



NIHON KOHDEN[®]
UNIVERSITY

AN EDUCATIONAL SERVICE OFFERING OF NIHON KOHDEN

CAPNOGRAPHY
GEORGE KIRSCHLING, RN
MAY 2019

Different Thinking for Better Healthcare.[®]

MCDOC 102 [A]-CO-2309



Course Description

The purpose of this session is to discuss the value of capnography monitoring both in the Critical Care setting, as well as those clinical areas that are typically not monitored.

We will discuss the applicability, the benefits and the barriers to overcome with using this technology.

Learning Objectives



History of Capnography



Define:

- Capnography and the vital sign parameter measured through patient monitoring
- The normal upper and lower limits of CO₂
- The differences between Mainstream and Sidestream capnography
- Three settings other than the operative suite where capnography is beneficial to patient care



Differentiate ventilation from oxygenation and identify the appropriate technology for measuring each



Articulate barriers to capnography technology use and potential remedies



History of Capnography



Based on a discovery in 1875
by chemist Joseph Black



He noted the properties
of a gas released during
exhalation that he referred
to as “fixed air”



That fixed air was determined
to be carbon dioxide

What Is Capnography?



Capnography is an objective measurement of exhaled carbon dioxide (CO₂) levels at the end of each breath



Commonly referred to as EtCO₂



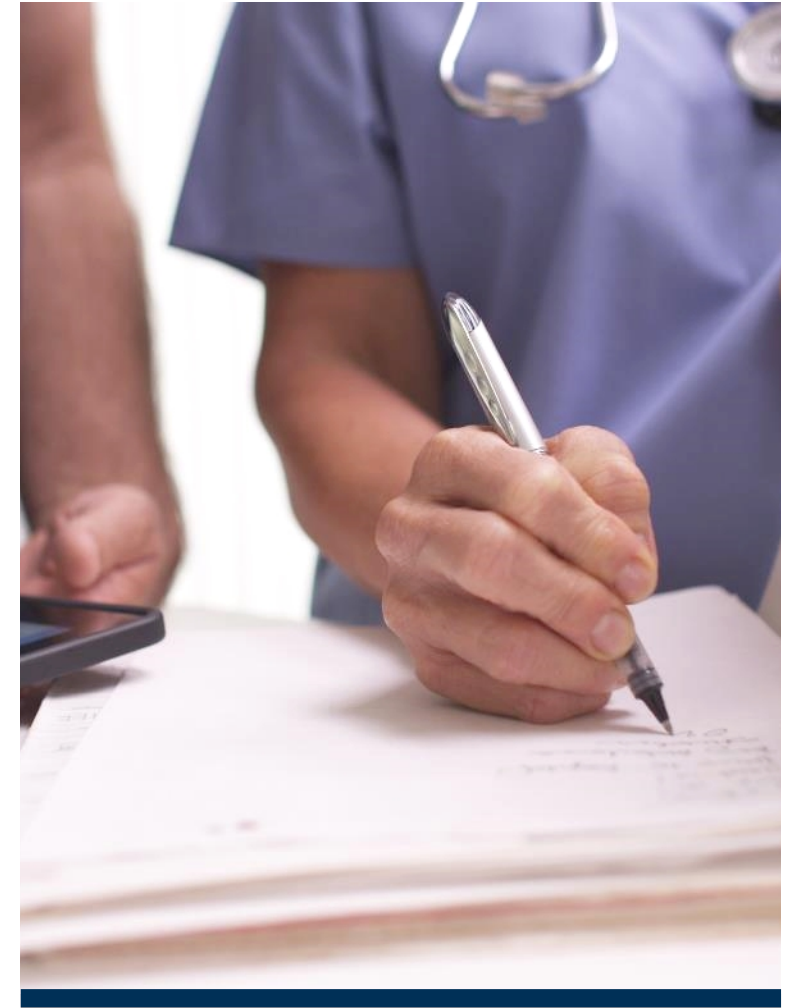
Capnography measures ventilation



Term capnography comes from the Greek word KAPNOS, meaning smoke¹



Gives insight into alterations in ventilation, cardiac output, distribution of pulmonary blood flow and metabolic activity



What Is Capnography?

