Anatomy of the Respiratory System

Upper Respiratory Tract:
- Nostrils, nasopharynx, Eustachian tubes, sinuses, larynx and upper trachea

Lower Respiratory Tract:
- Lower trachea
- Bronchi
- Right & Left Lung

Lower Respiratory Tract

- Three right lobes separated by a minor fissure
- Right main stem bronchus is shorter and wider
- More common to find foreign body
- Two left lobes separated by a major fissure
- Diaphragm is main muscle of respiration
- Accessory muscles: intercostal, sternocleidomastoid, spinal, neck and abdominal muscles
Anatomic & Physiologic Differences within the Pediatric Respiratory Tract

Factors Placing a Child at Risk for Respiratory Disease
- Premature birth
- Smoking within the home
- Maternal smoking during pregnancy
- Ill contacts (like Day Care or School)
- Altered immune mechanisms
- Chronic illnesses
- Congenital defects with respiratory association

Pertinent History
- Onset of symptoms
  - What day and time
- Key signs & symptoms
  - Shortness of breath
  - Noisy breathing
  - Cough
    - Type
    - Sputum production
### History

- Intensity/Progression of the symptoms
  - Worsening
  - Acute (less than three weeks)
  - Chronic (greater than 3 weeks)
  - Recurrent (symptom free at least 2 days in past weeks)
- Associated symptoms
  - stomach ache
  - ear ache
  - illnesses in past

### History

- Treatment currently being used
  - Any Over the Counter medications
  - Prescriptions
  - Home remedies

### History

- Environmental factors
  - Smoking in the home (Keep in mind adolescents)
  - Pets
  - Other new exposures
- Seasonal allergies
- Exercise related symptoms
- Birth/ Family History
Physical Examination

Vital Signs

- ↑ respiratory rate -- key indicator of lower respiratory involvement
- Remember – lowering temp may bring other vital signs into normal range

Normal Respiratory Rates

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Respiratory (breaths/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1</td>
<td>25-40</td>
</tr>
<tr>
<td>1-5</td>
<td>20-30</td>
</tr>
<tr>
<td>5-10</td>
<td>15-25</td>
</tr>
<tr>
<td>10-16</td>
<td>15-20</td>
</tr>
</tbody>
</table>
Respiratory Distress

- Resting respiratory rate > 60 breaths/min in infants < 2 months of age
- Resting respiratory rate of greater than 50 breaths/min in infants 2-12 months of age
- Resting respiratory rate of greater than 40 breaths/min in children 1-5 years

General Appearance

- Nasal flaring
- Position of comfort
- Level of anxiety
- Affect
- Color

Inspection

- Thoracic deformities or asymmetry
- Nasal flaring, mouth breathing
- Use of accessory muscles
- Retractions
Inspection of other body areas

- Respiratory Rate: Note depth, ease and rhythm
- Fingernails and nail beds for cyanosis
- Clubbing of fingers…related to decreased perfusion

Palpation

- Paranasal & frontal sinuses
- Chest & Abdominal configuration
- Areas of tenderness over the chest wall
- Lymph nodes for any enlargement

Transmitted Voice

- Tactile Fremitus…Ask the child to say “99” as you use the bony part of your palm to palpate the vibrations it makes through the anterior/posterior lung fields
  - Decreased sensation with asthma
  - Often absent in a collapsed lung
  - Increased over a consolidated area
Respiratory Expansion

- Place thumbs at base of lungs posteriorly.....placing your hands alongside the rib cage. Ask the child to inhale, as you observe how your thumbs separate & diverge.
- Feel for range of divergence and symmetry-abnormal in children with pneumonia, cystic fibrosis, etc.

Percussion

- Goal:
  - Transmit vibrations through the bones in the tapped finger to the underlying chest wall....
  - Should be brisk, bouncy....

