What is the difference

Oxygenation vs. Ventilation
Oxygenation vs. Ventilation

- **Oxygenation** - the ability of the red blood cells to pick up oxygen and move them to the tissues of the body

- **Ventilation** - the exchange of air between the lungs and the environment, including inhalation and exhalation
Oxygen must first be picked up by red blood cells, then dumped off at the tissue level.

The body must then take the $O_2$ and glucose to create energy through cellular metabolism.

This leaves the waste product (CO$_2$) which needs to be discarded through exhalation.
Pulse oximetry measures oxygenation and can be provided in a waveform.

Capnography measures ventilation and can also provide a graphical waveform for interpretation.
Oxygenation

- Measured with pulse oximetry (SpO$_2$)
  - Noninvasive measurement
  - Expresses the percentage of oxygen in red blood cells
  - Changes in oxygenation may take **minutes** to be detected (up to 5 minutes at times)
  - Affected by motion artifact, poor perfusion, nail polish, and some dysrhythmias
Pulse Oximetry Waveforms

- **Waveform**
  - Normal Heart Function
  - Irregular Heart Beat
  - Irregular Heart Beat
  - Weak Signal of Heart

- **Meaning**
Ventilation

• Measured by End-Tidal CO$_2$
  • Partial pressure (mmHg) or volume (% vol.) of CO$_2$ in the airway at the end of exhalation
  • Breath-to-breath measurement provides information within **seconds**
  • Not affected by motion artifact, poor perfusion or dysrhythmias
Capnography Waveforms

[Graph showing different waveforms labeled A, B, and C]
Oxygenation and Ventilation

- **Oxygenation**
  - Oxygen for metabolism
  - SpO$_2$ measures % of O$_2$ in RBC
  - Reflects change in oxygenation within 5 minutes

- **Ventilation**
  - Carbon dioxide from metabolism
  - EtCO$_2$ measures exhaled CO$_2$ at the point of exit
  - Reflects change in ventilation within 10 seconds
Don’t believe me about the time

• Try this:
  • Turn on the monitor and put an EtCO$_2$ filter line on and the SpO$_2$ sensor
  • Now hold your breath
• You will see that the capnography will show apnea almost immediately
• The SpO$_2$ will continue to show a high saturation
  • Because it does not register for several minutes
Pre-Hospital Use of Capnography
Utilizing Capnography

• Immediate information via breath-to-breath monitoring
• Information on the ABCs
  • Airway
  • Breathing
  • Circulation
• Documentation purposes
Capnography Uses - Airway

- Airway
  - Verification of ET tube placement
  - Continuous monitoring of ET tube position
Capnography Uses - Breathing

- Breathing
  - Hyperventilation
  - Hypoventilation
  - Asthma
  - COPD
Capnography Uses - Circulation

- Circulation
  - Checking the effectiveness of compressions during cardiac arrest
  - First indicator of ROSC
  - Monitors low perfusion states
As with all documentation, capnography can be utilized as legal evidence pertaining to the care that a patient received during a call.

The following are examples of the information that capnography provides:

- Baseline capnography assessments
- Waveform appearance
- Changes in the waveform with treatment (TRENDING)
- EtCO₂ values
  - Documenting the actual numbers shown on the monitor – how they change during transport
Capnography and Intubated Patients

- Verifies and documents ET tube placement
- Immediately detects changes in ET tube position
- Assesses effectiveness of chest compressions
- Earliest indication of ROSC
- Indicator of probability of successful resuscitation
- Allows crews to adjust manual ventilations in accordance with the patient’s needs
Research and capnography

A 2005 study compared field intubations that used capnography to confirm ETT placement vs. intubations that did not use capnography to confirm placement. The study showed:

- That 0% of intubations went unrecognized if misplaced when ETCO₂ monitoring was used.
- 23% went unrecognized in the non-EtCO₂ monitored group.

That’s why we confirm intubations with waveform capnography.