THREE SEGMENTS



Numeric CO₂ Value

Measured at point of maximum concentration of expired CO₂ (indicates PaCO₂ level)²



Respiratory Rate

Full inhalation/ exhalation cycles



CO₂ Waveform

Continuous/scalable/ shape can tell a story

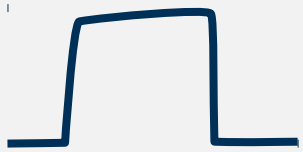


Terminology



Capnogram

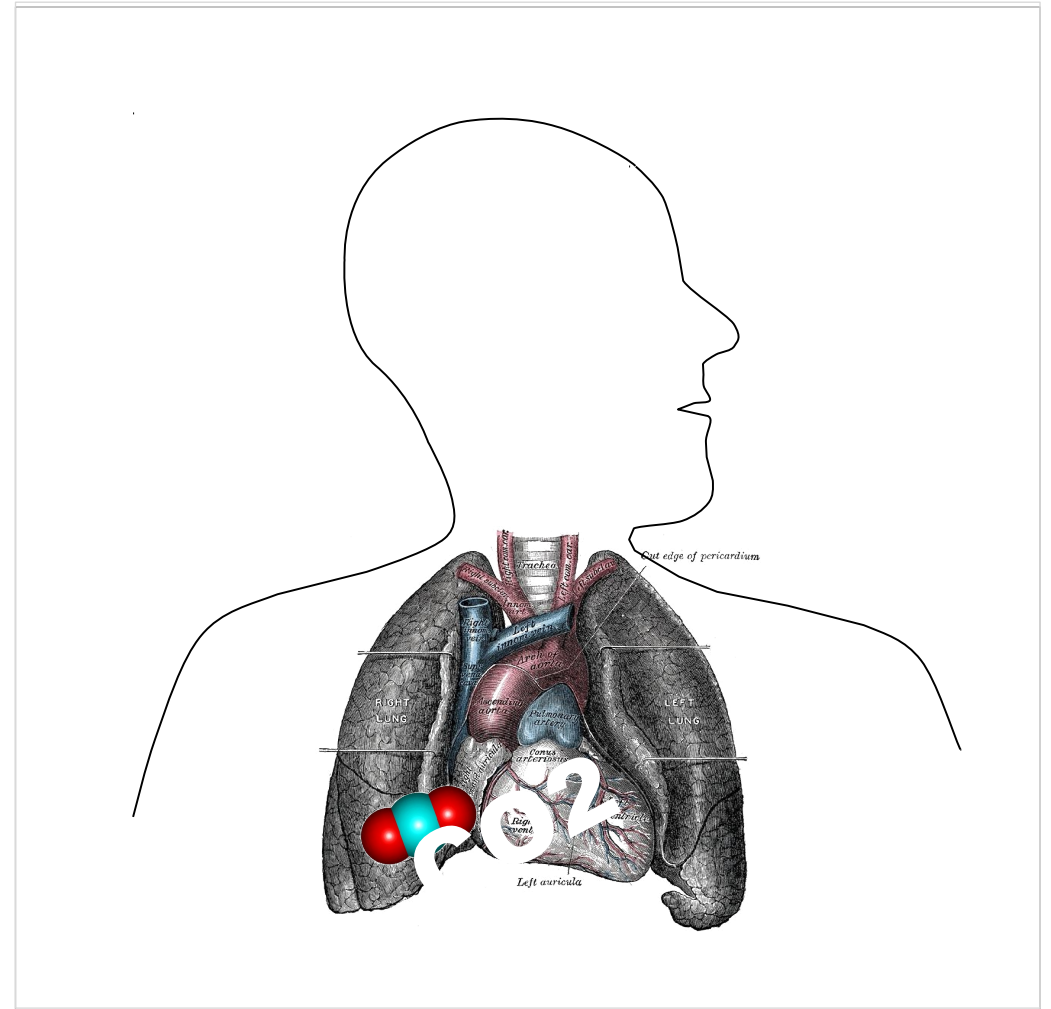
A real-time waveform record of the concentration of carbon dioxide (CO₂) in the respiratory gases



38 mmHg

Capnograph

Capnogram waveform plus numerical value



Why Do We Care?

