CAPNOGRAPHY IN YOUR PACU: IMPLICATION FOR PERIANESTHESIA NURSES

MAUREEN F. McLAUGHLIN, MS, RN, CPAN, CAPA

2ND INTERNATIONAL CONFERENCE OF PERIANESTHESIA NURSING
DUBLIN, IRELAND
SEPTEMBER 20, 2013
Objectives

- Describe what is commonly referred to as capnography
- Discuss clinical situations in which capnography is indicated
- Discuss the role of capnography in preventing adverse drug events
Oxygenation: Physiologic Process

- Pulmonary gas exchange
  - Inspiration
  - Diffusion
  - Perfusion
- Delivery
- Consumption
Pulmonary Gas Exchange

- \( PA_O_2 = 102 \text{ mm Hg} \)

- \( PV_O_2 = 40 \text{ mm Hg} \)

- \( PA_O_2 = 95 \text{ mm Hg} \)

- Venous blood in pulmonary artery

- Venous admixture

- Arterial blood in pulmonary veins and arterial circulation

- \( S_aO_2 \) vs. \( P_aO_2 \) graph
Diffusion

- $O_2$ crosses membrane enters pulmonary capillary
- **Factors:**
  - Pressure gradient
  - Surface area
  - Thickness of membrane
Oxygen Delivery

- Bound w/ Hgb
- Travels to L side of heart
- Pumped out into circulation

Factors:
- CO
- Oxygen content
- Autonomic nervous system
- Autoregulation
Oxygen Extraction

- Cells take $O_2$ from blood
- $O_2$ dissociates from Hgb in response to local tissue needs
Oxygen Consumption

- Capillary exchange
  - $\text{O}_2$ extracted into cells to generate energy
  - Waste products exits ($\text{CO}_2$)
Alveolar Carbon Dioxide
Carbon Dioxide and Ventilation

Exhaled air is pushed out through the nostrils or lips.

Exhaled air is pushed up the trachea to the throat.

Muscles relax and rib cage moves downward and inward.

Lungs shrink and squeeze air out.

Diaphragm relaxes and springs upward.
Traditional PACU Assessments

- Visual assessment
- Vitals: RR
  - Chest wall impedance
  - Dependent on lead placement
- Auscultation
- Oxygen saturation
Pulse Oximetry

- First discovered in 1974 by Aoyagi
- 1985 - major industry
- Lambert-Beer Law
  - Light emitting diodes
    - Red & infrared
    - Passes through tissue
    - More oxygenated blood: more red light
    - Less: more infrared light
    - Ratio of red/infrared = pulse oximeter reading = \(\text{SpO}_2\)
- Measures SATURATION
Pulse Oximetry

Factors that affect accuracy:

- Technical problems (patient movement, nail polish, dyes)
- Incorrectly fitting probes
- < Hgb levels
- Hypoxemia
- Vasoconstriction (PVD, < temp, shock, vasopressors)
- Acid-base imbalances
Pulse Oximetry

 Benefit

- Noninvasive
- Standard of care in many areas: required for PROCEDURAL SEDATION
- Reduces need for arterial stick if acid-base is not a problem
- Provides early recognition of alteration in oxygenation status (versus clinical observation)
Pulse Oximetry: SpO₂

- **No information re:**
  - Amount of Hgb
  - Delivery of O₂
  - Use of O₂ at the cellular level
  - Adequacy of ventilation/perfusion
  - Presence of respirations

- Measures O₂ saturation only-can provide some info on pulmonary gas exchange/ventilation
- **Does not provide information on oxygenation at the** *cellular* **level**
- **Does not provide any visual indication of respiration**
Capnography

- Capnometry: numerical value of PetCO₂
- Capnogram: wave tracing of CO₂ over time
- AW RR: measures ventilation with each breath
Capnography

- Noninvasive method of physiologic monitoring
  - 1st developed in 1943
  - Carbon dioxide
  - Infrared properties
  - Photodetector compares amount absorbed by CO₂ vs. amount absorbed by CO₂ free gas
Capnography/PetCO2

- **Mainstream:** measured directly at pt-ventilator interface
- **Sidestream:** sample of exhaled gas transported to device for measurement
- **Concentrations of expired CO\textsubscript{2} determined by infrared light**
Capnogram

