Good Air In, Bad Air Out: Assessment of Oxygenation and Ventilation

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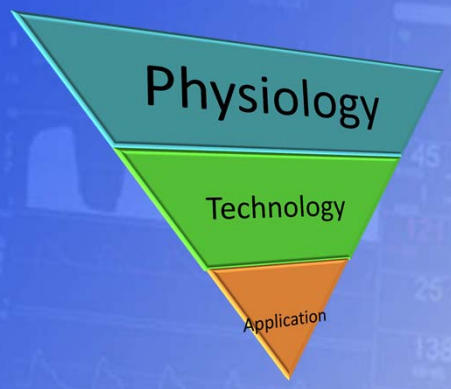
Objectives

- Understand respiratory physiology as it applies to oxygenation and ventilation.
- Understand the technology and limitations of the technology used to monitor oxygenation and ventilation using pulse oximetry, capnography, and co-oximetry.
- Apply the use of oximetry, capnography, and co-oximetry to assess a patient's respiratory and circulatory status.



Physiology

RESPIRATORY PHYSIOLOGY

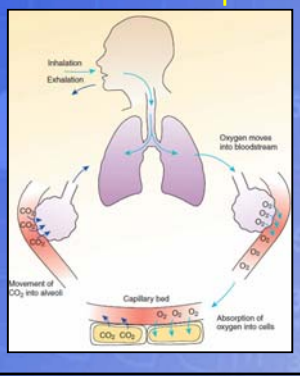
Physiology

What is respiration?

The process of moving oxygen in and carbon dioxide out of the body. This process occurs globally and on the cellular level.

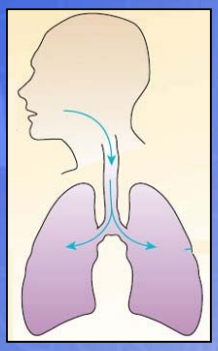
Physiology

The Process of Respiration



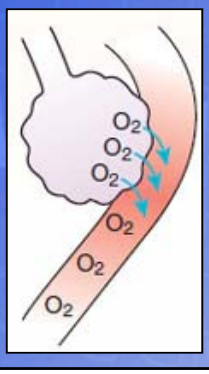
Physiology

Inhalation / Exhalation



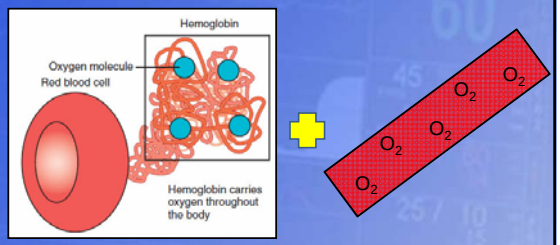
Physiology

Oxygen Diffusion



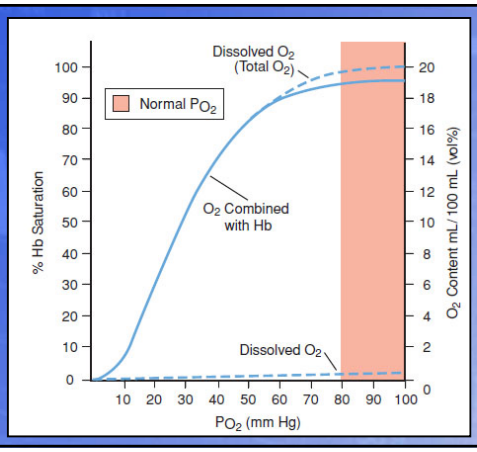
Physiology

Oxygen Transport



97% 3%

Physiology



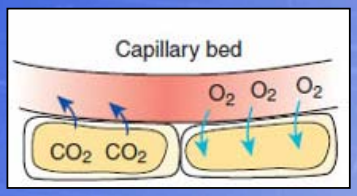
Physiology

Factors Affecting Hemoglobin Binding

Increased	Decreased
• Alkalosis	• Acidosis
• Decreased CO_2	• Increased CO_2
• Decreased temperature	• Increased temperature
• Decreased 2,3-BPG	• Increased 2,3-BPG