Capnography is:

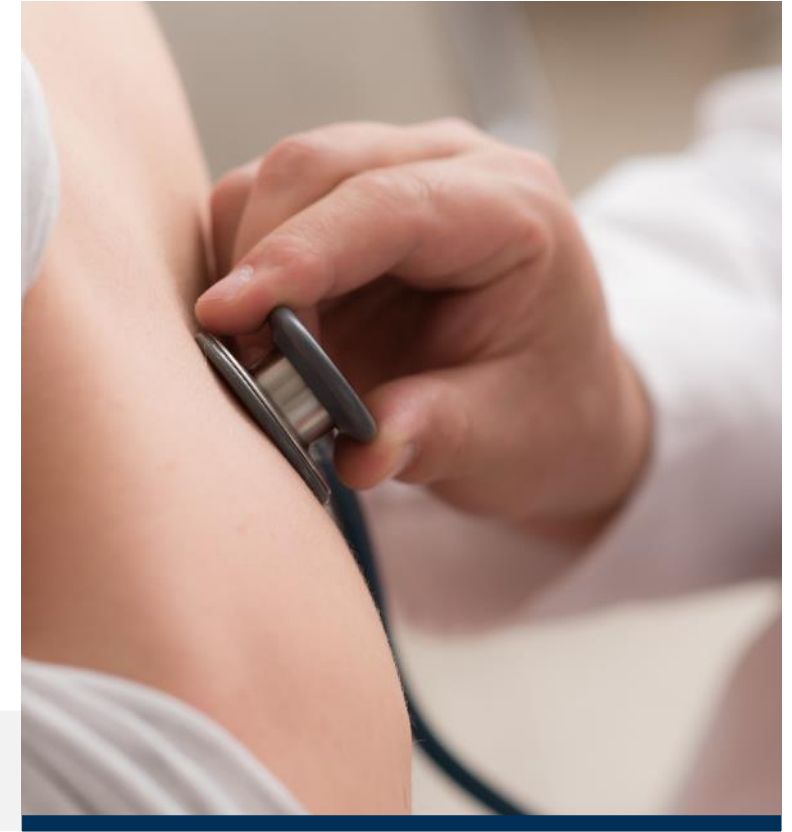
Probably the least understood, non-invasive vital sign.



2015 AHA **Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care** has helped to make EtCO₂ a more common parameter for use.³

Huge increase in demand—for the technology and for knowledge!

Why is this so important and what does it mean for patients?



Guidelines & Standards



25% Incidence of Tube
Misplacement/Displacement
Improved Resuscitation Outcomes
Better Intubations, Better CPR, Better Outcomes⁴



Misplacement/Displacement of ET Tube
Assessment of Pulmonary Circulation
and Respiratory Status
Optimization of Mechanical Ventilation

OK, so it's great for intubation and resuscitation... what else?

The Value of Capnography



A study monitoring patients using patient-controlled analgesia showed that respiratory depression has been found to be significantly higher than previously reported.⁵



Anesthesia Patient Safety Foundation (APSF) has recently said, “No patient shall be harmed by opioid-induced respiratory depression.”⁶

Oxygenation vs. Ventilation



Oxygenation

The addition of oxygen to any system, including the human body. Oxygenation may also refer to the process of treating a patient with oxygen, or of combining a medication or other substance with oxygen.⁷



Ventilation

The **movement or exchange** of air between the environment and the lungs via inhalation and exhalation. Designed to take in oxygen (O₂) and eliminate carbon dioxide (CO₂).⁸

Capnography is an objective measurement of exhaled CO₂ levels

Valuable parameter to predict patient outcomes

SpO₂ vs. EtCO₂

SpO₂

Familiar, easy concept

Easy to use and understand

Non-invasive, not painful for patient

What Does This Tell Us?

