Respiratory Emergencies I-III

Decreased Respiratory Rate and Effort

- Becomes a clinical concern when this leads to hypoventilation
- Hypoventilation is determined by measuring $PaCO_2$ and is NOT a physical exam finding!

Causes

- Respiratory center depression (brain disease vs drugs)
- Cervical spinal cord disease which impairs the phrenic nerve
- Peripheral nervous system disease
- Neuromuscular junction disease (generalized myasthenia gravis, botulism, polyradiculoneuritis)
- Airway muscle weakness

Treatment

- Oxygen therapy!
  - Hypoventilation is a mechanism of hypoxemia but it is responsive to O_2 therapy
- Treat Underlying cause
- +/- positive pressure ventilation

Increased Respiratory Rate and Effort

8 Mechanisms

1. Upper airway disease
2. Lower airway disease
3. Pulmonary parenchymal disease
4. Pleural space disease
5. Thoracic wall disease
6. Abdominal enlargement
7. Pulmonary embolism
8. "look alikes" (pain, anxiety)

Upper Airway disease

Components: Nose, Pharynx, Larynx and the portion of the trachea above the thoracic inlet

Recognizing upper airway disease

- NOISE on inspiration +/- expiration
- Stridor – high pitched, continuous sound

    - Usually associated with laryngeal disease
- Stertor – low pitched, discontinuous sound
    - Usually associated with nasal/pharyngeal type disease

Causes

- Mass lesion
    - Inflammation vs neoplasia
- Foreign body
- Trauma
- Laryngeal paralysis
- Tracheal collapse
- Congenital – BOAS

Medial management

- Oxygen therapy
- Reduce force of inspiration
    - Sedation (Acepromazine, Butorphanol)
- Active cooling
- Treat primary cause!

If you cannot stabilize the patient medically…

- Anesthesia and intubation
- Pre-oxygenation
- Rapid IV induction
- Attempt routine intubation
    - Range of ET tube sizes
    - Stylet

*When the patient is intubated, perform diagnostics and try to treat the primary disease. Long term management may be necessary including specific therapy to reduce edema, laryngeal tieback surgery, and/or a temporary tracheostomy if the disease is rostral to the tracheostomy site, and the treatment of the disease is likely to take days not hours

**If a temporary tracheostomy is performed, it is vital that the owner is able to provide adequate care following the procedure

Lower Airway disease

Components: Intrathoracic airway (intrathoracic trachea, mainstem bronchi, small bronchi and bronchioles)

Difficulty on exhalation!

Clinical Signs

- Respiratory distress
- Cyanosis
- Increased respiratory effort on exhalation (inspiration and exhalation)
- +/- wheezes (likely heard on exhalation)
- +/- crackles (can be heard with both lower airway dz and pulmonary parenchymal disease)

ER Diagnosis

- History
- Physical examination
- Radiographs – bronchial pattern and hyperinflation
- Response to therapy

Treatment

- Minimize stress
- Oxygen
- +/- sedation (helpful with dynamic airway disease; intrathoracic tracheal collapse, bronchial collapse)
- ID exacerbating factor
- Bronchodilators
    - Terbutaline
    - Albuterol
- Allergy/inflammation
    - Glucocorticoids (inhaled vs parenteral)

Pleural Space Disease

Components: Potential space, sub-atmospheric pressure allows for the maintenance of lung expansion, pleural space disease can be due to pulmonary collapse. The result of pleural space disease is hypoxemia

Pulmonary collapse

- Loss of gas exchange units (alveoli)
- Low and no V/Q
- Hypoxemia

Small tidal volume

- PCO_2 controlled by minute ventilation
- RR x TV
- Can increase RR so PCO_2 is likely normal or even low until it is terminal

What can accumulate in the pleural space?

- Air, fluid (transudate, exudate, blood, chyle), and soft tissue

Recognition of pleural space disease

- Increased respiratory rate and effort
- Discontinuous/paradoxical breathing pattern
- Abnormal auscultation
- Thoracic ultrasound
    - Pleural effusion
    - Soft tissue opacity
    - Pneumothorax
        - Loss of a glide sign
        - Etiology: Traumatic vs Spontaneous
        - Traumatic: blunt chest trauma, penetrating chest wound, airway injury, esophageal injury
        - Spontaneous: Pulmonary blebs and bullae, migrating foreign body, neoplasia, abscess, asthma, lung pathology
        - Closed vs open
        - Closed: pulmonary, airway, esophageal
        - Open: Chest wall defect
        - Tension pneumothorax
            - Pleural pressure > atmospheric pressure
            - Rapid deterioration and cardiovascular collapse
- Trauma patient

Treatment

- Oxygen therapy
- +/- sedation (avoid in life-threatening respiratory distress)
- Evacuate the pleural space
    - Thoracocentesis +/- chest tube placement
        - Can be diagnostic and therapeutic
        - Aim to maximally evacuate pleural space
- Treat primary disease

Pneumothorax

Ultrasound Finding: Loss of a glide sign

Etiology: Traumatic vs Spontaneous

- Traumatic: blunt chest trauma, penetrating chest wound, airway injury, esophageal injury
- Spontaneous: Pulmonary blebs and bullae, migrating foreign body, neoplasia, abscess, asthma, lung pathology

Closed vs open

- Closed: pulmonary, airway, esophageal
- Open: Chest wall defect

Tension pneumothorax

- Pleural pressure > atmospheric pressure
- Rapid deterioration and cardiovascular collapse

Closed pneumothorax stabilization

- Oxygen therapy
- Evacuate pleural space
    - Intermittent thoracocentesis +/- thoracostomy tube placement
    - Thoracostomy tube should be placed if intermittent thoracocentesis are inadequate (3 strikes), if there is a pyothorax, or in the case of a post-op thoracotomy
- Treat other conditions
    - Cardiovascular instability?
    - Analgesia?