Anesthesia 2000 accessed via Google
Capnogram

- A – B Baseline
- B – C Expiratory Upstroke
- C – D Expiratory Plateau
- D ETCO₂ value
- D – E Inspiration Begins
PaCO$_2$ vs PetCO$_2$

- Normal values: 30-43
  - Reflect alveolar end-tidal CO2
- **If** the following are present:
  - Normal cardiac function
  - Ventilation/perfusion match
  - Absence of lung disease
  - Normal capnogram
  - Gradient is 1-5 mmHg
    - PaCO$_2$ of 40 = PetCO$_2$ of 35
Capnography: Clinical Applications

- Confirmation of ETT placement
- Confirmation of non-pulmonary NGT placement
- CPR: assess adequacy, ROSC
- Opioid induced respiratory depression
- Procedural sedation related hypoventilation
- Ventilator weaning
- Prognostic indicator of survival after cardiac arrest
- Assessment of perfusion/dead space
- Transporting intubated pts
- Not a replacement for arterial blood gases
Capnogram

- Alerts provider to
  - Cessation of spont resps
  - Hypoventilation
  - Hyperventilation
Procedural Sedation

- Nurse administered sedative agents for “moderate” sedation

- Challenges
  - Darkened room- cannot visualize chest movement
  - Individualized pt response to meds
  - Painful procedures requiring >> sedation
  - Procedures that affect the airway: upper endoscopy
  - Pulse ox, vitals- late warning of resp depression
Procedural Sedation

- Capnography: Early Warning!!!!
  - Immediate detection of < RR via wave form
  - Immediate detection of airway obstruction
  - Allows for tighter control of sedative agents

- American Society of Anesthesiologists, 2011
  - Qualitative clinical signs
  - Presence of exhaled carbon dioxide unless prevented by equipment or procedure
Apnea
ETT Confirmation

- **Always risk of esophageal intubation**
  - As much as 7% of closed claims malpractice cases

- **Capnography: 93% sensitive for detecting tracheal intubation/97% specific**
  - Only 4% for bronchial intubation
  - Does not detect hypopharyngeal intubation
  - Recommend assessment for several breaths
A) Esophageal intubation
B) Tracheal intubation

Transport of Intubated Patients

- Potential for unplanned events, patient deterioration
- As many as $\frac{2}{3}$ pts experience adverse physiologic changes during intrahospital transport
- Resp changes common
- >>> movement, BVM, multi-tasking
- Capnography:
  - Unplanned extubation
  - Equipment failure
  - Inadequate ventilation
Unplanned Extubation

Figure 6. Unplanned extubation. (Courtesy of Respironics, Pittsburgh, PA).

Capnography During Transport

- Compared arterial CO$_2$ levels/PetCO$_2$ before and after transport
  - Airway/BVM by anesthesia resident
  - 5 minute transit time
- N=25: capnography during transport [person w/ BVM unaware of PetCO$_2$]
- N=25: no monitor
- N=10: monitor
- Greater variability of CO$_2$ levels in groups 1 & 2

Capnography in the PACU

- Transport- cont. confirmation of ETT placement/airway preservation
- Assess ventilation
- Pts at risk
  - OSA
  - Obese
  - Receiving opioids/sedatives
  - Those still “deep” from anesthesia
  - Abdominal incision/op affecting ability to breath
Hypoventilation

Gilboy & Hawkins, 2006
Asthma/Airway Obstruction

Gilboy & Hawkins, 2006
Some Unusual Capnogram Waveforms

- Cleft in Alveolar Plateau
- Steep Plateau
- Cuff Leak

Early Decrease of CO₂
Guidelines

- Recommend develop guidelines for use
  - Transport of critically ill or patients from OR
  - Procedural sedation
  - OSA
  - > BMI
  - Patient controlled analgesia
  - Weaning from mechanical ventilation
Conclusion

- Documented staff education
- Clear guidelines for use
- On-going audits of use and non-use, interventions, reversal agents
- Standardize use across organization
THANK YOU!!!!!

MAUREEN_MCLAUGHLIN@LAHEY.ORG