What can it do for my patient?
Why you need it more than they do!
Is this what you use?
Have you ever read the package insert?

Dear Past, thank you for all the lessons.

Dear Future, I am ready.
Don’t Cry, We’re Here To Help
What is ETCO2?

• It is CELL POOP!!
• It’s a WASTE product!!
• Your body MUST have the ability to get rid of it or bad things can happen!!
Terminology

- **Capnometry**
  - Measurement of CO$_2$ in the airway during respiration

- **Capnography**
  - Graphic display of this measurement over time
Devices

- Sidestream
- Mainstream
- Colorimetric
The Beginning of ETCO2

• Where did it get its beginning?
• Why is this important?
  • DKA
  • Tension Pneumothorax
  • ARDS
• Many Other Conditions
**Question**

- Try this on yourself
  - SPO2 and ETCO2
  - Hold your breath for at least 30 seconds
- Which parameter tells you first about the apnea?
Normal Ranges

- What is the normal range for ETCO2?
Question

- Is 30 seconds important?
- If a patient has been hyperoxygenated how long can it take them to desaturate?
  - What happens to O2 sat and ETCO2 when a patient goes into PEA?
Could it be PEA?
ETCO2

- ETCO2 levels have a strong correlation with cardiac output.
  - As cardiac output decreases during cardiopulmonary arrest, pulmonary blood flow diminishes, CO2 available for exhalation is decreased, and ETCO2 levels drop.
Uses for ETCO2

- Verification of ETT placement/displacement
- ETT surveillance during transport
  - In Hospital
  - Out of Hospital

predictor
Uses for ETCO2

- Diagnosis of specific medical conditions
  - Like what?
- Guide treatment decisions
- CPR: adequate compressions, survival predictor
Uses for ETCO2

- Asthma attacks
  - Early/late
  - Compensating/unable to compensate
- Ventilator changes
- PE-pulmonary embolus
- Head Injuries
- Hypercarbia/Lethargy
Uses for ETCO2

- Bronchospasm
  - COPD
  - Anaphylaxis
- Hypoventilation
  - Drugs, stroke, CHF, post-ictal
  - Shock & circulatory compromise
- Hyperventilation syndrome
- Pre-arrest tool
How to interpret a waveform

Zero baseline (A-B)
Rapid, sharp rise (B-C)
Alveolar plateau (C-D)
End tidal value (D)
Rapid, sharp downstroke (D-E)
How to interpret a waveform

- 4 QUESTIONS to ASK EVERY TIME CAPNOGRAPHY IS USED
  - IS THERE RISE AND FALL OF THE WAVEFORM?
  - WHAT IS THE VALUE?
  - WHAT IS THE SHAPE?
  - DOES IT RETURN TO BASELINE?
5 Reasons for a Flat Line

- ET Tube displaced
- ET tube is plugged/kinked
- Cardiac arrest
- Patient has quit breathing/not being ventilated
- Equipment malfunction
Is the ET tube correctly placed?

- How long does it take to get a CXR?
- Is it still vital to listen to breath sounds if you use ETCO2?
- Can you be confident in using the colorimetric device?
- What will happen to ETCO2 if the ET tube is in the right mainstem bronchus?
Mask Ventilation Pushes Alveolar Gas into the Esophagus and Stomach
Normal
Hyperventilation

Will patients who hyperventilate ALWAYS have a lower than normal ETCO2?
Hyperventilation

• Question
  - If a patient is breathing fast but their ETCO2 is normal or high are you concerned?

Remember TV
Hypoventilation

Will all patients who hypoventilate ALWAYS have a higher than normal ETCO2? (DO and metabolism)
Hypoventilation

• If you have a patient who is a drug overdose and breathing 6 times a minute does that mean they need to be intubated immediately if they do not respond to Narcan?

