Capnography in Cardiac Arrest – The Only Parameter to Monitor Both Ventilation and Perfusion

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Learning Outcome

- Describe how capnography is used to identify ROSC and guide decision making regarding continuing or stopping resuscitation efforts.
Health Care Costs

- Do we have enough money for healthcare in the US?
- If you see a new technology at the NTI and go back to your hospital to request its purchase, what will be the first question you are asked?
- Can technology both improve patient outcomes and reduce costs?
Health Care Costs in the US

- United States is different than any other country: Over $90 billion spent in critical care (CCM 2006, 34)

- Patients
  - 40% are low risk
    Likely to recover without ICU admission
  - 50% are mid risk
    Will benefit and usually recover due to ICU care
  - 10% are high risk
    High mortality even with ICU care – But 50% of costs
Cost–Effectiveness of Various Interventions in Critically Ill Patients

- tPA: 18,000 dollars
- Coronary stent: 40,000 dollars
- Implantable defibrillators: 40,000 dollars
- Lung transplantation: 44,000 dollars
- Coronary angiography: 52,000 dollars
- CABG: 7,100 dollars
- rhEPO: 121,000 dollars
- Mechanical ventilation in stroke: 174,200 dollars
- In-hospital CPR: 215,000 dollars

Resuscitation – What Determines Success?

- What caused the code?
  - Usually life-ending event that cannot be managed at the time
  - Dysrhythmia only?
  - Time since event?

- About 50% of patients survive a code.
  - We are good at resuscitation techniques.

- About 10–20% will be discharged.
Physiological Aids in Resuscitation

Capnography and Assessment of Blood Flow
Capnography in Resuscitation

- Predicting return of circulation
  - Kalenda – 1978
- Predicting blood flow – literature begins in 1985
- Predicting survival – 1997
Continuous quantitative waveform capnography is now recommended for intubated patients throughout the periarrest period. When quantitative waveform capnography is used for adults, applications now include recommendations for confirming tracheal tube placement and for monitoring CPR quality and detecting ROSC based on end–tidal carbon dioxide (PETCO2) values.”
Methods for Measuring Exhaled CO2 – Colorimetric

• Limited due to lack of waveform and easy to interpret numeric value

Purple – PetCO2%: < .5%
Tan – PetCO2%: .5–2%
Yellow – PetCO2%: > 2%

Normal PetCO2: >4%
Methods for Measuring Exhaled CO2 – Capnography

- Hand held side stream capnogram
- Bedside monitor mainstream capnogram
Ventilator Placement (Sidestream or Mainstream)
At the end of exhalation (called end tidal CO2 or PetCO2 for pressure of CO2 at end tidal breathing), the exhaled CO2 reflects alveolar CO2. Normally, the PetCO2 value is 1–5 mm Hg below the arterial (or alveolar) CO2 level.
Can Capnography Predict Non Survival in Cardiac Arrests?

Literature would suggest “Yes”!
CPR, Blood Flow, and Outcomes

- Ahrens T; Schallom L; Bettorf K; Ellner S; Hurt G; O'Mara V; Ludwig J; George W; Marino T; Shannon W. End-tidal carbon dioxide measurements as a prognostic indicator of outcome in cardiac arrest. American Journal of Critical Care. 10(6):391–8, 2001 Nov.
- Salen P; O'Connor R; Sierzenski P; Passarello B; Pancu D; Melanson S; Arcona S; Reed J; Heller M. Can cardiac sonography and capnography be used independently and in combination to predict resuscitation outcomes? Academic Emergency Medicine. 8(6):610–5, 2001 Jun.
- Kalenda Z. The capnogram as a guide to the efficacy of cardiac massage.. 1978;6(4):259–263.
PetCO2 Levels During Cardiac Arrest

- PetCO2 values should rise to $>10\text{mm Hg} - 14 \text{mm Hg}$ during successful resuscitation efforts.
- Prolonged PetCO2 levels $<10$ have been shown to correlate with low cardiac outputs and poor survival.
Mr. Snitzer suffers a cardiac arrest with V fib.

20 first responders do CPR for 96 minutes.

- 12 defibrillations

After 10 days in the hospital, discharged

The reason to keep going was a PetCO2 value of 28–35.
Capnography During 96 minutes of Resuscitation

PetCO2 – 28–36 mm Hg

Case details found at:
https://www.youtube.com/watch?v=OSYDR7xeJnk
Case Study

A 66-year-old female is brought into the ER. CPR is in progress. She was found “down” in her house by her husband. Paramedics have been doing CPR for > 20 minutes. Her capnography wave shows a value of 6 mm Hg.

**Question:** How would you assess the adequacy of the resuscitation effort?

a) The resuscitation is proceeding adequately.
b) Ventilation is great but blood flow is poor.
c) Ventilation is poor but blood flow is adequate.
d) The patient will not survive.

*Capnography wave with value of about 6*
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Case Study

A 51-year-old male admitted to the floor with pneumonia following the flu. Found in cardiac arrest following the pulse ox alarm being heard. CPR occurs; defibrillation for V fib has been performed 4 times. No ROSC is noted. The resuscitation has been in place for 24 minutes. His wife is in the room observing the code. The capnogram below has been unchanged despite changing personnel.

Question: What should you do?

a) Continue with resuscitation.
b) Stop resuscitation efforts.
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Post Code – How is the Cardiac Output?
5 minutes Post Fluid Bolus

*Did the fluid bolus help?*
Return of Circulation

- No need for pulse checks if a capnogram is available.
- A sudden increase in the PetCO2 will indicate a return of circulation.
- A return to normal PetCO2 of the capnogram indicates ROSC.
- The change is striking and immediately apparent.
PetCO2 Indicating ROSC

PetCO2 - 15

PetCO2 - 30
**Question:** During a cardiac resuscitation effort, is there a need to assess for a pulse (to validate return of circulation)?

a) No. Circulation has not been reestablished.

b) Yes. Spontaneous circulation may have been reestablished.
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Summary

- Resuscitate only when in patient’s best interest.
- Capnography can help identify patients who will not survive.
- Capnography is an indicator of cardiac output. Increases in the PetCO2 indicates a ROSC as well as hypovolemia.
Questions???

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