Capnography and Non-Intubated Patients

- Assists in the assessment of acute respiratory disorders
  - Asthma
  - COPD
  - Among many others
- Helps in determining a patient’s response to our treatment(s)
- Contributes in the formation of a field diagnosis
Hypoventilating Non-intubated Patients

- Capnography can estimate the severity of the condition that leads to hypoventilation
  - Stroke
  - Head injury
  - ETOH intoxication
  - Drug overdose
  - DKA patients
  - Congestive heart failure
  - Analgesia and sedation medications
- Great for assessing perfusion status of these patients
End-tidal CO$_2$ (EtCO$_2$)

- Reflects changes in
  - **Ventilation** - movement of air in and out of the lungs
  - **Diffusion** - exchange of gases between the air-filled alveoli and the pulmonary circulation
  - **Perfusion** - circulation of blood
What’s occurring in the Lungs

Pulmonary Blood Flow
The Right Ventricle of the Heart pumps blood into the Pulmonary Artery.

- Remember the Pulmonary Artery (P.A.) is the only artery that carries deoxygenated blood.

- When in the lungs, the blood will dump CO\(_2\) off where it will be diffused into the alveoli.

- In return, the alveoli will push O\(_2\) into the blood, oxygenating the blood.

- The Pulmonary Vein (P.V.), the only vein that carries oxygenated blood, then takes the newly oxygenated blood back into the heart, specifically into the Left Atrium.

Look at the diagram again.
How CO₂ gets to the Alveoli

See how the pulmonary artery dumps CO₂ off

Deoxygenated blood

Perfusion

Oxygenated blood

Pulmonary Blood Flow
Oxygenated blood

The pulmonary vein then picks up oxygen from the alveoli and carries it back to the heart.
Now carbon dioxide ($\text{CO}_2$) is exhaled and we capture it via the capnography filter line.
Changes in EtCO$_2$ Levels
Why $\text{ETCO}_2$ levels decrease

- Decreased cardiac output
  - Cardiac arrest
  - Pulmonary embolism
- Bronchospasm
- Decreased muscular activity
- Hypothermia
Why $\text{ETCO}_2$ levels increase

- Increased cardiac output
  - Good compressions during cardiac arrest
- Increased muscular activity
  - Shivering
- Effective therapy for bronchospasms
Anatomy of a waveform

- The height shows the amount of carbon dioxide exhaled.
- The length shows the time.
- This represents the normal waveform of “one” respiratory cycle.
Waveform breakdown

Phase 1

- Baseline of waveform
- Initial upstroke of the waveform
- Represents exhaled gas from upper airways
  - a.k.a. anatomical dead space

Exhalation begins many reverse this and believes that it begins inhalation, it does not
PHASE 1
“Dead Space” Ventilation

- Begins exhalation
- CO₂ is absent
- Air is coming from the mouth, nose, and pharynx
  - Gas exchange does not occur here

Dead space area is shaded orange
Define Dead Space

- Ventilated areas that do not take part in the exchanging of gases:
  - Airways leading to the alveoli
  - Ventilated areas in the lungs without blood flow
Waveform breakdown

Phase 2

- Transitions from upper to lower airway ventilation
- Shows changes in the perfusion status of a patient

$\text{CO}_2$ present and increasing in exhaled air
PHASE 2
Ascending Phase

- $\text{CO}_2$ from the alveoli reaches the upper airway and mixes with the dead space air
  - Why you see a rise in $\text{CO}_2$
  - $\text{CO}_2$ is now detectable in exhaled air via capnography
Waveform breakdown

Phase 3

- Shows alveolar gas exchange
  - Indicates changes in gas distribution
- Increases in this slope indicates problems with distribution of gas delivery

CO₂ exhalation - the wave plateaus
Phase 3
Alveolar Plateau

- CO$_2$ now makes up the majority of the exhaled air
- The concentration of the CO$_2$ remains fairly constant from alveoli to the nose/mouth at this phase
PHASE 3
END-TIDAL

- The end of exhalation contains the highest concentration of CO₂
  - “End-Tidal CO₂”

The star marks the end of the wave of exhalation
Waveform breakdown

Phase 4

- Beginning of inhalation
- CO$_2$ levels drop to baseline (zero)
- Oxygen is now in the airway

Descending Phase Inhalation

Inspiratory down stroke returns to zero or “baseline”
What is the normal range for a capnography waveform?
Normal range = 35 - 45mmHg
ABNORMAL VALUES

- ETCO$_2$ less than 35 mmHg
  - Hyperventilation / Hypocapnia
    - Hypocapnia – low CO$_2$

- ETCO$_2$ greater than 45 mmHg
  - Hypoventilation / Hypercapnia
    - Hypercapnia – high CO$_2$
Question

• How would your waveform change if you intentionally started to breathe at a rate of 40?
  • Frequency of waveforms
  • Duration of waveforms
  • Height of waveforms
Hyperventilation

1) Note how the respirations increase – seen in the increased number of waves in the bottom capnogram, the duration of each wave is also shorter.