• Their ETCO2 is 40 and O2 sat is 97%
Loss of Alveolar Plateau
Apnea - Loss of Waveform

What else can cause loss of waveform?
Esophageal Intubation

Why do you show some ETCO2 with esophageal intubation?
Elevated Baseline

What is causing this and how can you correct this? Is it dangerous? How?
Curare Cleft

HUH?
COPD or Bronchospasm or airway obstruction - tube kinking or blockage

Note the shape of the waveform
Angled, sloping down stroke on waveform
Adult: Tube is too small
Pediatric: Tube is too small
Management: Assess patient, oxygenation, ventilation; may need to reintubate

Name 2 other conditions where there is resistance to bagging the patient
Patient Connections

15 mm Connector

Airway tube

Inflation line

Inflation Pilot Balloon

Valve

Aperture Bars

Cuff

No LATEX
Before and After Treatment

ET CO2 = 43

Before

ET CO2 = 67

After
Possible Causes
What Would You Do For This Patient?

[Diagram showing EtCO2 levels over time]
What would you do?

- 85 year old female brought to the ER by EMS
- She appears restless and it trying to get out of bed
- The Nurse receives orders to administer Ativan 2 mg IV for agitation
Question

- If a patient presents with agitation and restlessness is it likely due to hypoxia or hypercarbia (an elevated ETCO2)?
- If a patient presents with lethargy is it likely due to hypoxia or hypercarbia (an elevated ETCO2)?
Would You Give A Breathing Treatment?

- 52 year old male presents to you with SOB and a decreased O2 saturation of 85%
- He is breathing 30 times a minute
  - Rales are audible in the right posterior base
  - He has a temperature of 100.4
- Possible diagnosis
- Treatment?
Patients with Seizures

- In seizing patients a low ETCO2 indicates inadequate respirations and they should be managed aggressively.
- A normal waveform in normal ETCO2 range calls for less aggressive interventions but close monitoring which can be done with ETCO2.
Question 1

1. The normal value of end tidal CO2:
   a. Below 30 mmHg
   b. Above 50 mmHg
   c. Between 35-45 mmHg
   d. 120/80 mmHg
While treating a 56 yo male in cardiac arrest you notice that the end tidal CO2 levels are decreasing below 20 mmHg, what should you do?

A. Make sure the chest compressions are at least 100 per minute
B. Make sure chest compressions are at least 2 inches
C. Change out the person performing chest compressions
D. All of the above
You are treating a 26 yo female for shortness of breath. You are unable to hear bilateral breath sounds and place the patient on ETCO2. You observe this waveform. Which treatment would be most appropriate?

A. Hyperventilate the patient
B. Administer Albuterol
C. Administer Narcan
D. Do nothing, the waveform is normal

What other drug could be warranted if they do not improve and why?
After successfully performing a drug assisted intubation you note the following waveform. What actions would you do to correct what you see?

a. Increase ventilation rate to decrease ETCO2 levels
b. Administer a bronchodilators or perform tracheal suctioning
c. Decrease ventilation rate to increase ETCO2 levels
d. Do nothing, this is normal.
After intubating a patient you see the following waveform, what does this tell you about the tube placement?

a. Placement in the trachea
b. Esophageal placement
c. Hypoventilation
d. Hyperventilation
After intubating a patient you see the following waveform, what does this tell you about the tube placement?

- Placement in the trachea
- Esophageal placement
- Hypoventilation
- Hyperventilation

Does the patient have a pulse?
- **Increased ETCO2**
  - Fever
  - Sepsis
  - Malignant Hyperthermia
  - Bicarb Bolus
  - Increased cardiac Output
  - Restoration of pulse in cardiac arrest
  - COPD
  - Respiratory Failure

- **Decreased ETCO2**
  - Decreased Cardiac Output
  - Cardiac Arrest
  - Hypothermia
  - Hyperventilation
  - Hypometabolic States
  - Hypotension
  - Decreased Cardiac Output
  - Esophageal Intubation
Capnograms

Time
Intubation

- An ETCO2 waveform corresponding to administered ventilations is considered to be a definitive sign of proper placement.
- It should be combined with positive breath sounds and absent gastric sounds.
- Can ETCO2 tell you if you have a right mainstem intubation?
- How?
Is the ET tube in or not?