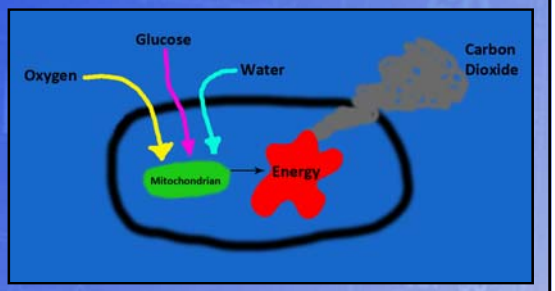
Physiology

Oxygen Diffusion Into Cell



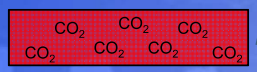
Physiology

Cellular Respiration

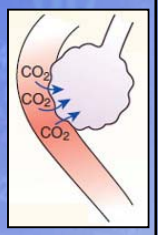


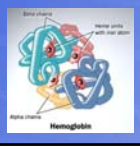
Physiology

CO_2 Transport & Removal



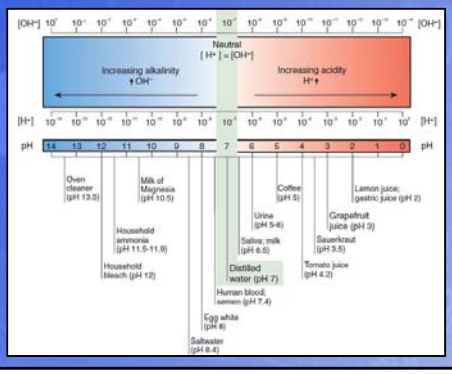
CO_2 + = Bicarb





Physiology

Acidosis



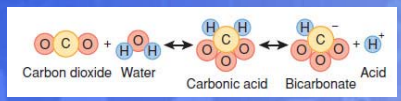
Physiology

Effects of Acidosis

- Release of O_2 from hemoglobin
  - The Good: O_2 off loads into tissues
  - The Bad: central circulation acidosis prevents O_2 from getting to tissues
  - The Ugly: tissues hypoxic, become more acidotic, worsens cycle
- Alter action of medications

Physiology

Compensation for Acidosis



- Respiratory
  - Increased respiratory rate removes more CO_2
  - Acid moves reaction left
  - Increases Water & CO_2
- Fast process (minutes)
- Renal
  - Increase bicarbonate production
  - Binds with acid
  - Urinated out
- Slow process (48 hours)

End result: Increased rate and depth of ventilation

Technology & Limitations

TECHNOLOGY & LIMITATIONS

Technology & Limitations

- Pulse Oximetry
- Capnography
- Co-Oximitry

Tech & Limits – Pulse Oximetry

What does Pulse Oximetry Measure?

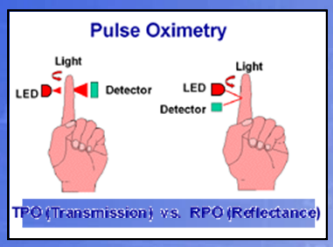
% Saturation of the hemoglobin molecules in the arterioles passing by the sensor. An indication of ***oxygenation***

Tech & Limits – Pulse Oximetry

Pulse Oximetry

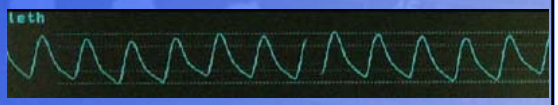
Tech & Limits – Pulse Oximetry

Pulse Oximetry



Tech & Limits – Pulse Oximetry

Pulse Oximetry Waveform



Tech & Limits – Pulse Oximetry

Oximetry Limitations

- Carbon Monoxide
  - May read normal
- Methemoglobin
  - May read upper 80s without other signs of distress
- Assesses ***oxygenation*** and not ***ventilation***

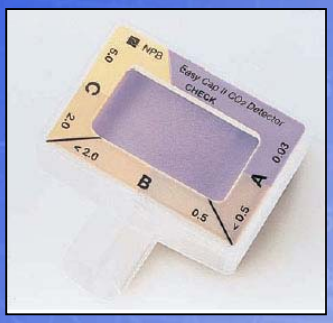
Tech & Limits – Capnography

What does Capnography Measure?