Percussion

- Resonant: Normal lung-low pitch, loud.
- Hyper-resonant: Very loud booming (child’s lung); present with asthma
- Dullness: over a density such as liver; Pneumonia-medium pitch, medium intensity & duration
- Flat: can be noted over bone-scapula; Pleural effusion-high pitched, soft, short
- Tympanic: can be noted over stomach; Pneumothorax- high pitched, loud
Auscultation

Use of stethoscope

- Diaphragm: High pitched sounds (better in measuring normal and abnormal lung sounds)
- Bell: Low pitched sounds

Auscultation

Correct Technique

- Placing bell or diaphragm against chest wall.
- Keeping noise level down.
- Attempting to have child upright to access all areas for auscultation

Errors

- Listening to breath sounds over clothing
- Auscultating in a noisy room
- Auscultating only convenient areas

Auscultation

- Note:
  - Symmetry of breath sounds
  - Normal?
  - Increased?
  - Decreased?
  - Adventitious sounds = extra sounds
Cough

- Become familiar with the characteristics of the various types of coughs
- Ask the child to cough during the examination
- Different kinds of cough associated with common and not so common respiratory conditions

Abnormal Inspiratory/Expiratory Ratio

- Expiration is prolonged in asthma due to air trapping (called hyperinflation)
- As a result, the inspiratory/expiratory ratio is often 1:2 (expiration is more than twice as long as inspiration.)

Abnormal or Adventitious Lung Sounds

- Crackles:
  - Intermittent, brief, non-musical type sounds
  - Fine Crackles: soft, high pitched & brief
  - Coarse Crackles: louder, lower in pitch & not very brief
Abnormal or Adventitious Lung Sounds

- **Wheezing:**
  - Musical
  - Continuous sounds
  - High pitched
  - Shrilling quality

Abnormal or Adventitious Lung Sounds

- **Rhonchi:**
  - Musical,
  - Continuous sounds, Low pitched
  - Similar to snoring

Abnormal or Adventitious Lung Sounds

- **Stridor:**
  - Continuous, sharp inspiratory noise (often associated with croup)

- **Grunting:**
  - Episodic, short respiratory sound
### Clinical implications

- **Crackles:** May suggest pneumonia, bronchitis or congestive heart failure.
- **Wheezing:** Suggests constricted or narrow airways as in asthma or bronchiolitis.
- **Rhonchi:** Indicate secretions within the large airway (upper respiratory congestion).

### Coughs

- **Sinusitis:** Productive, night and day, worse when first laying down and on awakening.
- **Bronchitis:** Dry, then loose and rattling cough.
- **Pneumonia:** Often loose cough.
- **Asthma:** Dry, tight, occasionally wheezy.
- **Pertussis:** Spasmodic, choking, repetitive (no inspiration during coughing spasm).
- **Croup:** Seal-like bark.

### Common Respiratory Illnesses

- **Upper Respiratory Tract**
  - Upper respiratory infection
  - Sinusitis
  - Foreign body of the airway
  - Pharyngitis (viral, bacterial) & Tonsillitis
  - Pertussis
- **Lower Respiratory Tract**
  - Bronchitis
  - Pneumonia
  - Asthma
Airway Obstruction

Airway Obstruction - Symptoms
• Wheezing
• Repetitive hacking cough, often ineffective
• Dyspnea
• Post-tussive vomiting
• Cyanosis

Obstruction – Physical Findings
• Diminished chest excursion
• Prolonged expiratory phase
• Increased respiratory rate
• Increased airway resistance; over-inflation of lungs; barrel chest
• Percussion over inflated chest hyper-resonance
• Increased use of accessory muscles
Allergic Rhinitis

- Can significantly interfere with Quality of Life
- Affects important social interactions
- Affects school performances
  - Decreased attention
  - Increased difficulty with cognitive skills due to combination of medications and symptoms

Allergic Rhinitis - Treatment

- Allergen identification
- Environmental controls
- Stepwise approach similar to asthma (modify based on symptoms)
- Intranasal steroids are most effective
- Antihistamines
- Immunotherapy if indicated
Sinusitis