- 55 year old cardiac arrest patient
- Medic tells you to stop compressions while they intubate
- Once intubated you get the waveform below
CPR and ROSC

- During CPR a steady decrease in ETCO2 and waveform size may be the result of CPR responder fatigue.
- Maintaining and monitoring high levels of ETCO2 during CPR is a great real-time feedback mechanism for providers doing compressions.
- A sudden dramatic increase in ETCO2 is a strong indicator that pulses have been regained.
- ETCO2 less than 20 mmHg throughout the...
Metabolic Conditions

- Low ETCO2 (less than 29 mmHg) in the absence of respiratory abnormalities is a sign of metabolic acidosis
- A 2002 study showed that 95% of diabetic children entering the ER with an ETCO2 reading less than 29 mmHg were in ketoacidosis
Metabolic Conditions

- Carbon Monoxide poisoning at high levels will produce metabolic acidosis resulting in low ETCO2 readings
- Hypothermia can result in a decreased production of CO2 resulting in low reading
- Hyperthermia can result in increased oxygen consumption and resulting hypercarbia - increased ETCO2
In head injuries use capnography to avoid hyperventilation and hypoventilation by maintaining ETCO2 between 32-35 mmHg.

Tell me why.

Define Cushing’s Triad.

What should you target your ETCO2 at in this situation and why?
Causing Harm to a Patient

“Recent evidence suggests hyperventilation leads to ischemia almost immediately.

Current models of both ischemic and TBI suggest an immediate period during which the brain is especially vulnerable to secondary insults.

This underscores the importance of avoiding hyperventilation in the prehospital/hospital environment.”
Causing Harm to a Patient

• “In a study of 291 intubated head injured patients, 144 had ETCO2 monitoring
• Patients with ETCO2 monitoring had lower incidence of inadvertant severe hyperventilation (5.6%) than those without ETCO2 monitoring (13.4%)
• Patients in both groups with severe hyperventilation had significantly higher mortality (56%) than those without (30%)
Breath Sounds

- Tell me about abnormal breath sounds
  - Name 3
  - Where do you hear them?
  - What do they sound like?
  - What causes the noise you are hearing?
  - How will you treat?
    - Will they all get a breathing treatment?
Case Study 1

• A 62 year old female arrives in you ER complaining of not feeling well for the past 3-5 days and SOB, worsening over the past hour

• You listen to her breath sounds and hear crackles in the right posterior base of her lung, left side is clear
Case Study 1

- BP 150/80
- HR 100
- RR 24 and moderately labored
- O₂ Sat 82%
- PMH is for an MI 3 years ago and elevated cholesterol
- What will you do for this patient’s airway?
Case Study 1

- What could be some possible causes?
Case Study 1

- Would she benefit from ETCO₂?
- Did you consider CPAP?
- Does she need a diuretic?
- Does she need a breathing treatment?
Case Study 1

• Things to think about
  - Paramedics and EMT’s must attempt to make “differential diagnoses” in the field
  - Otherwise, how will they treat the patient?
  - How would they know if this patient is CHF, COPD, asthma, anaphylaxis/pneumonia, pulmonary edema.....
    • Treatment varies
  - They do not have the luxury of getting a chest Xray, labs, ABG’s, respiratory, a physician at bedside......
Scenario 2

- You receive a patient in the ER who has been involved in a meth lab explosion
- Upon arrival to the ER you find a 30 year old male conscious and alert with 2\textsuperscript{nd} and 3\textsuperscript{rd} degree burns on his chest and abdomen
- 1\textsuperscript{st} degree burns on his neck
- He was entrapped in the house for several minutes and on scene time to the hospital was 45 minutes
- Vitals
  - Respiratory rate is 24 and shallow
  - B/P is 150/86
  - Pulse is 112
  - O2 sat is 95% on 4 liters NC
Scenario 2

• The patient states he’s starting to have trouble breathing and chest tightness
• What treatment does this patient need?
• What are you going to do for him?
Scenario 2 after Intubation
Scenario 2

• Should we have intubated this patient initially?