Amount of exhaled CO_2 in mmHg. An indication of ***ventilation***

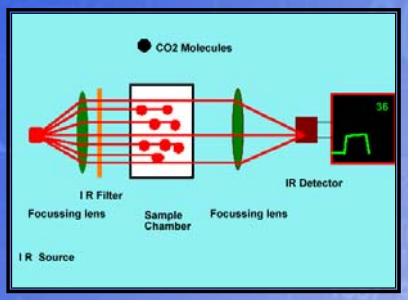
Tech & Limits – Capnography

Colorimetric Capnography



Tech & Limits – Capnography

Measuring CO_2



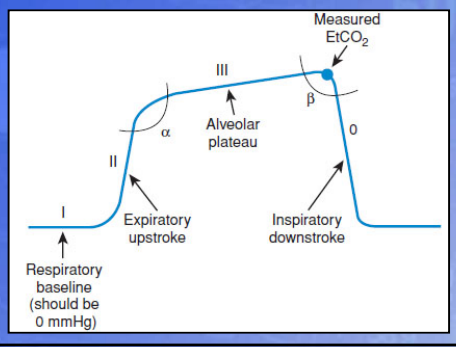
Calibrated to a known sample of CO_2

Tech & Limits – Capnography

Mainstream vs. Sidestream

Tech & Limits – Capnography

Anatomy of Capnography Waveform



Tech & Limits – Capnography

Capnography Limitations

- Affected by:
  - Ventilation rate and volume
  - Metabolism
  - Circulation
- Sensor condensation

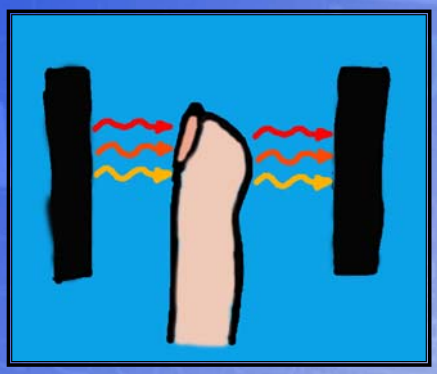
Tech & Limits – Co-oximetry

What does a co-oximeter measure?

Amount of CO and Methemoglobin in the blood. Helps determine appropriate level of oxygenation

Tech & Limits – Co-oximetry

Tech & Limits – Co-oximetry



Tech & Limits – Co-oximetry

Limitations of Co-oximetry

- Same as pulse oximetry
- Technology / algorithms proprietary
- Few studies that look at clinical impact of the devices

Application

APPLICATION

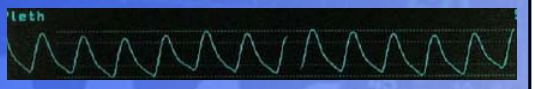
Application – Clinical Parameters

Clinical Assessment

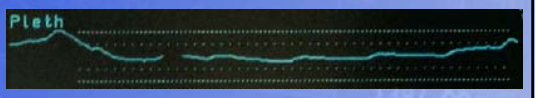
- Respiratory rate
- Chest rise
- Mentation
- Skin color
- Breath sounds