2) Notice how the pink waves are under the 45mmHg line – this shows that the ETCO$_2$ levels have dropped (the patient is blowing CO$_2$ off).
Hyperventilation Waveform

- Indicates CO$_2$ deficiency
  - Hyperventilation
  - Decreased pulmonary perfusion
  - Hypothermia
  - Decreased metabolism

- Interventions
  - Adjust ventilation rate
  - Evaluate for adequate sedation
  - Evaluate anxiety
  - Conserve body heat

Regular Shape, Plateau Below Normal
Question

• How would your waveform change if you intentionally decreased your respiratory rate to 10?
  • Frequency
  • Duration
  • Height
Hypoventilation

1) Note how the respirations decrease – seen in the decreased number of waves in the bottom capnogram, the duration of each wave is also longer.

2) Notice how the **green** waves are over the 45mmHg line – this shows that the ETCO$_2$ levels have increased (the patient is retaining CO$_2$).
Hypoventilation Waveform

- Indicates increase in ETCO$_2$
  - Hypoventilation
  - Respiratory depressant drugs
  - Increased metabolism

- Interventions
  - Adjust ventilation rate
  - Decrease respiratory depressant drug dosages
  - Maintain normal body temperature

Regular Shape, Plateau Above Normal
Waveform patterns

Normal

Hyperventilation

Hypoventilation
What is happening here?
Bronchospasm Waveform

- Bronchospasm restrict proper ventilation
  - Alveoli unevenly fill during inspiration
  - They also empty unevenly during expiration
  - Uneven air flow during exhalation dilutes exhaled CO₂

- This alters the ascending phase and plateau
  - Slower rise in CO₂ concentration
  - Characteristic pattern for bronchospasm
  - “Shark Fin” shape to waveform
Capnography waveforms

- Normal
- Hyperventilation
- Hypoventilation
- Bronchospasm
Capnography and Advanced Airways

“In-line capnography”
Confirmation of the tube

- Utilized to confirm that your tube is in place
- Remember improper placement of the tube will result in the “lack” of a waveform
- This tube is confirmed!
Med-Legal

- Capnography provides
  - Documentation of correct placement
  - Ongoing documentation over time through the trending printout
  - Documentation of correct position at ED arrival
Dislodgement of tube

- Tube dislodgment is immediately detected when a waveform drops suddenly.
- Initially this tube was confirmed, then displaced.
Detect ET Tube Displacement

- This is only provided through the use of capnography
  - A continuous numerical value of EtCO₂ with apnea alarm after 30 seconds (if you have the alarm set) and
  - A continuous graphic waveform for immediate visual recognition

Can Capnography Assist With CPR?
Absolutely!

- Determination of how effective your chest compressions are

- Helps to show early detection of ROSC

- Provides data for the decision to cease resuscitation
  - i.e. the EtCO$_2$ reading remains under 10mmHg for over 20 minutes of working a code
Capnography and CPR Assessment

- When a patient is in cardiac arrest, remember the EtCO$_2$ is going to be low – the patient is not perfusing enough therefore gas exchange is not occurring appropriately.
- In cardiac arrest we are hoping to keep the EtCO$_2$ around 10 to 15mmHg. Without a number this high the chances of getting ROSC are very low.
- You can increase the EtCO$_2$ by providing better compressions (thus providing better perfusion to the alveoli) during CPR.

How does providing better compressions help to raise EtCO$_2$ numbers?
• Better compressions simply means we are moving blood better
• A patient in cardiac arrest is not circulating blood to the lungs and therefore limits the amount of CO₂ being diffused into the alveoli
• When you provide quality compressions it increases the movement of blood to the lungs where CO₂ can diffuse into the alveoli and O₂ can diffuse into the pulmonary vein
• If you notice your capnogram wave is low during the next code, just compress harder and faster and watch the boxes increase in height
In 1978

A scientist, Kalenda,

“reported a decrease in ETCO$_2$ as the person performing CPR fatigued, followed by an increase in ETCO$_2$ as a new rescuer took over, presumably providing better chest compressions.”
Another study suggests

- Reductions in ETCO$_2$ during CPR are associated with comparable reductions in cardiac output....The extent to which resuscitation maneuvers, especially precordial compression, maintain cardiac output may be more readily assessed by measurements of ETCO$_2$ than palpation of arterial pulses.”