Spontaneous pneumothorax

*Need to diagnose underlying cause once the patient has been stabilized

- Thoracic rads
- Thoracic CT

Chest wall injury

Diagnosis

- Visual +/- sound (sucking chest wound)
- Small penetrating injuries can be life threatening
- Evaluate both sides of the chest

General approach

- Oxygen therapy
- Appropriate shock resuscitation
- Assess for other injuries
- Analgesia
- If severe, anesthetize and intubate

Rib fractures

- Without an open chest wound, do not generally need anything other than analgesia
- Assess for pneumothorax +/- hemothorax
- Assess for pulmonary contusions
- Analgesia!!!

Flail chest

- Rib fractures of >2 adjoining ribs top and bottom
- Free floating section of chest wall
- Paradoxical movement of segment
- Ensure there is not an open chest wound
- Assess for pneuo/hemo thorax
    - Thoracocentesis
- Assess for pulmonary contusions

Treatment

- Oxygen
- Stabilize flail segments
    - Flail side down, chest wrap
- Thoracocentesis
- Analgesia
- Surgical stabilization

Management of an open chest wound

- If the patient appears to be coping
    - Analgesia
    - Re-establish negative pleural pressure
        - Thoracocentesis +/- chest tube
        - Evacuate pleural space
    - Seal wound +/- surgical repair
- If the patient appears to be struggling
    - Anesthetize and intubate
    - Ventilate

- Keep chest wound open
- Surgical repair

Hemothorax

- Blood in pleural space
  - Trauma, coagulopathy, bleeding neoplastic mass
  - PCV is similar or higher than peripheral PCV

Pulmonary Parenchymal Disease

- Impairs oxygenation ability
- Hypoxemia
  - $PaCO_2 < 80$ mmHg, $SpO_2 < 95\%$
- Severe hypoxemia
  - $PaCO_2 < 60$ mmHg, $SpO_2 < 90\%$

Causes of hypoxemia

1. Low inspired oxygen
2. Hypoventilation – only on room air
3. Venous admixture
   a. No or low V/Q
      i. Low V/Q is responsive to oxygen
      ii. No V/Q is not responsive to oxygen
   b. Anatomic shunts
   c. Diffusion defects

Causes of Pulmonary Parenchymal Disease

- Pneumonia
- Edema
  - Cardiogenic vs non-cardiogenic
- Hemorrhage
  - Trauma, coagulopathy, neoplasia
- Neoplasia
- Anything that can cause alveolar infiltrates on a thoracic radiograph

Recognition

- History
- Physical examination
  - Oxygen

    - Increased respiratory rate and effort
    - +/- crackles on auscultation
    - Concurrent disease
- Inadequate oxygenation (pulse oximetry, arterial blood gas)
- Thoracic radiographs
- ER ultrasound (POCUS)

Therapy

- Oxygen!
    - Goals include PaO_2 of 80-120 mmHg
    - SpO_2 of 95-100%
    - Resolution of respiratory distress
    - Minimize FIO_2 as possible <60%
    - High flow nasal oxygen therapy or PPV
- Sedation
- Specific treatment of primary disease
- +/- Positive pressure ventilation

Pulmonary edema

Cardiogenic vs non-cardiogenic

Cardiogenic = increased hydrostatic pressure due to CHF or volume overload

Non-cardiogenic = Transient increase in hydrostatic pressure due to upper airway obstruction, neurogenic (seizures), electrocution, or abnormal pulmonary vascular permeability seen with ARDS

Acute Respiratory Distress Syndrome

- Result of systemic inflammatory insult to the lungs
    - Occurs secondary to a severe primary disease
        - Peritonitis, pneumonitis, SIRS/sepsis, smoke inhalation, pulmonary contusions, drowning, etc.
    - Alveoli are flooded with proteinaceous fluid and WBCs
    - Microthrombi of pulmonary vessels worsen the V/Q mismatch
- Diagnostic criteria
    - Severe primary disease causing systemic inflammation
    - Acute onset <72h
    - Sever hypoxemia (P/F ratio <400
    - Diffuse alveolar infiltrates on radiographs
    - Not thought to be due to fluid overload/CHF

    - Histopathology is the only way to get a definitive diagnosis
- Treatment
    - Oxygen therapy
    - Positive pressure ventilation
    - Resolve underlying disease
    - Guarded prognosis

Pulmonary Hemorrhage

- Contusions
- Coagulopathy
- Neoplasia

Indications for mechanical ventilation

1. Severe hypoxemia despite oxygen therapy
    a. Lung disease
    b. PPV when PaO_2 is < 60 mmHg despite O_2 therapy
2. Severe hypoventilation despite therapy
3. Excessive breathing effort/concern for fatigue

The “magic” of PPV

- Recruits gas exchange units (opens collapsed alveoli which increases the surface area available for gas exchange)
- Takes over the work of breathing
- Reduces oxygen consumption
- PPV is not directly “fixing the lung”
    - Oxygen can resolve hypoxemia, the ventilation is used to support the respiratory rate and effort (control PCO_2)

Pulmonary embolism

- Pulmonary arterial obstruction
    - Can be a single or multiple obstruction
    - Result: Abnormal gas exchange and pulmonary hypertension

Diagnosis

- Acute respiratory distress and hypoxemia
- Thoracic radiographs
- Primary disease = prothrombotic
    - Neoplasia

    - Hyperadrenocorticism/glucocorticoid Rx
    - Protein losing nephropathy
    - Immune-mediated hemolytic anemia
- Heartworm disease

Treatment

- Oxygen
- Anticoagulation to prevent recurrence
- +/- thrombolysis therapy (tissue plasminogen activator)
- Resolve underlying disease