Application – Pulse Oximetry

Good Waveform

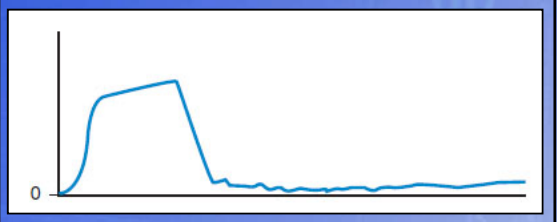


Bad Waveform



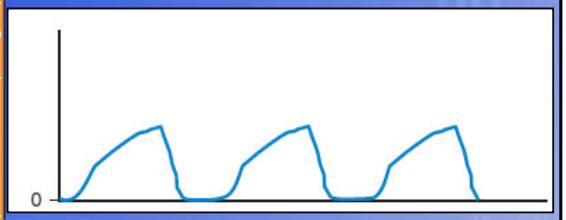
Application - Capnography

ETT Dislodgement



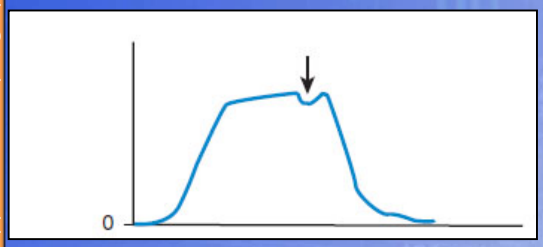
Application - Capnography

Bronchoconstriction



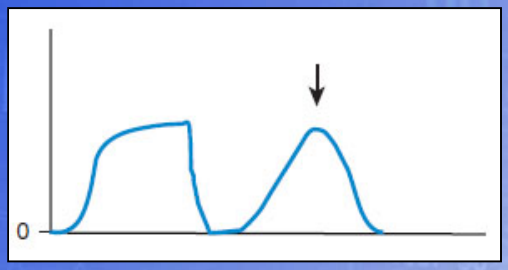
Application - Capnography

Spontaneous Respiration Attempt



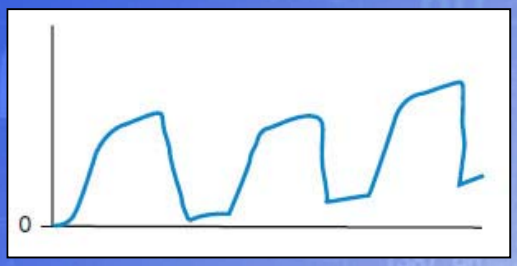
Application - Capnography

ET Obstruction

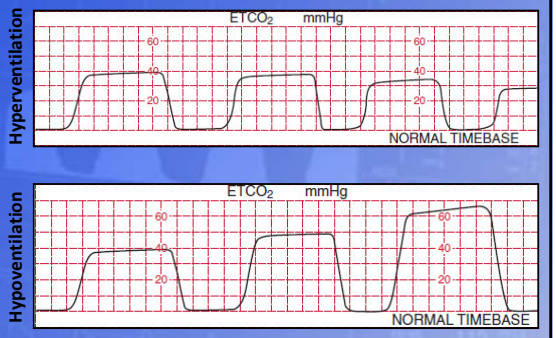


Application - Capnography

Sensor Condensation



Application - Capnography



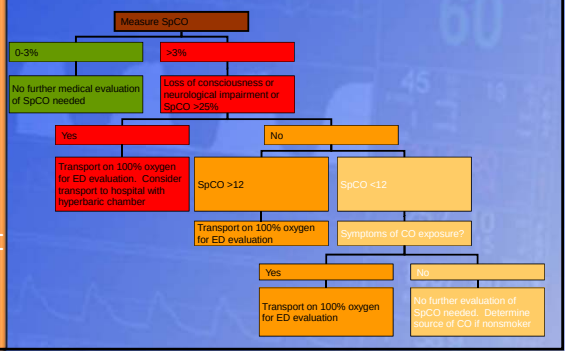
Application - Capnography

Cardiac Arrest

- Level used to guide compression depth and ventilation rate / depth
- Sharp rise in level before ROSC
- Level < 10 mmHg after 20 minutes ACLS = 0% survival

Application – Co-oximetry

CO Triage Algorithm



Review

REVIEW

Review

Review

- Respiration is the process of moving oxygen in and carbon dioxide out of the body. This process occurs globally and on the cellular level.
- Oxygen diffusion affected by many respiratory diseases

Review

Review

- Most oxygen is transported attached to hemoglobin while a small amount is dissolved in the blood
- Oxygen, glucose, and water is used within the cell to produce energy. CO_2 is a byproduct of energy production

Review

Review

- Most CO_2 is dissolved in the blood, some forms bicarb and a small amount attach to hemoglobin.
- Acidosis can impair oxygen movement to the tissues and disrupt the action of certain medications

Review

Review

- Pulse oximetry, capnography, and co-oximetry use light to measure the amount of the oxygen saturation, CO_2, CO, and methemoglobin.
- Pulse oximetry and co-oximetry ***does not*** provide information about the patient's ventilation. A well oxygenated patient can still go into respiratory failure from impaired ventilation

Review

Review

- Clinical assessment based on factors such as chest rise, mentation, and skin color
- A poor pulse oximetry waveform affects the accuracy of the reading
  - Nail polish
  - Vasoconstriction
  - Materials on the skin surface

Review

Review

- Discussed several ways of applying capnography from ETT monitoring to cardiac arrest management
- Discussed CO exposure algorithm suggested by RAD-57 manufacturer (follow local protcols)

Questions?

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GUIDING MEDICAL EDUCATION

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