyanosis

Visual and auditory evaluation of the obstructed airway

• reservoir bag movement

Capnography

Main stream
Side stream
50uL sample size
Sampling line location with different airways
  • Nasal hood

Sampling line location with different airways
  • NPA breathing room air during emergence

Capnography- placement of sampling line
Capnography - normal breathing

expiration

inspiration

dead-space

CO2 rebreathing

Can you see the elephants?
Can you see the elephants?

Ideal capnogram tracing

Capnography- tachypnea
Capnography - narcotized breathing

Capnography - changes after fentanyl administration

Argument against the routine use of capnography

These elaborate monitors may be harmful; they may distract and confuse the clinician, may present deceptive artifacts, and may give rise to misinterpretations leading to unnecessary and even injurious interventions.
Deceptive artifacts?

high inspired CO2

low FiO2

Deceptive artifacts?

low inspired CO2

correct FiO2
Deceptive artifacts?

Chinning a mild obstruction

Deceptive artifacts?

Chinning a mild obstruction

Deceptive artifacts?

Mouth breathing with a nasal hood
Mouth breathing with a nasal hood

Deceptive artifacts?

Cardiac oscillations
Cardiac oscillations

Deceptive artifacts?

Deceptive artifacts?

Sub-diaphragmatic obstruction
Thoraco-lumbar rocking
Deceptive artifacts?

What could possibly go wrong?

Connecting the CO2 sampling line to the IV catheter

The space shuttle instrument panel

These elaborate monitors may be harmful; they may distract and confuse the clinician, may present deceptive artifacts, and may give rise to misinterpretations leading to unnecessary and even injurious interventions.

When you don't know how to use them
Capnography

Effective July 1, 2011
American Society of Anesthesiologists
Standard 3.2.4

“During moderate or deep sedation, the adequacy of ventilation shall be evaluated by continual observation of qualitative clinical signs and monitoring for the presence of exhaled carbon dioxide unless precluded or invalidated by the nature of the patient, procedure, or equipment.

“The use of capnography for patients under moderate sedation, deep sedation and general anesthesia should be instituted in OMS practice and be used on these patients effective January 2014”

“With supplemental oxygen, pulse oximetry becomes a late detector of hypoventilation. Monitoring for the adequacy of ventilation...will be an emphasis on capnography.”

AAMOS website

Stand alone capnography units

BCI Capnocheck II
The new standard of care that is proven to be more effective than Spo2
Sampling with a bi-flow canula

Rationalization for not fully monitoring a patient during sedation or anesthesia

There is no excuse

Capnography

Conclusion

Capnography is now easy to monitor, has become cost-effective, and allows a more detailed assessment of the respiratory function of the sedated or anesthetized dental patient.

Anesthesia vital signs should include analysis and recording of EtCO2 levels as part of the complete monitoring of the patient during sedation and anesthesia.