- 1 Oxygenation status
- 2 Detects hypoxic conditions
- 3 Quick and reliable indicator... **but is it quick enough?**

EtCO₂

Easy to use

Easy to interpret

Non-invasive, not painful for patient

What Does This Tell Us?

- 1 Ventilation status
- 2 Detects respiratory rate changes and apnea
- 3 Detects ventilation potential changes with each breath
- 4 Quick, reliable indicator; changes caught sooner

Capnography or Pulse Oximetry?

It depends... what do you need to be measured?



Oxygenation

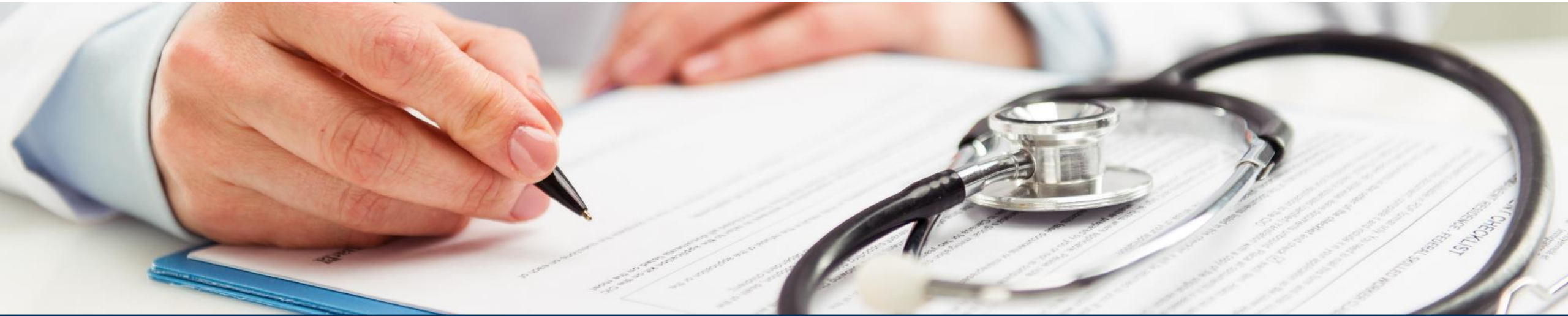
How are we doing at getting oxygen to the tissues?



Ventilation

How are we doing at getting rid of carbon dioxide?

Capnography vs. Pulse Oximetry



Pulse Oximetry

Will show an elevated saturation for up to several minutes, as it takes time for existing oxygen saturation to decline. Pulse oximetry may fail to detect respiratory deterioration, particularly if a patient is receiving supplemental oxygen.⁹

Capnography

Provides an immediate picture of patient condition such as apnea, impaired gas exchange is visible 30-60 seconds sooner than with SpO₂.¹⁰

Capnography vs. Pulse Oximetry

Capnography



Reflects changes in ventilation
within **10 seconds**

Pulse Oximetry



Reflects changes in oxygenation
within **5 minutes**

About Capnography



Mainstream

Mainstream CO₂ samples are taken directly from the airway. This method provides a very accurate reading because the sensor is at the actual airway, there are far less variables involved that could interfere with an accurate reading



Sidestream

Sidestream CO₂ uses a sensor that is located inside the monitor instead of an external sensor. The patient's exhalation air is pulled through a small tube, usually 6-8' long, from the sample site and into the monitor.¹¹



***Mainstream is widely regarded as the more accurate method of measuring CO₂ readings**

And the Point Is?

Anesthesia

- 1 Long established standard-of-care
- 2 Known gold standard

Intensive Care—Progressive Care/Emergency

- 1 Resuscitation
- 2 Ventilator Support
- 3 Sedation
- 4 Becoming gold standard

On the
Horizon...