Yeah it’s old but it still applies today!

-Max Weil, M.D., Cardiac Output and End-Tidal carbon dioxide, *Critical Care Medicine*, November 1985
New Guidelines

- With the new American Heart Association Guidelines calling for quality compressions ("push hard, push fast, push deep"), rescuers should switch places every two minutes.
- You should be setting the monitor up so the compressors can view the ETCO$_2$ readings as well as the EKG waveform generated by their compressions.
- We encourage you to keep the ETCO$_2$ number up as high as possible during CPR.
What is this a sign of?
This capnogram is a sign that your patient has just had a return of spontaneous circulation (ROSC)

Note how high the wave is – why does it look this way?
Retention of CO$_2$

- The wave is large because the patient in cardiac arrest has been retaining CO$_2$.
- When ROSC is achieved the patient, whose heart is now working, is able to perfuse better getting rid of the retained CO$_2$.
- This exhalation of retained CO$_2$ is what gives the box such a high appearance.
- Remember the box is a representation of an actual figure. In this case the EtCO$_2$ number is about 60mmHg.
ROSC and ETCO$_2$

- Survived to discharge from hospital
  - Average EtCO$_2$: 30mmHg

- Non-survivor
  - Average EtCO$_2$: 4-10mmHg
INCREASED INTRACRANIAL PRESSURE (ICP) AND CAPNOGRAPHY
ICP and EtCO$_2$ Levels

- Capnography should also be utilized in patients with ICP issues
- The following ICP patients are very sensitive to fluctuations in EtCO$_2$ levels:
  - Stroke patients (possible bleeds)
  - Trauma to the head
  - Neoplasms (brain tumors)
  - Brain infections
Question

What do you think will occur to cerebral vasculature if the patient has high CO$_2$ levels?
Cerebral Vasodilation

- High CO\textsubscript{2} levels cause cerebral vasodilatation
  - **The Good**: It increases cerebral blood flow (CBF) to counter cerebral hypoxia
  - **The Bad**: Increased CBF increases ICP and may increase brain edema
What do you think will occur to cerebral vasculature if the patient has low CO$_2$ levels?
Cerebral Vasoconstriction

- Low CO\(_2\) levels lead to cerebral vasoconstriction
  - **The Good**: It lowers CO\(_2\) levels that can cause mild cerebral vasoconstriction which may decrease ICP
  - **The Bad**: Although low CO\(_2\) levels decrease ICP it may cause or increase cerebral hypoxia
Pearls

- Hypoventilation increases CO$_2$ levels
  - Not blowing off the CO$_2$
  - Results in cerebral vasodilation

- Hyperventilation decreases CO$_2$ levels
  - Blowing off too much CO$_2$
  - Results in cerebral vasoconstriction
Treatment Goals

• Avoid cerebral hypoxia
  • Maintain adequate cerebral blood flow
  • Monitor oxygen saturation with pulse oximetry
• Utilize the capnography in conjunction with pulse oximetry
  • Your target should be an EtCO₂ of 35mmHg
Warning when hyperventilating patients

- “Recent evidence suggests hyperventilation leads to ischemia almost immediately...current models of both ischemic and Traumatic Brain Injury (TBI) suggest an immediate period during which the brain is especially vulnerable to secondary insults. This underscores the importance of avoiding hyperventilation in the pre-hospital environment.”

The Dyspnea Patient
Other Patients Needing CO$_2$ Monitoring

- COPD
  - Emphysema
  - Chronic Bronchitis
- Asthma
- CHF/Pulmonary Edema
- Pneumonia
- Possible Pulmonary Embolism
- Cardiac Ischemia
Why you should use capnography for these patients

- To assess and trend your patients’
  - Low-perfusion status
  - Hyperventilation status
  - Hypoventilation status
- To identify changes in capnography waveforms
  - i.e. bronchospasms in COPD and Asthma patients
Capnography and Bronchospasms

- Produces changes in ascending phase (2) with loss of the sharp upslope.
- Alters alveolar plateau (3) producing a “shark fin”
Normal vs. Asthma

What you should see after treatment

Prior to therapy

After therapy
In COPD patients the PaCO$_2$ or the partial pressure of carbon dioxide in the arterial blood INCREASES.

