Using Capnography to Establish Endpoints of Resuscitation

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Tuesday: EXED219, Wednesday EXED219A

Objectives

- Review the concepts of Capnography monitoring in cardiac arrest
- Discuss methods of utilizing Capnography to assess perfusion
- Describe the role of Capnography in fluid resuscitation
2010 AHA ACLS Guidelines

- Bigger emphasis on compressions
- Early defibrillation
- Waveform Capnography
- Post resuscitation algorithm

Waveform Capnography is Level 1A Recommendation for airway confirmation

2010 AHA ACLS Guidelines
AHA Levels of Evidence Utilizing Capnography

- Using Capnography as a quality indicator of chest compressions
  - Class IIB, LOE C

- Indicator of ROSC
  - Class IIA, LOE B

- Use in non-intubated for quality of chest compressions & ROSC indicator
  - Class IIB, LOE C

2010 Adult Cardiac Arrest Guidelines

Normal values:
- PetCO₂: 35 – 40 mmHg
- PaCO₂: 35 – 45 mmHg
**When to use waveform Capnography**

- When an endotracheal tube is placed
- Gold standard for endotracheal tube placement
- Intra-arrest
  - Quality marker of compressions
  - Information helpful to determine cessation of resuscitation efforts – esp. in asystole
- Post arrest

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**Waveform Capnography**

- Attaches to ET tube, measures end tidal CO₂
Why use waveform Capnography?
- The main determinant of PetCO$_2$ during resuscitation is perfusion to the lungs
- Quality indicator of compressions
- Surrogate marker for perfusion
- Correlates with cardiac output & myocardial blood flow during resuscitation
- It may help with prevent over-ventilation**
  - Most devices display the ventilation rate
- If it is persistently low, it suggests ROSC is unlikely
- If it abruptly increases, it may suggest ROSC

What’s in the waveform?
Measure the CO$_2$ concentration at the end of expiration

Devices should display a value & the waveform
Do we need all this fancy stuff?

- How do you currently evaluate quality of compressions?
- With ineffective compressions CO₂ remains in the tissues
- CO₂ is not making it to the heart to be eliminated by the lungs
- If we improve compressions, the CO₂ is picked up & eliminated with assisted ventilation

Special considerations

- **Pulmonary embolus**
  - May have a consistently low PetCO₂

- **Endotracheal tube dislodgement**
  - PetCO₂ reads zero

- **Termination of efforts**
  - PetCO₂ never above 10 mm Hg
Waveform Capnography during ROSC

- Abrupt increase over 40 mmHg
- Education PERLS – wait until the end of the 2 minute cycle

Case #1

- 54-years old, collapsed Jan 5, 2011 outside Don’s Foods in Goodhue, MN (pop. 900)
- 2 dozen rescuers took turns providing CPR for 96 minutes
- 6 shocks with first responder AED, 6 more shocks by Mayo Clinic Air Flight Medics
- Transported to Mayo Clinic Cardiac Cath Lab
Ventricular fibrillation continues…

- Ongoing CPR with transport
- Defibrillation every 2 min
- Epinephrine every 3 – 5 min
- Amiodorone 300 mg
- PetCO₂ reads 32 – 37 mmHg

What should you do?

- Keep going!!! Get the patient to the cath lab!!!

Why Not Quit?

- Thrombectomy, stent to LAD
- 10 days in hospital
- “The capnography told us not to give up!”
- EtCO₂ averaged 35 mmHg (range 32 – 37)
What's the Goal During CPR?
- Try to maintain a minimum EtCO₂ of 10 mmHg
- Push
  - HARD
  - ≥ 2" or 5 cm
  - FAST
  - at least 100, but < 120 per min
- Change rescuers
  - Every 2 minutes

Case #2  52 year old patient goes into Ventricular Fibrillation
- Chest compressions started
- Defibrillated with 200 j, chest compressions immediately restarted
- Epinephrine 1 mg administered
- Intubated with assisted ventilations with 1 breath every 6 – 8 seconds
- Waveform Capnography started initial reading is 20 mmHg

- Recommendations?
**After 4 minutes…**

- Rhythm is assessed, remains in Ventricular Fibrillation
- Defibrillated with 300 joules, new provider begins compressions
- Waveform Capnography reading 9 mmHg
- Recommendation?
  - **Compress deeper, assess rate!**

- Provider compresses deeper, but PetCO$_2$ remains < 10 mmHg
- Recommendations?

**3 minutes later (7 min into arrest)**

- Waveform Capnography is reading 38 mmHg
- Recommendations?
  - **Go until the end of the 2 minute cycle & assess for a pulse**

- At the end of 2 minutes, there is a pulse!!!
- Waveform Capnography is currently ready 34 mmHg
Post-Resuscitation started

- Patient is mechanically ventilated
- Capnography has trended from 34 mmHg to 26 mmHg
- What do you think about this?
- The patient's cardiac output is dropping...assess need for fluid, positive inotrope, vasopressor

Post-Arrest Capnography

- 1.5 liters of fluid administered
- Capnography went from 26 mmHg to 32 mmHg
- Recommendations?
- Consider more fluid, assess LV function
ETCO₂ predicts fluid responsiveness in passive leg raising

- 65 ventilated patients needing volume expansion d/t
- Compared changes in ETCO₂ with arterial pressure to reflect changes in CO
- CO evaluated with PICCO device
- ETCO₂ increase ≥ 5% predicted fluid responsiveness (p=0.0001)
- Increase in the CI ≥ 15%
- Sensitivity 71% (95% CI 48 – 89%) and specificity of 100% (CI 82 – 100%)
- The changes in ETCO₂ induced by a PLR test predicted fluid responsiveness with reliability, while the changes in arterial pulse pressure did not.


Post arrest care algorithm

It can be especially helpful to monitor PetCO₂ post arrest!

Downward trends could signify low perfusion & re-arrest
Case #3 Exceptions…
- 49 year old female s/p bowel resection surgery
- Transferred to acute care and developed a LLE DVT
- C/O shortness of breath with increasing O₂ needs and “impending feeling of doom”
- Rapid response activated
- Goes into PEA Arrest
- Chest compression started

- Your differential?
  - **Pulmonary embolism**

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Case #3 continued
- rTPA ordered & given
- Intubated without interrupting chest compressions
- EtCO₂ read 8 mmHg
- CPR quality is incredible!!!

- Why is it only reading 8 mmHg?
  - **She has a VQ mismatch**
  - **What will happen to serum levels of CO₂?**
Case #3 continued

- EtCO$_2$ up to 11 mmHg and we achieved ROSC
- rTPA completed
- 2 hours later EtCO$_2$ was 15 mmHg, FiO$_2$ 100%
- 6 hours later EtCO$_2$ was 24 mmHg, FiO$_2$ 80%
- 12 hours later EtCO$_2$ 30 mmHg, FiO$_2$ 70%

- Prognosis?
  - Good! The rTPA lysed the blood clot
  - This is evidenced by the improvement in the V/Q mismatch!

In conclusion…

- Waveform Capnography is a highly underutilized tool in resuscitation
- It is the Gold Standard or endotracheal tube placement
- It can be used to evaluate CPR quality & detect ROSC
- Waveform Capnography can also be used to predict fluids responsiveness when used with passive leg raising
- There are limitations such as pulmonary embolism, however, it can be used to gauge improvements in V/Q mismatch!