Pulmonary Problems of the Neonate

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Lower Respiratory Diseases

- Ventilation/Perfusion Abnormalities
- Pneumonia
- Secondary pulmonary disease
Ventilation/Perfusion Abnormalities

- Mismatching
- Shunting
  - Retention/ reversion to fetal physiology
- Hypoventilation
- Progressive atelectasis
Ventilation/Perfusion Abnormalities

- **Mismatching**
  - Uneven perfusion
    - Poor cardiac output
    - Poor vascular reactivity to oxygen?
  - Uneven ventilation
    - Body position
    - Weakness
    - Fatigue

- **Hypoventilation**
  - Fatigue
  - Central weakness
  - Upper airway disease
V/Q Mismatching

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Ventilation/Perfusion Abnormalities

- **Fetal to neonatal cardiopulmonary physiology**
  - Delayed transition
    - Many not occur at birth
    - May not occur for 12 hr
    - Few signs noted (ABG)
      - Tachypnea - normal
  - Failure transition
    - Persistent Pulmonary Hypertension
      - Idiopathic
    - Congenital interstitial pneumonia
    - Congenital heart defect
Ventilation/Perfusion Abnormalities

- **Reversion to fetal circulation**
  - Induced pulmonary hypertension
    - Severe sepsis
      - Pulmonary vasoconstriction
  - Significant acidosis
  - Significant hypoxemia
- Marked systemic hypotension
  - Severe sepsis
    - Systemic vasodilation
- Both may play a role
  - After normal birth systemic and pulmonary BP similar
Ventilation/Perfusion Abnormalities

- Reversion after birth caused by
  - Hypoxemia
  - Inflammatory mediators
  - Systemic hypotension

- Reversion as a safety net

- Neonatal period dangerous
  - Full decrease in pulmonary resistance
    - May take 2-3 weeks
  - Ductus arteriosus/ foramen ovale remain patent
  - Increases pulmonary resistance/ decreases systemic pressure
    - Increase right to left shunt fraction
    - Significant hypoxemia
## Right-to-Left Shunt

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Arabian Colt

- 48 hr old foal
- Weak, needed assistance rising
  - But able to ambulate
- Tachycardic and tachypneic
- Dysphagic (milk out nose)
- At 48 hr noticed blue mucous membranes
Right-to-Left Shunt

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Hypoventilation

- **Hypoventilation** = increased \( \text{Paco}_2 \)
  - Casually misused “decreased respiratory rate”
- **Decreased alveolar ventilation**
  - Depressed respiratory center
    - Neonatal Encephalopathy
    - Phenobarbital therapy
    - Head trauma
    - Sepsis
  - Neuromuscular disease
    - Spinal cord injury
    - Botulism
  - Respiratory muscle fatigue
    - Weak foal
    - Stiff lungs
Hypoventilation

- **Decreased alveolar ventilation**
  - Limitation movement thorax or lungs
    - Fractured ribs
    - Pneumothorax/ hemothorax
    - Diaphragmatic hernia
  - **Pulmonary Disease - decreased compliance**
    - Atelectasis
    - Pneumonia
    - Surfactant?
    - Obstructive lesions - increased rz
      - Pharyngeal collapse
Progressive Atelectasis

- **Unable to maintain FRC (Functional Residual Capacity)**
  - Weakness/compliant chest wall
  - Stiff lungs
- **Some alveoli collapse on exhalation**
  - Repetitive collapse - eject surfactant
  - Some alveoli don’t reopen
  - Closed alveoli pull on others
    - More alveoli close
- **Decreased compliance**
  - As more atelectasis
  - Causes more fatigue
- **Self-perpetuating**
Wave Chest Fatigue

- No longer be able to hold the chest open
- Inspiration
  - Diaphragm contracts
  - Chest wall pulled towards the lungs
  - Abdomen expands
- Expiration
  - Diaphragm relaxes
  - Chest wall moves out
  - Abdomen moves in
- Significant fatigue
  - Respiratory failure
  - Respiratory/cardiac arrest
- Sleeping neonate
Progressive Hypercapnia

- **Paco₂ > 60 mmHg (acidotic)**
  - Release catecholamines
    - Increased in CO
    - Increase BP
- **Catecholamine**
  - Maximum catecholamine response
    - With Paco₂ = 80
  - Marked tachypnea
Progressive Hypercapnia