This is the waveform that you will probably see.

Notice how the ascending phase and plateau look abnormal.

This is because there is an uneven emptying of gases.

Do you see the COPD patient is retaining CO$_2$?
Scenario

- 70 year old female
- C.C.: Dyspnea, with moderate chest pain
- History: MI, CABG X 3, on oxygen at 2 l/m
- Pulse 60, BP 144/70, RR 38 labored and shallow, skin cool and diaphoretic, some pedal edema
- Initial SpO₂ 79%; EtCO₂ 20mmHG
You….

- Place the patient on NRB M 15L (100% O₂)
- Administer 1 inch nitro paste
- During transport you trend her vitals, this is what you see:
  - SpO₂ 99%
  - EtCO₂ 35mmHg

In order to see documented improvement in your patients you must TREND!
Pulmonary Embolism and Capnography
Ventilation/Perfusion Mismatch (V/Q Mismatch)

• This is when the amount of ventilation or perfusion is altered

• In pulmonary embolism patients there is a decrease in perfusion when compared to ventilation

• This increases deadspace
  • Remember deadspace is the parts of the airway that are unable to take part in gas exchange due to the lack of perfusion
INCREASEDDEADSPACE

- P.E. patients therefore show a reduction in exhaled CO$_2$ on your capnography due to the increased deadspace.

The green line represents the normal level of CO$_2$. See how this PE patient is way under it?

Low EtCO$_2$ due to increased deadspace.
Why use capnography in P.E.

- We should utilize capnography in these patients because it can assist us in forming a field diagnosis.
- Most of us know what to look for in these patients. Give me some examples of how P.E. patients present.
Presentation of pulmonary embolism patients

- Sudden dyspnea
- Tachycardia
- RR > 20
- Chest pain
- Hypoxia
- Anxiety

- Feeling of doom
- Hemoptysis
- Syncope
- And if you were paying attention
  - A sudden decrease in $\text{EtCO}_2$
Scenario

- 25 year old female
- C.C. – shortness of breath and sharp pain in chest
- History: healthy no issues
- Meds: Chantix (smoking cessation), Yasmin (birth control)
- Sound like a possible P.E. candidate? YUP!
Patient begins to hyperventililate

- You place her on capnography and see this

- Without warning you see a marked decrease in EtCO2 and patient mental status
So what caused the drop in $\text{EtCO}_2$

- Typically hyperventilation alone does not cause a sudden rapid drop in $\text{EtCO}_2$
- Pulmonary Embolisms however DO!
- Remember a P.E. will increase the deadspace of the lung
- The increased deadspace will produce a decrease in exhaled $\text{CO}_2$
- Now put the P.E. signs and symptoms together with the $\text{EtCO}_2$ information and you have just made an excellent field diagnosis

Having the tools are nice, but knowing when to use them is key!
Using Capnography for Hypoventilatory States
First of all, think of some differential diagnosis that can cause a patient’s breathing to be slow
Differentials

- Patients with altered mental status
  - Head injury
  - CVA
  - Drug overdose
  - Heavily sedated
  - ETOH
  - Sepsis/Infection (specifically CNS in nature)
Which of these is a patient hypoventilating?
In this case the patient is retaining too much CO₂
Note: the EtCO₂ is above 45mmHg
What is this patient doing
Hint: he is still hypoventilating

This patient is actually breathing very shallow which causes most of the waveforms to be small and uneven.

However when the patient lets out a larger exhale you note the height increase of one of the boxes. This shows he was breathing shallow then exhaled a high amount of retained CO$_2$
WHAT IS OCCURRING HERE?

You are called to a nursing home. As you approach your patient you note that the patient is on an O₂ mask and lying semi fowlers (his chin is nearly touching his chest)

You place him on capnography and this is what you see.....

Tell me what is going on based on this waveform?