• What did this patient need?
Case # 3

- 42 year old male patient involved in an ATV accident who is unconscious and unresponsive
- Respiratory rate 12
- B/P 150/90
- Pulse 110

He has an obvious depression to the left side of his head
Case # 3

- Remember, what is C02?
- Is it a Vasodilator or Vasoconstrictor?
- What do we want his ETCO₂ to be and why?
- His respiratory rate is 12
  - Is this adequate?
  - How will you make the determination?
Case # 3

- Remember ETC02 is usually 2-5 less than PaC02
- Neurologists want head Injuries to be on the low end of normal 35-38
- So ETC02 should be 32-35
Case # 3

• You re-evaluate your patient
  - B/P  190/130
  - Pulse 44
  - Respirations 20 but a very irregular pattern

• What are these signs and symptoms of?
Case # 3

- Cushings Triad or herniation
  In this patient neurologists would like the PaCO2 to be 32 - 35
- So where would we want the ETCO2 to be?
  - 28-31
- Why is the patient bradycardic?
Case # 3

- Which one is worse?
  - Decorticate
  - Decerebrate
Scenario # 4

- A 50 year old female arrives by POV to your ER with difficulty breathing
- The patient is in obvious distress, using accessory muscles
- $O_2$ sat is 82%
- The patient cannot provide you with any history due to the severe respiratory distress
- What are some possible causes and how will you treat this patient?
Scenario # 4

• Possible causes?
Scenario # 4

• You notice a medical alert bracelet and it states the patient has a history of Asthma
Scenario # 4

- Vitals:
  - BP  180/90
  - HR  110
  - RR  30
  - O2 Sat  82%

- Would this patient benefit from ETCO2 monitoring?
Scenario # 4

- ETCO$_2$ is 30
- Is this concerning to you?
- Is this what you expected?
  - Would you expect the ETCO2 to be high or low and why?
  - Is this patient compensating?
    - How would you know?
Scenario # 4

• Would you be more concerned if the ETCO2 was high or low on this patient and why?
Scenario # 4

• What would your treatment consist of for this patient with Asthma in severe respiratory distress?
Scenario # 4

- Albuterol/Atrovent
- How beneficial would a breathing treatment be for a patient in severe respiratory distress breathing 30 times a minute?
- Epinephrine
  - Why?
  - How?
Scenario # 4

- Treatment
  - Did you consider CPAP?
  - Why or why not?
  - Would it be a first line treatment?
    - Why or why not?
  - Would CPAP be beneficial in administering a breathing treatment?
    - Why or why not?
Scenario # 5

- You are treating a patient in the ER who suffered a GSW to the abdomen. Anesthesia intubates the patient successfully and the ETCO2 is 38
- 30 minutes later as you are packaging the patient for the OR you notice the ETCO2 is 50
- The patient is intubated and his rate is 12 and has not changed. He is chemically paralyzed
- His BP remains unchanged but his heart rate has increased from 100 to 120
Scenario # 5

- Thoughts?
- Possible causes?
Scenario # 5

• Hyperthermia - Metabolism is on overdrive in fever, which may cause ETCO2 to rise

• Observing this phenomena can be life-saving in patients with malignant hyperthermia, a rare side effect of RSI (Rapid Sequence Induction)

• Which drug is the culprit?
Question

• Why would we be concerned if we transported a patient to your ER with CHF and moderate to severe respiratory distress on CPAP and you took them off of it on our arrival and placed them on a NRB or a nasal cannula?
Question

• A patient in your ER cardiac arrests and the ER physician intubates the patient and you resume chest compressions

• Your ETCO2 is below
How to save your
Time and date stamped indicating time care turned over to hospital

Square waveform indicating correct tracheal placement
To all of the brave EMS/Fire and nursing staff who are walking this path of culture change with us...

Thank You.