- **Paco$_2$ > 80 ... 90 ... 100**
  - CNS depression
  - Myocardial depression
  - Slow RR
  - They look better

- **Severe hypercapnia**
  - Respiratory arrest
  - Cardiac arrest
  - Death

- **Treatment**
  - Mechanical ventilation
  - Methylxanthines (caffeine)
  - Doxapram
Positive Pressure Ventilation
Infectious Pneumonia

- **Septicemia**
  - Primary pulmonary infection
    - Usually GI invasion
    - Localize diffusely in lungs
  - Systemic infection
    - Bacteremia
    - Secondary localize in lungs
- **Bacterial**
  - Hematogenous colonization
    - Usually opportunists - variety of pathogens
    - Nosocomial - multiply resistant
Infectious Pneumonia

- **Bacterial**
  - Aspiration
    - Often mixed infections
    - Usually opportunists - variety of pathogens
    - Nosocomial - multiply resistant
- **Fungal**
  - Candida
    - Usually multifocal
      - Pneumonia common
      - Hyperkeratotic tongue surface
      - Esophageal, intestinal lesions
      - Joint infections
    - Can be primary or secondary
  - Aspergillus
- **Viral pathogens**
  - Herpes Virus
  - Equine Viral Arteritis virus
  - Equine Influenza virus
Aspiration Pneumonia

- May or may not be symptomatic
- Lung changes caudal heart base
  - Except foals in lateral recumbency when they aspirate
- Signs
  - Respiratory effort and rate are increased
  - Pneumonic sounds
    - Referred upper airway sounds
  - Apneustic breathing pattern
  - Radiographs or ultrasound examination
  - Hematology and blood fibrinogen
- Mixed bacterial flora expected
- Prognosis
  - Most important factor - stopping aspiration
Meconium aspiration

- **Rare**
  - **Before birth**
    - Associated with asphyxia
    - Fetal gasping
  - **During delivery**
    - Liquid meconium - upper airways
- **Diagnosis**
  - Stained nasal discharge
  - Radiographic changes
- **Signs**
  - Persistent tachypnea
  - Inflammatory hemogram
  - No bacterial infection
    - Persist up to a week or longer
    - Tachypnea and hyperfibrinogenemia
    - May be no radiographic/US changes
  - Secondary bacterial infections
Birth Trauma
Secondary Pulmonary Disease
Traumatic Pulmonary Disease

- Fractured ribs
  - Pulmonary contusions
  - Pulmonary/Plural hemorrhage
  - Lacerations of major arteries
  - Pneumothorax
  - Traumatic diaphragmatic hernia

- Pleuritis and pleural effusion
Rib Fractures
Physical Examination

• 2 - 4 cm above costochondral junction
• Involving 4 to 12 ribs in a straight line
• Any rib or set of ribs may fracture
  o Most frequently anterior chest (ribs 2-8)
• Over the heart
• Palpation - feeling click
• Auscultation - click associate with heartbeat
• Easily confirmed on radiographs
  o Ultrasound?? - needs to be done carefully
Rib Fractures
Hemorrhage

- Primarily bleeding from intercostal arteries
- Most often diffuse chest wall
  - Can be subpleural
  - Can develop hemothorax
- May be extensive - not evident externally
- Lung contusions - hemothorax
- Lacerations of the myocardium
  - No pericardial damage - Cardiac tamponade
  - Arrhythmias
- Trauma to other structures
Rib Fractures
Clinical Signs

• **Signs are variable**

• **From pain, anemia, cardiac arrhythmias**
  - Tachycardia
  - Tachypnea

• **Positional**
  - Exacerbated during examination
  - Exacerbated when down
  - Weak, minimally responsive foal
    - Distressed when on one side - relief when turned
    - Exacerbated of hypotension when turned
Secondary Pulmonary Disease
Abdominal Hypertension

- Abdominal hypertension
  - Ruptured bladder
  - Intestinal distension
    - Acute enteritis
    - Ileus
- Decreased pulmonary blood flow
- Increased atelectasis
- Decreased compliance
- Increased mismatching/shunt fraction