Sinus Development

- Maxillary – 3rd to 4th month fetal gestation
- Ethmoid – birth
- Sphenoid – 5 years
- Frontal – 7-8 years (fully developed by age 20)

Risk Factors

- Frequent viral infections
- Environmental allergies
- Allergic rhinitis
- Smoke exposure
- Day care
- Gastroesophageal Reflux
Sinusitis - Characteristics

- Inflammation of mucous membranes that line the sinuses
- Interferes with normal sinus drainage
- Air and mucous become trapped
- Bacteria multiplies

Symptoms

- "Cold" lasting more than 2 weeks
- Thick yellow/green discharge
- Post nasal drip
- Sore throat especially in AM

Symptoms

- Usually no headache/toothache
- No facial tenderness
- Swelling around eyes
- Appearance of conjunctivitis
- Irritability or fatigue
Microbiology

- Principal pathogens
  - Streptococcus Pneumoniae 30%
  - Haemophilus influenzae 20%
  - Moraxella Catarrhalis 20%

Treatments

- Imaging studies not recommended <6 years
- CT scan sometimes necessary for severe disease

Prevention

- Vaccinations
  - Hib
  - Prevnar and/or Pneumovax
  - Environmental Controls
  - Nasal Saline Washes/sprays
  - Nasal steroids
Asthma -- Characteristics

• A Chronic inflammatory disease of the airways
• Characterized by
  • Episodic wheezing
  • Episodic coughing
  • Chronicity
  • Hyper-responsiveness of airways to a variety of stimuli
  • Largely reversible obstruction of the airways

Asthma - Physical Findings

• Dyspnea, labored breathing
• Retractions
• Cough, restlessness, apprehension and fatigue
• Cyanosis of lips, nail beds, gums
• Tachycardia
Asthma - Physical Findings

- Physical Signs
  - Prolonged expiratory phase
  - Wheezing & Rhonchi
  - Increased Obstruction: High pitched; breath sounds diminished
  - In severe obstruction, breath sounds may be silent because of poor air exchange

Asthma - Physical Findings

- Dullness to percussion over the area of consolidation
- Decreased breath sounds
- Tactile Fremitus increased
- Crackles suggest pneumonia occasionally wheezing

HFA Bronchodilators
Current Albuterol Formulations

• Ventolin HFA – with built-in dose counter
• Proventil HFA
• ProAir HFA
• Combivent – (Albuterol and Atrovent)
• Xopenex HFA - Levalbuterol

Long-Term Control

• Taken daily, over a long period of time

• Used to reduce inflammation, relax airway muscles, and improve symptoms and pulmonary function
  • Inhaled corticosteroids
  • Long-acting beta2-agonists
  • Leukotriene modifiers

Inhaled Corticosteroid and Combination Therapies in MDIs
Long Term Control: Inhaled Corticosteroids

- Fluticasone (Flovent)
  - 3 different strengths, all orange
- Budesonide (Pulmicort)
- Ciclesonide (Alvesco)
- Mometasone (Asmanex)
- Beclomethasone (QVAR)
- Flunisolide (Aerospan) New in 2014
- Fluticasone furoate (Arnuity Ellipta) New in 2015

Flunisolide (Aerospan)

- Similar molecule to Aerobid
- Spacer attached
- Covered by private insurance with $25 co-pay
- Approved for ages ≥ 6
- Now covered by Mass Health

Fluticasone furoate (Arnuity Ellipta)

- Once daily therapy
- Dry Powder
- Available in 100mcg and 200mcg
- Approved for ≥ 12 years old
Long-acting Beta2 Agonists

- Relax bronchial smooth muscle
- Available as DPI
- 12 hour duration of action
- Most effective when in combination with inhaled steroids (not mono therapy)
- Effective control for nocturnal symptoms

Combination Inhaled Corticosteroids and Long Acting Beta Agonists

Advair
- Fluticasone/salmeterol
- MDI or Discus
- Approved for 6 years and older

Symbicort
- Budesonide/Formoterol
- MDI – requires a spacer
- Approved for ≥ 12 y.o

Dulera
- Mometasone/Formoterol
- MDI – requires a spacer
- Approved for ≥ 12 y.o

Breo
- Fluticasone/Vilanterol
- Approved for ≥ 18 y.o.