Medical/Surgical

- 1 Opioid-Induced Respiratory Depression (PCA, OSA)
- 2 Acute & Chronic Lung Diseases
- 3 Failure to Rescue



Barriers to Use of Capnography



Knowledge

- 1 Differing EtCO₂ technologies within a hospital
- 2 Varying features and functions with existing SPO₂ and EtCO₂ equipment
- 3 Lack of clear benefit of use in comparison to EtCO₂
- 4 Resistance to change



Initial Costs

- 1 Expense to hospital to replacement equipment to ensure one vendor and standard to deploy EtCO₂
- 2 Initial training of staff/physicians



Education Needs

- 1 Ongoing staff education
- 2 Patient/Family education

What Is to Be Gained?



Improved Patient Safety and Outcomes

- Intervene early (rescue) and keep the patient on their plan of care
- Fewer Code Blues and unplanned transfers
- More people survive and live healthier lives



...Improved Bottom Line

- Decreased LOS
- Improved reimbursements
- Better utilization of hospital resources and beds

Everybody wins! Good for the patient and the organization

How Can We Get There?

We need to challenge our current monitoring practices and no longer believe that:



Trusting that intermittent spot checks of vital signs is sufficient



Continuously monitoring **only** high risk patients



Relying on Pulse Ox **alone** to detect respiratory depression



Implementing a monitoring program **without** creating an education plan



Medical Staff

Must have their "Buy-In" for long-term success.



Nursing Staff

What are the benefits, for Me and for my Patient?



Patients and Family

The importance of monitoring.

Pay Attention & Talk It Out



New Technology

Look to minimize inconveniences, ensure staff have equipment readily available



Order Sets/Policies/ Procedures

Research best practices and use as guidelines for your own



QA/Processes

Incorporate data into Meaningful Use/EMR

Future Trends in Capnography



Current Trends

- PCA
- Sedation
- Asthma/OSA
- CPR/Tube Placement

Future Trends

- Emerging uses of capnography in pre-hospital medicine
- Increasing value in the Emergency Department
- EtCO₂ monitoring during transport outside of the hospital
- Home care monitoring

Closing Thoughts



Regardless of the future, capnography is an emerging and growing parameter



Capnography is a life-saving modality as it provides an early indicator of potentially critical conditions



Knowledge is power—educate yourself on capnography!



Make a difference—Be part of a team to develop practices, policies and workflows that are evidence based and support best practice.

References

1. <https://centegra.org/wp-content/uploads/2013/06/Capnography.pdf>
2. <http://lifeinthefastlane.com/ccr/capnography-waveform-interpretation>
3. <https://www.capnoacademy.com>
4. <https://www.capnoacademy.com>
5. <https://www.americannursetoday.com/case-capnography-patients-receiving-opioids/>
6. <https://www.apsf.org/wp-content/uploads/newsletters/2011/fall/pdf/APSF201110.pdf>
7. <http://centegra.org/wp-content/uploads/2013/06/Riding-the-Waves-ETCo2.pdf>
8. <http://centegra.org/wp-content/uploads/2013/06/Riding-the-Waves-ETCo2.pdf>
9. http://www.physio-control.com/uploadedFiles/Physio85/Contents/Trade_Shows/Capno%20handout.pdf
10. http://www.physio-control.com/uploadedFiles/Physio85/Contents/Trade_Shows/Capno%20handout.pdf
11. <http://www.oem.respironics.com/Downloads/Main%20vs%20Side.pdf>

Different Thinking for Better Healthcare and Nihon Kohden University are registered trademarks of Nihon Kohden.



NIHON KOHDEN[®]
UNIVERSITY

AN EDUCATIONAL SERVICE OFFERING OF NIHON KOHDEN

THANK YOU FOR YOUR TIME!

To download this presentation, visit www.nkuniversity.org/resources

Different Thinking for Better Healthcare.[®]