Hypercarbia

An increase in PaCO2 or ETCO2 with associated sequelae (respiratory acidosis) and the potential for life threatening emergency. Requires simultaneous diagnosis and treatment.

ANESTHETIC CONSIDERATIONS:

- Decreased CO2 elimination
  - Rebreathing
  - Hypoventilation
    - Decreased RR – volatile anesthetics, opioids
    - Decreased effective alveolar ventilation– restrictive lung disease, severe obstructive lung disease, anesthetic induced respiratory depression (shallow breaths)
    - Inability to diffuse CO2 – end stage interstitial lung disease (very end stage – CO2 rapidly diffusible)
- Increased CO2 production
  - Hypermetabolic state:
    - Sepsis
    - Thyrotoxicosis
    - Malignant hyperthermia
    - NMS
    - Cocaine
    - Pheochromocytoma
    - Transfusion reaction
  - Exogenous CO2
    - CO2 insufflation
    - NaHCO3 administration

ANESTHETIC GOALS:

- Simultaneously diagnose and treat a potentially life threatening emergency.
- Prevention and detection of early manifestations and sequelae

ETIOLOGY

F. CO2 Production

- **CO2 insufflation**
  - Laparoscopy
  - Thoracoscopy
- **Increased metabolic rate and CO2 production**
  - Sepsis
  - Hyperthermia
  - MH
  - NMS
  - Thyrotoxicosis
  - Pheochromocytoma
  - Transfusion reaction

G. Decreased CO2 elimination

- **Hypoventilation**
  - Failure to maintain airway patency
    - Upper airway obstruction
    - Decreased level of consciousness
    - Failure to ventilate
  - Machine issues
  - Surgical issues
    - Retraction
    - Intra-abdominal insufflation
  - Patient issues
    - Obstructive lung disease
    - Restrictive lung disease
    - Drugs causing respiratory depression
- **V/Q mismatch (increased dead space ventilation – causes increased PaCO2 vs ETCO2)**
  - Pulmonary embolus
  - Atelectasis
  - Pneumonia
  - Pneumothorax
  - Etc.

TYPICAL SITUATIONS

- Laparoscopic surgery
- Inadequate ventilation from any cause
  - Failure to maintain the airway during general anesthesia
  - Failure to ventilate adequately during general anesthesia
  - Morbid obesity
- Hypermetabolic state

MANIFESTATIONS

- Increased ETCO2 or increased PaCO2 on ABG

        - Respiratory acidosis and associated sequelae
        - Watch for increased temperature and hemodynamic instability

MANAGEMENT

- Increase FiO2 to 100%
    - Use high oxygen flow to equilibrate the breathing circuit rapidly
    - Verify that FiO2 approaches 100%
    - Check the patient's vital signs including TEMP, HR, BP, Oxygenation
- Check that ventilation is adequate
    - Check end-tidal CO2
    - Increase respiratory rate and assess for decrease in ETCO2 with increased minute ventilation
    - Switch to hand ventilation to assess pulmonary compliance
    - Hand ventilate with large tidal volumes to expand collapsed lung segments (recruitment maneuver)
    - Auscultate the breath sounds bilaterally, assess the adequacy and symmetry of chest movement
    - Obtain ABGs including Hb
- Check the position of the ETT
    - Auscultation
    - Direct visualization of ETT at mouth opening
    - Direct visualization of ETT cuff below cords
    - Fiberoptic bronchoscopy to visualize tracheal rings and the carina
    - Adjust the position of the ETT if necessary
- Verify function of CO2 absorbant (in circle system) or that flow are adequate to prevent rebreathing
- Inform surgeons if difficulty in maintaining adequate ventilation persists
    - Discontinue insufflation with CO2
    - Check for retractors causing difficulty with ventilation
    - Terminate surgery as soon as possible
    - Arrange for ICU transfer for postoperative care

PREVENTION

- Perform a careful check of the anesthesia machine, ETCO2, CO2 absorbant, and alarms before use
- Maintain adequate ventilation, using appropriate clinical and electronic monitors
- Avoid spontaneous ventilation in patients with lung disease or significant respiratory depressants or when the patient is not in the supine position

COMPLICATIONS

- Respiratory acidosis
- Altered LOC and delayed emergence
- Arrhythmias
- Hypotension/hypertension
- Bradycardia/tachycardia

REFERENCES

- Crisis Management in Anesthesiology