Leukotriene Modifiers

- Montelukast (Singulair) – Once daily tablet, chewable, & sprinkles
  - Approved for ages ≥ 1 year
  - 4 mg, 5 mg, 10 mg
  - Black Box Warning

- Zafirlukast (Accolate) – Twice daily tablet
  - Ages ≥ 5 years
  - Requires routine monitoring of Liver function

- Zileuton (Zyflo) – BID or QID
  - ≥ 12 years
  - Requires routine monitoring of Liver function
Omalizumab (Xolair)

Indications for Xolair
- 12 years or older
- Moderate or Severe Persistent Asthma
- Positive skin test
- Poor control on inhaled steroids
- IgE levels are 30-700 IU/ml

Mepolizumab (Nucala)
- Add-on maintenance treatment
- ≥ 12 years old, with severe asthma
- Reduces blood eosinophils, which may contribute to asthma
- 100 mg subcutaneous injection every 4 weeks
Reslizumab (Cinqair)

- Add-on maintenance treatment
- ≥ 18 years old, with severe asthma
- Reduces blood eosinophils, which may contribute to asthma
- IV infusion, 3 mg/kg, every 4 weeks, over 25-50 minutes

Reasons for Poor Control

- Wrong Diagnosis
- Poor adherence to recommended Treatment
- Under estimation of Asthma Severity
- Co-morbidities
  - Obesity
  - Gastroesophageal reflux
  - Mental illness

Follow up

- Visits every 2-6 weeks until control is achieved
- Are adjustments necessary?
  - Before increasing meds, consider
    - Environment
    - Adherence
    - Co-morbidities
  - Step up if not controlled
  - If poor control, consider increasing by 2 steps, oral corticosteroids, or both
Follow up

- When follow up is achieved, contact every 3 – 6 months

General Guidelines for Referral to an Asthma Specialist

- Patient has had a life-threatening asthma exacerbation.
- Patient is not meeting the goals of asthma therapy.
- Signs and symptoms are atypical.
- Other conditions complicate asthma.
Asthma Action Plans

- Describe regular medications and measures
- Describe actions to take when asthma worsens
- Asthma severity classification
- School Nurse permission form

Website for 2007 NHLBI guidelines

- www.nhlbi.nih.gov/guidelines/asthma

Asthma/Allergy Connection

- Treatment of one disease improves the other
- Allergen immunotherapy lowers risk of asthma
Asthma Management

1. Education of patient / family
2. Pharmacological approaches
3. Identify and eliminate or decrease exposure to allergens
4. Allergen immunotherapy

Guideline for Management of Ambulatory Asthma Patients

Patient (2-25 years) presents in clinic with wheezing or SOB

Triage assessment by RN/NP/MD

Is patient in Severe Respiratory Distress? (Emergent)
- Color pale to cyanotic
- Severe Dyspnea
- Inaudible breath sounds
- Altered mental status

Provide supplemental oxygen
Immediate transport to ED via wheelchair by RN/NP/MD or call Code Blue ED charge nurse (5-1800) and expect line (5-2170) called by another clinician

Is patient in Moderate Respiratory distress? (Urgent)
- Moderate Dyspnea
- Inspiratory &/or expiratory wheezes
- Moderate retractions

Neb #1 – Albuterol 0.5%, 0.5ml in 2ml NS
Steroids (prednisone/prednisolone) if incomplete response to 1st Neb or sooner if clinically indicated (Patients ≤ 40 kg: 2 mg/kg; Patients > 40 kg: 40-80 mg x 1 dose)
Neb #2 – Albuterol 0.5%, 0.5mL in 2 mL NS or combination of Albuterol and Ipratropium 0.02% neb (infants and children less than 12 y/o: 250 mcg; children >/=12 y/o 500 mcg)

Is patient in Moderate Respiratory distress after receiving ≥ 2 Nebs?