Observe this one carefully, something is not right
• Note that the baseline is elevated

• This is a situation that many patients experience and we often don’t recognize

• Patient “Rebreathing”

The baseline never comes back to zero because of the poor positioning of the patient. Also because he is wearing a mask that allows him to “rebreath” his own CO₂

He is not clearing the dead space that would allow a return to “0”
DKA PATIENTS
What is occurring in DKA

- Diabetic Ketoacidosis (DKA)
- The issue with a Insulin Dependent Diabetic Mellitus (IDDM) and some Non-Insulin Dependent Diabetic Mellitus (NIDDM) patients is that they do not have insulin available to breakdown glucose (a.k.a. sugar) for energy creation
- Instead the IDDM (type 1) diabetic and in some case NIDDM (type 2) patients will sometimes have no choice but to utilize fat stores for energy production (termed Gluconeogenesis)
Fat for energy

- When fat stores are used for energy, acids called Ketones begin to build up in the blood and urine
  - Ketones become toxic in high levels – this is what we call ketoacidosis
  - In many cases people find out that they have diabetes because they initially had a DKA experience
  - These are the patients with very high blood sugar levels and whose breath smells sweet or some say like acetone
Buffering

• Eventually the body turns to the bicarbonate buffering system in order to balance the acid build up
  • bicarbonate is a base that opposes acid, decreasing acid levels
  • The problem is this system is quickly overwhelmed and other mechanisms must work to compensate for the acidosis
• So what does the body do?
  • It triggers hyperventilation to lower the blood CO$_2$ levels
So how do DKA patients breathe?

• Remember what is occurring in these patients
  • Ketones are building up (causing acidosis)
  • This means that there is a high level of CO$_2$ in the blood
  • Therefore what type of waveform will you see?
DKA and Capnography

- When patients are in (DKA) the body attempts to correct acidosis.
- High levels of CO$_2$ in the body creates an acidic environment.

In this waveform you are seeing a patient whose body is attempting to correct the acidosis.

Note how the EtCO$_2$ is above 45mmHg showing an acidic state.

This is why a patient breathes fast in DKA – initially, they are trying to blow off the CO$_2$ and therefore lessen the acidosis that may kill them.

Be sure to utilize end-tidal with suspected DKA patients.
However!

• Just like in the case of fast heart rates, a patient breathing this fast cannot keep it up, so what occurs?
• The patient begins a pattern of labored and deep breathing
• Remember in metabolic acidosis (in this case DKA) breathing is first rapid and shallow

BUT...

• As acidosis worsens breathing becomes deep, labored and gasping (Kussmaul respirations)
Shock Patients
Perfusing warning!

- Capnography can provide an early warning sign of shock.
- A patient with a sudden drop in cardiac output will show a drop in ETCO$_2$ numbers that may be regardless of any change in breathing.
- This has implications for trauma patients, cardiac patients – any patient at risk for shock.
Another Pig Study

- 5 pigs had hemorrhagic shock induced by bleeding, 5 pigs had septic shock induced by infusion of e-coli, and 6 pigs had cardiogenic shock induced by repeated episodes of v-fib. The pigs' cardiac output was continuously measured as well as their PETCO$_2$. 
Results

• “A patient with low cardiac output caused by cardiogenic shock or hypovolemia resulting from hemorrhage won’t carry as much CO$_2$ per minute back to the lungs to be exhaled
  • Therefore this patient’s ETCO$_2$ will be reduced
  • This doesn’t necessarily mean the patient is hyperventilating or that their arterial CO$_2$ level will be reduced. Reduced perfusion to the lungs alone causes this phenomenon. The patient’s lung function may be perfectly normal

When to use capnography

- Capnography is not cheap yet the benefits for the medic and the patient outweigh the cost.
- However, we still want to be selective when utilizing the filter lines.
Utilize capnography for these patients

- STEMIs
- Cardiac arrest
- Respiratory patients
- Patients on sedation and analgesic meds
- Altered mental states
- CNS infections
- Sepsis
- Drug/ETOH intoxication
- Hyperglycemia
  - DKA
- Patients with potential increased ICP issues
Capnography is just another tool in your arsenal of equipment that can be utilized to further confirm your field diagnosis. Remember that the your “field diagnosis” assists to lead you in your treatments.

As stated previously the placement of EtCO$_2$ filter lines are not intended for every patient. Instead it should be used only for those patients who can benefit from it’s information. If utilized please trend your findings after every treatment and document accordingly.

*Thank you for you attention!*
Post-Test

Please complete the post test and return to administration via interoffice mail or fax to: 352-735-4475 attention Scott Temple

This program is worth 3 CEUs in the Airway, Medical, Operations, or Electives categories

Please specify on your post test where you would like the CEUs to be inserted.
References


• Max Weil, M.D., Cardiac Output and End-Tidal carbon dioxide, *Critical Care*