Call ED Charge nurse (5-1800) and expect line (5-2170) Transport Patient to ED Discharge home

Is patient in Mild Respiratory distress? (Non-Urgent)
- Mild Dyspnea
- None or end expiratory wheezes
- None or mild retractions
- O2sat (RA) ≥ 95%

Yes
No
Yes
No
Yes

Consider Albuterol MDI with spacer or Neb
Continue to monitor or transfer – per provider’s clinical judgment

Risk Factors for Asthma Deaths

- Previous life-threatening asthma, respiratory arrest
- Hospitalization or emergency room visit for asthma within the past year
- Use of two or more Beta agonist, metered dose inhalers (Albuterol) each month
- Poor perception of hypoxia or airway obstruction
- Psychosocial disturbances, obesity, drug abuse

© Updated May 2013
**Gastroesophageal reflux**

- Worsens asthma symptoms
- Most likely minor aspiration component
- Inflammation/swelling of esophagus may cause pressure on main bronchus complicating asthma symptoms

**Reflux Symptoms**

- Coughing after meals
- Coughing with reclining
- Nausea after meals
- Bad taste in mouth
- Complaints of stomach aches
- Not usually heartburn symptoms
- UGI usually normal

**Management of Reflux**

- Medications
- Timing of meals
  - No food before bedtime
- HOB elevated
- Avoidance of trigger foods
- Referral to GI specialist
Pneumonia

- Caused by infectious agents which invade the lungs, creating an inflammatory response....loss of air and consolidation

Pneumonia - Characteristics

- Cough
  - Day & night
  - Often productive-yet not noticed since children swallow mucus

Pneumonia – Physical findings

- Chest pain (often a complaint of older children)
- Tachypnea
- Retractions
- Nasal Flaring
- Cyanosis
### Cystic Fibrosis - Characteristics

- Autosomal recessive genetic disorder
- Inadequate salt and water secretion on the cellular level
- Inability to clear mucoid secretions
- Inability to clear secretions from endo-bronchial spaces-leads to colonization by bacteria and results in chronic inflammation

### Cystic Fibrosis - Physical Findings

- Increase cough
- Increase sputum production
- Decreased breath sounds
- Inspiratory and Expiratory crackles
- Shortness of breath
- Fatigue
- Tachypnea

### Bronchitis - Characteristics

- Inflammation of the bronchus main stem-combined with concurrent or lower respiratory tract infection
- Usually preceded by a viral URI
Physical Exam Findings

- Low grade or no fever
- Nasopharyngeal infection-conjunctivitis and rhinitis
- Coarse breath sounds
- Rhonchi-high pitched and resemble wheezes

Pertussis

- Commonly known as “whooping cough”
- High-pitched inspiratory whoop
- Highly contagious in young children
- Caused by Bordetella pertussis, Bordetella parapertussis, Bordetella bronchiseptica
- Transmitted via aerosol droplets from close contact

Pertussis - Physical Findings

- Catarrhal Stage- 1-3 weeks
- Mild cough, sneezing and fever
Pertussis - Physical Findings

- Paroxysmal Stage- 2-4 weeks
- Persistent staccato, paroxysmal cough ending with inspiratory whoop
- Vomiting at end of paroxysmal cough and whoop
- Cyanosis, sweating, exhaustion after coughing

Pertussis - Physical Findings

- Convalescent Stage- 2-3 weeks
- Waning of paroxysmal coughing episodes

Deformities of the Thorax
Pectus Excavatum
Depression in the lower sternum; “Funnel Chest”. Usually only cosmetic…..but if very pronounced, it can restrict lung capacity.

Pectus Carinatum: Upper ribs bending inward and the sternum is being thrust outward (more anteriorly)…also called pigeon breast.

Scoliosis – Curving of the spine
One shoulder may seem higher than the other.
**Kyphosis** -- curving of the spine that causes a bowing of the back, such that the apex of the angle points backwards leading to a hunchback or slouching posture.